WILL ECONOMY GET SICK WHEN THE WEATHER IS TOO HOT?

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DECLARATION

We hereby declare that:

(1) This undergraduate FYP is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this FYP has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the FYP.

(4) The word count of this research report is 17799.

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LIST OF ABBREVIATIONS

2SLS	Two-Stage Least Squares
ARDL	Autoregressive Distributed Lag
AR (1)	Arellano-Bond test (1)
AR (2)	Arellano-Bond test (2)
CO_2	Carbon Dioxide
DICE	Dynamic Integrated model of Climate Economy
FDMA	Fire and Disaster Management Agency
FEM	Fixed Effect Model
EGMM	Effective Generalized Method of Moments
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GHG	Green House Gas
GMM	Generalized Method of Moments
IAM	Integrated Assessment Model
LAB	Labour Force
LCA	Life Cycle Assessment
MIC	Ministry of Internal Affairs and Communications
OLS	Ordinary Least Square
PREC	Precipitation
R&D	Research and Development
SSA	Sub-Saharan Africa
TO	Trade Openness
TEMP	Temperature
VECM	Vector Error Correction Model
WDI	World Development Indicator

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PREFACE

This research is submitted to partially fulfil the requirement of Bachelor of Finance (HONS). This research is supervised by Dr. Yiew Thian Hee.

Extreme climate change can cause some disaster which might bring huge losses to economic growth. On the other hand, climate change also brings benefit towards the economic growth. Therefore, climate change becomes one of the factors that influence the economic growth and it must be investigated.

This research will determine the impact of climate change towards economic growth. The major findings for this research show non-linear impact of climate change towards economic growth in overall and developing countries. Meanwhile, the developed countries do not have non-linear impact of climate change towards economic growth.

ABSTRACT

The purpose of this research is to determine the impact of climate change towards economic growth in overall, developed and developing countries which total are 166 countries from year 1990 to 2016. This research applies GMM estimator to capture the dynamic effect of data and deal with endogeneity problem. System and Difference GMM apply in this research to run the empirical test. The result shows mixed impact of climate change towards economic growth in overall, developed and developing countries. The major findings for this research show non-linear impact of climate change towards economic growth in overall and developing countries. Meanwhile, the developed countries do not have non-linear impact of climate change towards economic growth.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

Chapter one provided an outline of the research. Research background, problem statement, research objectives, research questions and significance of study are included in this chapter. The main objective of this research is to examine the impact of climate change which are temperature, precipitation and carbon dioxide emission on economic growth in overall, developed and developing countries. In this research, overall countries are combination of developed and developing countries. Besides, the controlled variables used are gross fixed capital formation, trade openness and total labour.

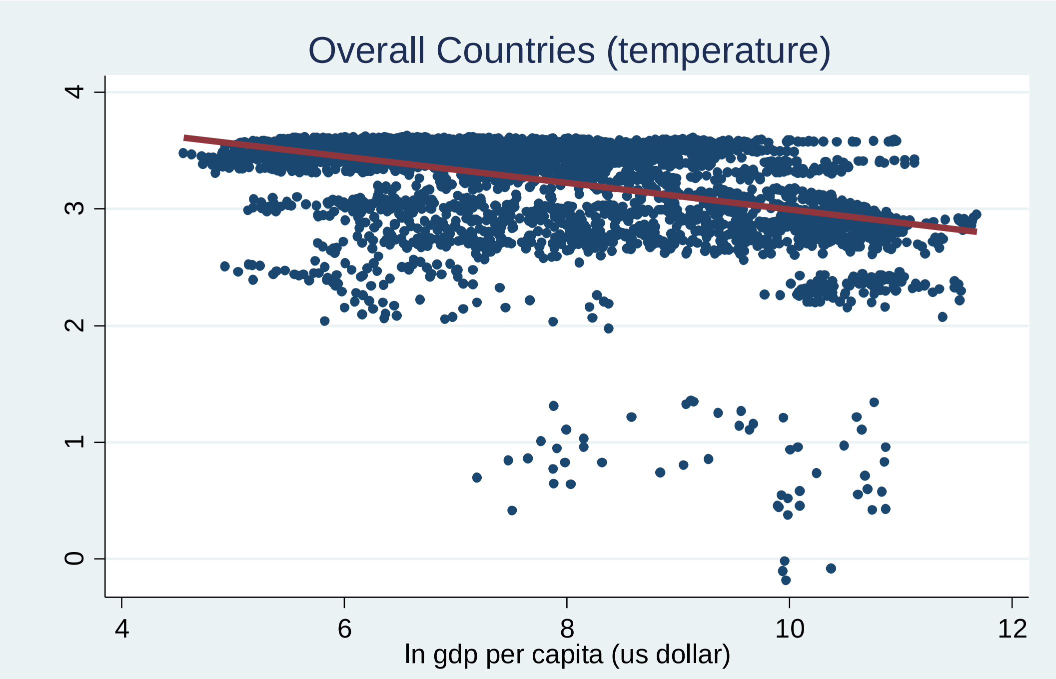
1.1 Research Background

The air, water and land as the natural resources of our planet are all related to climate change, as these factors are the indicators to determine the Earth's climate (Dell, Jones & Olken, 2008). In simple words, climate change referred to a long term significant alteration in global climate. For instance, climate change in a country can be illustrated from rising temperature, changing the pattern of precipitation and the amount of carbon dioxide emission. Generally, one of the most discussed climate change is global warming. Global warming is defined as a gradual increase in temperature in the Earth's atmosphere and it is one of the greatest concern by the climate scientists and they found out that economic growth has been affected (Ali, Ying, Nazir, Ishaq, Shah, llyas & Tariq, 2019). This is because extra heat energy has added into the system of global climate and it has caused several significant effects. For example, the glacier melted in Himalaya due to increasing in temperature and sea level will increase which was predicted to increase river swelling, flooding and rock avalanches (Sharma & Sharma, 2008). Moreover, an increase in the temperatures will lead to potential storms due to warmer sea-surface temperatures (Chen, Wilson & Tapley, 2013). As a result, climate change has always become the greatest environmental threat toward humanity and it has been categorized as the “mother” of all problems (Griffin, 2003).

Notably, the pace of climate change is accelerating in the most recent decades (Zhang, Lee, Wang, Li, Pei, Zhang & An, 2011). In recent years, more and more climate scientists have pointed out that the problems of climate change are non-negligible and the impacts on economic growth are getting more serious. Thus, what evidence showed that economic growth is affected by climate change? The scatter plots below have shown the impact of climate change on economic growth visually and obtained a brief expectation on the impact of climate change.

Figure 1.1:

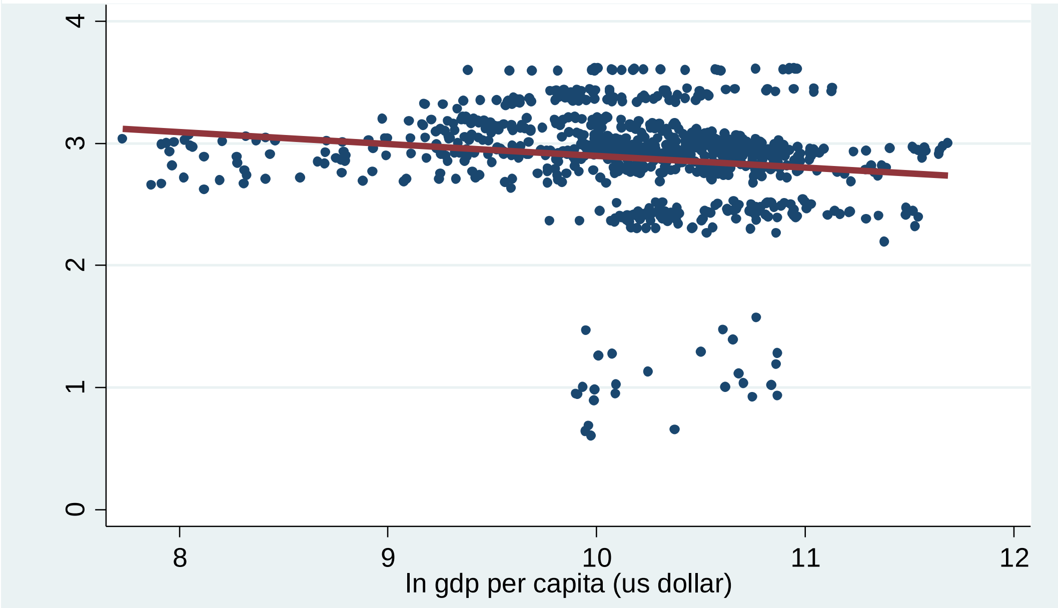
The impact of temperature on economic growth in overall countries (166 countries)



Note. Adapted from World Development Indicator (2020)

Figure 1.2:

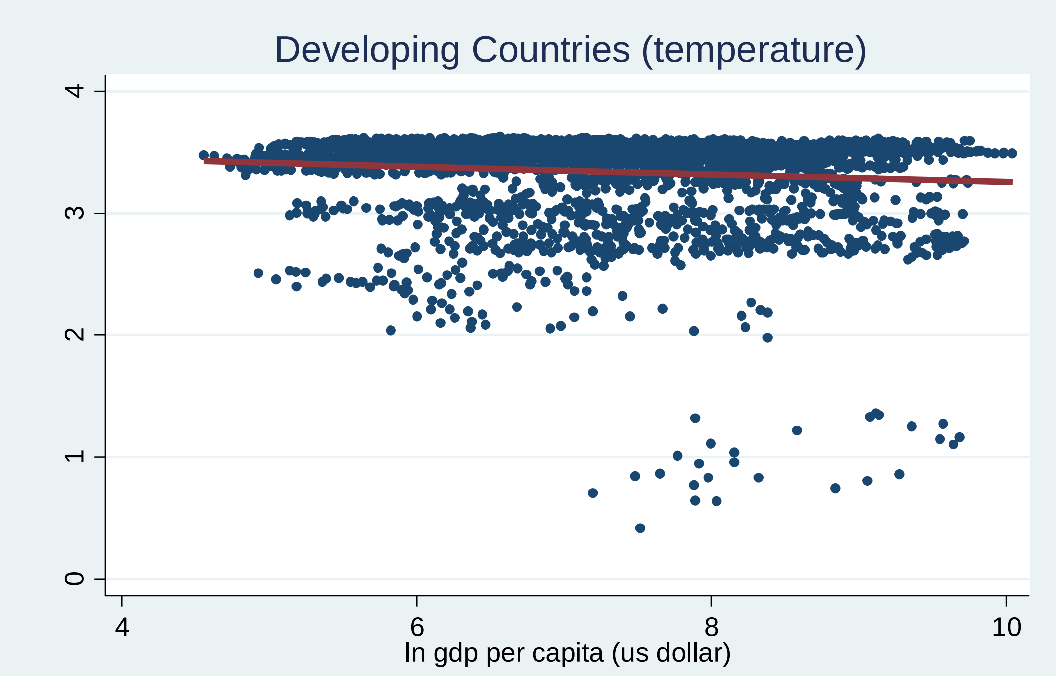
The impact of temperature on economic growth in developed countries (31 countries)



Note. Adapted from World Development Indicator (2020)

Figure 1.3:

The impact of temperature on economic growth in developing countries (135 countries)

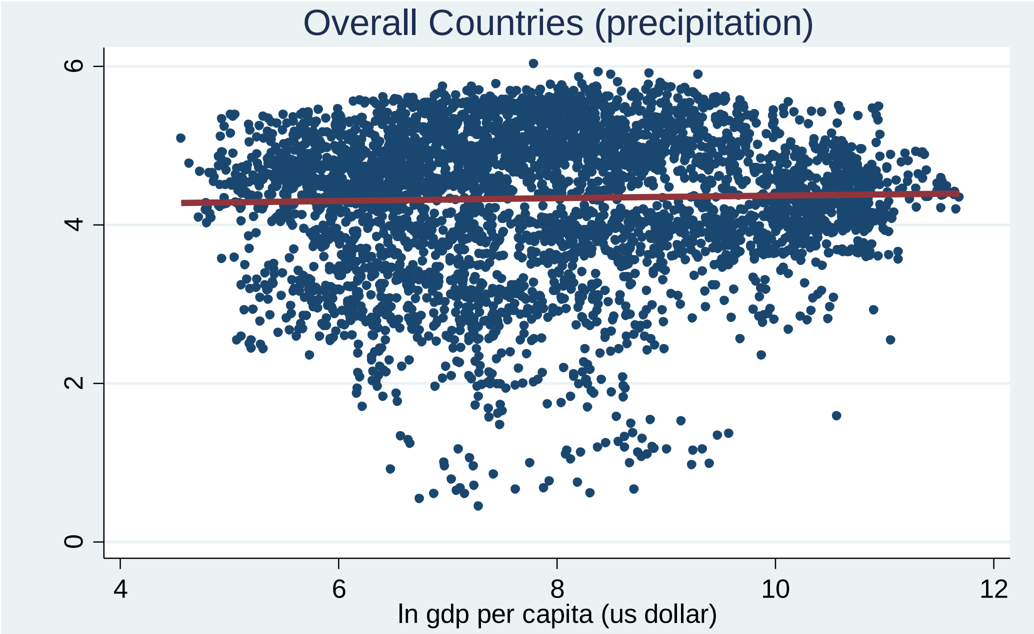


Note. Adapted from World Development Indicator (2020)

The scatter plots in Figures 1.1, 1.2, 1.3, showed that higher temperature countries have lower GDP per capita. Besides, the results showed that as the temperature increases, GDP per capita will decrease. It demonstrated that temperature has significant negative impact on economic growth (Jones & Olken, 2010).

Figure 1.4:

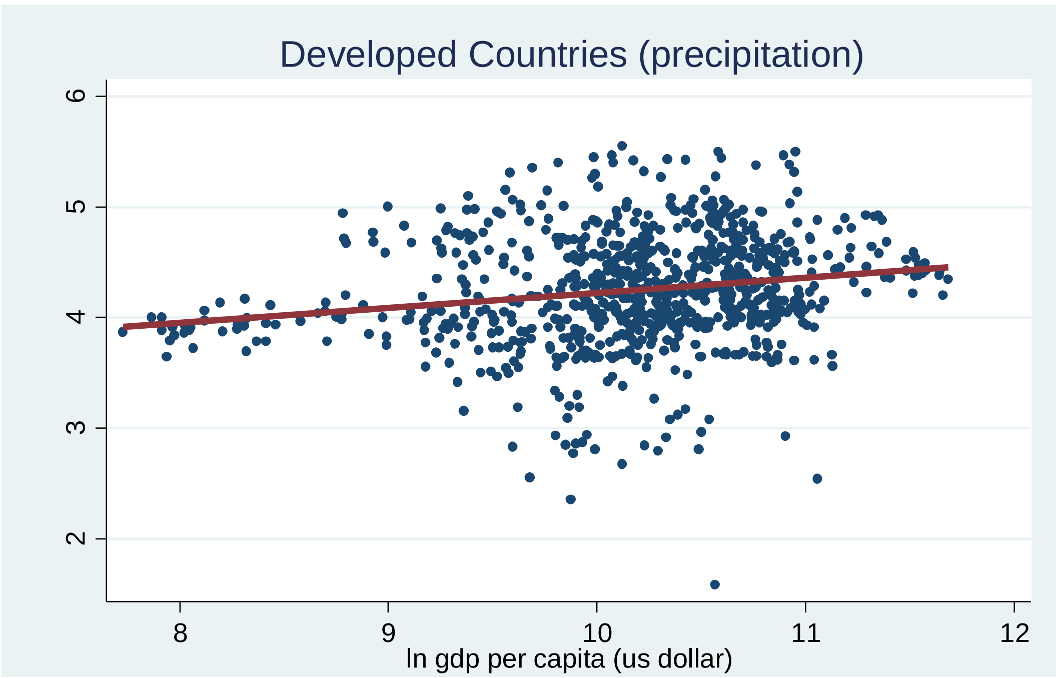
The impact of precipitation on economic growth in overall countries (166 countries)



Note. Adapted from World Development Indicator (2020)

Figure 1.5:

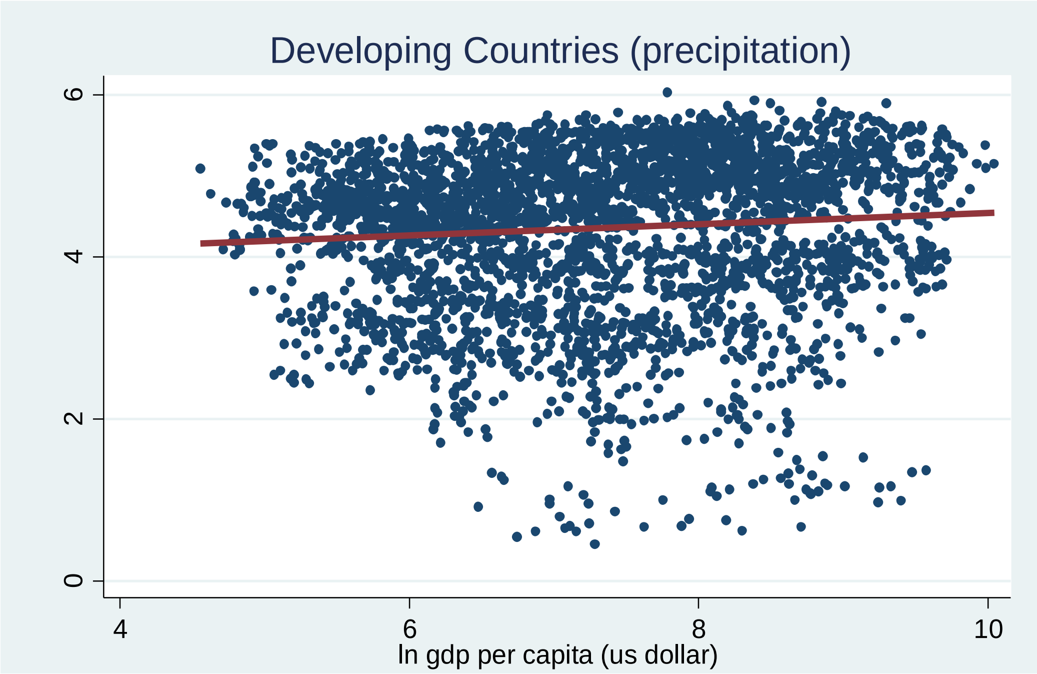
The impact of precipitation on economic growth in developed countries (31 countries)



Note. Adapted from World Development Indicator (2020)

Figure 1.6:

The impact of precipitation on economic growth in developing countries (135 countries)

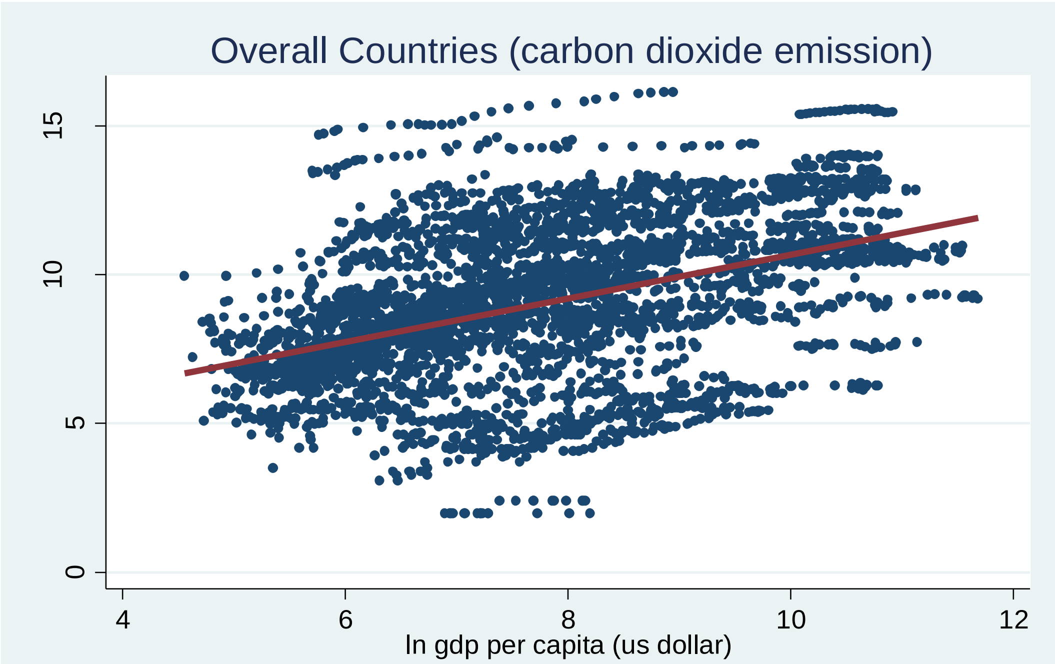


Note. Adapted from World Development Indicator (2020)

The scatter plots in Figures 1.4, 1.5, 1.6, showed that higher precipitation countries have higher GDP per capita. The scatter plots showed that precipitation has a positive impact on GDP per capita because it facilitated the agriculture production (Guo, Xu, Gong, 2014).

Figure 1.7:

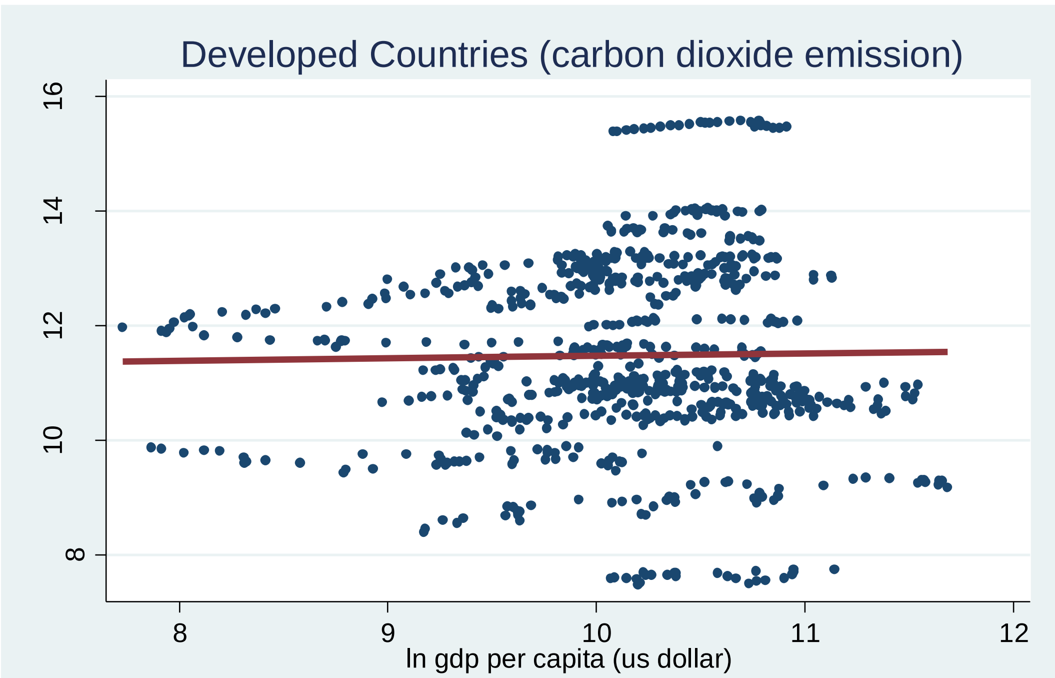
The impact of carbon dioxide emission on economic growth in overall countries (166 countries)



Note. Adapted from World Development Indicator (2020)

Figure 1.8:

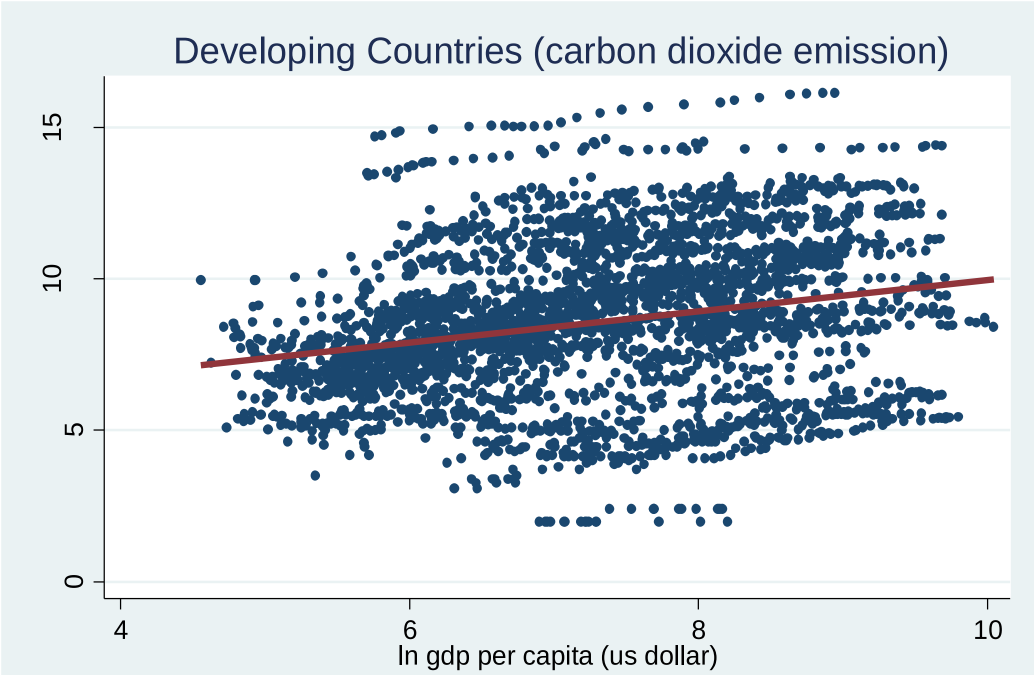
The impact of carbon dioxide emission on economic growth in developed countries (31 countries)



Note. Adapted from World Development Indicator (2020)

Figure 1.9:

The impact of carbon dioxide emission on economic growth in developing countries (135 countries)



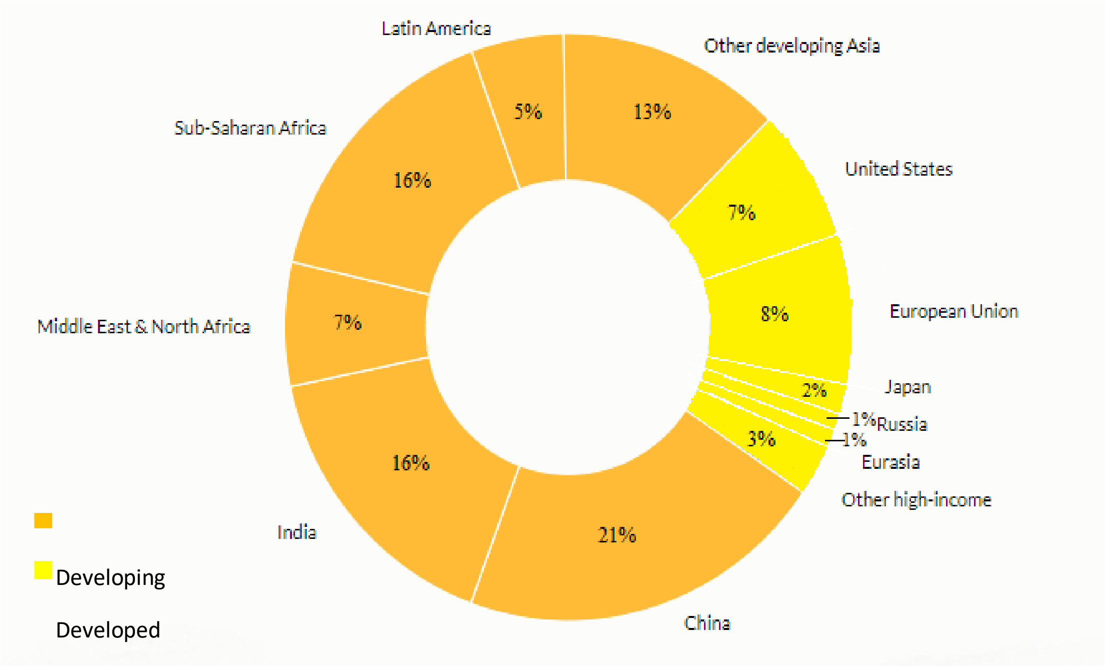
Note. Adapted from World Development Indicator (2020)

The scatter plots in Figures 1.7, 1.8, 1.9, showed higher carbon dioxide emission countries will result to higher GDP per capita. It showed that carbon dioxide emission has positive impact on GDP per capita, as higher carbon dioxide emission signified that higher industrial production and leads to higher economic growth (Bozkurt & Akan, 2014).

Basically, climate change affected the nation's sustainable development in many aspects such as economic, social, environment and potential development footpath. Specifically, the economic growth in both developed and developing countries have been significantly affected by the climate change such as rising temperature and increasing amount of precipitation (Ali et al., 2019). Therefore, which countries experience the greatest impact from the climate change?

Figure 1.10:

Developing and Developed Countries Affected by Climate Change



Note. Adapted from Center and Global Development (2020)

Based on figure 1.10, it showed the impact of climate change on both developed and developing countries in 2015. The figure showed that climate change such as extreme weather and storms brought approximately 7% and 8% impact to the United States and European Union economy respectively. The impact of climate change has the least effect on Russia and Eurasia which was 1% compared to other developed countries. As for the developing countries, it showed that China was the country that was most affected by climate change. This is because climate change will damage infrastructure assets such as power plants, transport systems and water treatment centres, which all these assets are essential services that provide to a large number of individuals and industries. Besides, the damages caused by climate change in Sub-Saharan Africa was up to 16%. This is consistent with the finding of Sub-Saharan Africa (SSA) which was the most affected by climate change as SSA is merely specialized in agriculture related business (Alagidede, Adu & Frimpong, 2012). In conclusion, it showed that developing countries are affected the most by climate change compared to developed countries. The Intergovernmental Panel on Climate Change said that climate change hits the poor hardest. The reason behind is that the housing structure and the infrastructure in developing countries are vulnerable to storms and extreme weather. On the other hand, developed countries experienced a lower impact compared to developing countries because they have advanced technology that minimized the damages to the economy that are caused by climate change.

Many economic researchers merely focused on the macroeconomic determinants that affected economic growth but they ignored the consequences of climate change. However, climate change is one of the vital factors that triggered the economy to become fluctuated (Pei, Zhang, Li, Foret & Lee, 2016). This research aims to examine the economic growth from developed and developing countries as both of them are experiencing significant impact from climate change.

1.2 Research Problem

In recent years, climate change has become a global issue that everyone should be concerned about as it has caused a lot of disastrous problems to economic growth, human health as well as biodiversity. Besides, climate change has affected economic growth especially in agriculture production in developing and developed countries (Ali et al., 2019). For example, extreme weather has brought several disasters such as drought and heat wave which reduced the agriculture production, increased the cost to import agriculture crops and eventually affect economic growth. Drought and heat wave has destroyed more than 2.5 billion tons of rice, wheat and other crops production in many countries (Zhang et al., 2011). Besides, extreme precipitation increased the soil erosion by changing the amount of soil temperature and the organic input matter from soil. Since the soil has lost its organic matter from soil and it unable to support the crop yields which will impact the GDP of the agriculture sector in the developing countries. In serious cases, extreme precipitation may cause floods and it will destroy and drown most of the agriculture and the livestock. The incoming flood will impact the food supply. When the food supply decreases, the demand remains the same. Eventually, the price for relative goods will increase and it disrupts the marketplace (Renee Cho, 2019). Agriculture production in developed countries is also heavily affected by climate change due to maximizing profit with big monoculture farms compared to developing countries. The reason behind is when disasters bring impact to the agriculture area, developed countries will face huge losses compared to developing countries which try to minimize losses with smaller yield of agriculture production (Mcdonnel, 2016).

Climate change is not only impacted agriculture production, but it also has significant impact on non-agriculture production. Besides, the non-agricultural production loss approximately 2.4% compared to agricultural production that lost about 0.1% (Hsiang, 2010). Moreover, extreme weather such as winter and summer has also affected the housing industry by delaying the construction process and increasing the depreciation rate for the outdoor buildings (Hsiang, 2010). Moreover, there are mainly 2 categories of export goods such as agricultural goods and light manufacturing goods are negatively affected by the rise in temperature (Jones & Olken, 2010). Not only that, the wool production fell when the temperature increased. There is evidence that Australian wool industry has reported both the price and production of wool have dropped due to climate change and affected the economic growth of the country since the year 1987 (Kumar & Yalew, 2012).

On the other hand, climate change acts as a significant factor that affect the demand for tourism across the globe. Evidence showed that precipitation has a positive impact on the United State of America tourism demand while temperature has a negative impact towards the tourism demand in the United State of America from other countries (Ridderstaat, Oduber, Croes, Nijkamp & Martens, 2014). Hence, extreme climate change such as rising temperature has impacted tourism in a country which leads to a decrease in GDP from the tourism sector. Apart from that, in January of 2020, Australia had experienced one of the worst bushfires which are caused by climate change with abnormal high temperature which leads to extreme drought and eventually flamed up by the lightning strike. More than 1 billion living creatures, 3000 homes and 25 innocent lives died due to the blazes. Besides, a total of 6.3 million hectares has been wiped out and Australia's economy is expected to lose more than $4.4billion through critical air pollution and direct harm to tourism and farming industries (Katrina, 2020). Tourism had taken a big hit as the number of tourists experienced a drastic plunge due to the significant air pollution in the hot spots. Notably, this showed that the calamitous impact towards the economy which caused by climate change is non-negligible (Dell, Jones & Olken, 2008).

Based on the previous studies, there are contradictory results from different researchers. The results showed that there is a positive relationship between climate change and economic growth (Pei et al., 2016). However, Ali et al. (2019) criticized the arguments by stating that climate change has a negative effect toward economic growth. Therefore, the impact between climate change and economic growth remains ambiguous. Thus, this research not only aims to examine the linear impact but also non-linear impact of climate change on economic growth in developed and developing countries in order to fill up the gap of this research topic.

1.3 Research Question

1.3.1 General Research Question

1. Does gross fixed capital formation have impact on economic growth?

2. Does trade openness have on economic growth?

3. Does labour force have impact on economic growth?

4. Does climate change have impact on economic growth?

1.4 Research Objectives

The general objective of this research is to examine the existence of any significant impact between climate change and economic growth. If climate change has a significant impact on economic growth, then it needs to further discern whether it is a positive impact or a negative impact.

1.4.1 General Research Objectives

1. To examine the impact of gross fixed capital formation on economic growth.

2. To examine the impact of trade openness on economic growth.

3. To examine the impact of labour force on economic growth.

4. To examine the impact of climate change on economic growth.

1.4.2 Specific Objectives

1. To examine the linear impact of climate change on economic growth in overall countries.

2. To examine the linear impact of climate change on economic growth in developed countries.

3. To examine the linear impact of climate change on economic growth in developing countries.

4. To examine the non-linear impact of climate change on economic growth in overall countries.

5. To examine the non-linear impact of climate change on economic growth in developed countries.

6. To examine the non-linear impact of climate change on economic growth in developing countries.

7. To determine the threshold level of climate change on economic growth in overall countries.

8. To determine the threshold level of climate change on economic growth in developed countries.

9. To determine the threshold level of climate change on economic growth in developing countries.

1.5 Significance of Study

This research aims to examine the impact of independent variables which are temperature, precipitation, carbon dioxide emission, gross fixed capital formation, trade openness and labour force against the dependent variable which is economic growth. Considering the detrimental consequences of inconsistent climate change that bring a calamitous impact toward the economic growth. By conducting this research, it stipulated much useful information to policymakers, investors, firms, communities and the governments. As a result, they unable to have deeper understanding on how climate change impacted the economic growth.

Besides, this research helps and guides the policymakers to have a clearer view and more knowledge about the consequences of climate change toward economic growth. Furthermore, this research focused on determining the non-linear impact of temperature, precipitation, carbon dioxide emission on economic growth. With this knowledge, policymakers are able to take some actions to minimize the impact of climate change toward the economy. In addition, policymakers are able to raise awareness about the ways to prevent the consequences that caused by climate change.

By knowing this concept of the research, investors should consider climate change as one of the potential risks that could affect their investment portfolio and make wiser decisions by analyzing the effects of climate change on economic growth.

Furthermore, the government is able to know the consequences before implementing a new policy by implementing a new policy. In addition, the government could provide useful knowledge regarding the prevention of natural disaster to raise public awareness by serving this research as references. Thus, this research has made a major contribution by examining the impact of climate change on economic growth.

1.6 Chapter Layout

There are total 5 chapters will be discussed in this research which are research overview, literature review, methodology, data analysis and conclusion. Chapter 1 mainly consists of the background of study and contribution of the research. Followed by chapter 2 which will discuss the previous literature and theoretical model. Besides, the chapter 3 and 4 will discuss the data collection and analysis of the result. Lastly, chapter 5 will cover the conclusion and the implication of study.

1.7 Conclusion

This chapter has discussed the overall impact of climate change on economic growth. Climate change not only directly affected agricultural production but also affected the non-agriculture sector such as tourism and housing sector. Besides, this research has stipulated many information to policymakers, investors and government in order to have better understanding on the impact of climate change on economic growth. Next, past literature review and theoretical review will be discussed in chapter 2.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In chapter 2, this research describes about theoretical review which were Cobb Douglas, Dynamic Integrated model of Climate Economy (DICE) model and Solow model. In addition, this research also examined the relationship of economic growth towards each variable which were labour, gross fixed capital formation, trade openness and climate change with 3 proxies as temperature, precipitation and carbon dioxide emission.

2.1 Theoretical Review

2.1.1 Cobb Douglas Production Function

The very first study on the production function was contributed by Knut Wicksell in 1906. In 1928, Charles and Paul developed a Cobb Douglas production function and it was widely used by many economics' researchers. The 2 major factors in this production function were labour and capital. $Q = (K, L)$ where total production (the monetary value of all goods produced in a year), (usually use GDP). K is investment capital input which is represent by the total investment in fixed assets (the monetary worth of all machinery, equipment and buildings) and L is the quantity of the labour input (the total number of person - hours worked in a year) (Cobb & Douglas, 1928). Parameter α and β are the output elasticities to capital and labour, respectively. Cobb Douglas production function is applied in this study. This research used total labour force and gross fixed capital formation (GFCF) as a proxy of labour and capital.

2.1.2 Dynamic Integrated Climate Economy Model (DICE)

Integrated Assessment Model (IAM) was used by many researchers to evaluate the impact of climate change toward the global economy. This model was used by the government to evaluate the impact of climate policy such as forecasting the Social Cost of Carbon from this model (Schwanitz, 2013). Based on Nordhaus (1994), the researcher had developed Dynamic Integrated model of Climate and Economy (DICE) which this model had included economic growth functions and geophysical functions. The main mechanism for DICE model by including damages functions which was affected by adaptation to climate change. Below is the original damage function in DICE model:

$$\frac{D_t}{Y_t} = a_1 TE_t + a_2 TE_t \qquad (1)$$

Where D_t represent the net damages, Y_t represent the output and TE_t represent the temperature changes compared to the 1900 temperature. The Protection cost (which is used to invest in adaptation for climate change) and residual damages (damages that done by climate change) is the mix combination for the above damage function (Nordhaus, 1994).

2.1.3 Solow Model

So, this approach was adjusted to the standard Solow Growth model which to study the relationship between economic growth and climate impact. Below are the functions of Solow Growth model which it was modified from Cobb Douglas production function (Cobb & Douglas, 1928):

$$Y_t = A_t K_t^{\propto} \qquad (2)$$

Where Y_t will be represent as output per worker; A_t will represent technology while $K_t^{\propto}$ will represent the capital. This model is used by many researchers for their own purpose to determine the climate change. After that, the production function in the model is slightly altered to be the following:

$$Y_t = D_t A_t K_t^{\propto} \quad (3)$$

Where $D_t = 1/(1 + \theta_1 T_t^{\theta_2}) \leq 1$ which is represent the damage function and T_t is the temperature irregularity in year t. When temperature increases, then the output per worker will be reduced, by holding another variable constant. Hence, this paper has added trade openness and climate change as new variables to the above functions. The model above has highlighted in 2 aspect which it predicts that future generations are better off despite climate change and it is consistent with other IAMs. This theory explains that the carbon emission growth because affluence along a stable state because it offset the impact of growth from damages growing over time with population growth, growth in total factors productivity and growth of capital per worker. Moreover, this theory also explains the model will produces an inverted u-shape emission in long-run due to affection by the emission intensity. In addition, this theory can be used to teach the controversy over how damages from an increase in temperature and the implication approach to evaluate the 2-degree Celsius target which the government should control the carbon dioxide emission. Hence, this paper had chosen Solow model because it is more suitable for this paper model.

2.2 Empirical review for Control Variables (Gross Fixed Capital Formation, Trade Openness, Labour Force)

2.2.1 Gross Fixed Capital Formation (GFCF) and Economic Growth

Numerous researches had been done by researchers to examine the relationship between gross fixed capital formation and economic growth.

Studies had proved that there were mixed results among gross fixed capital formation and economic growth.

There were varieties of research examining the effect of gross fixed capital formation on economic growth which were done by the past researchers. According to Bakare (2011), the research studied the relationship of capital formation and economic growth by applying Ordinary Least Square (OLS) multiple regression analytical method and found that capital formation has a positive impact on economic growth. The result is consistent with the research done by Mehta (2011) which studied the short-term relationship between capital formation and economic growth and the results had shown that capital formation has a positive relationship on economic growth. Based on Lach (2010), it showed that there is a positive long-term effect of gross fixed capital on GDP. A research tested the effect of capital formation on economic development in Nigeria. The research has showed that there is a positive and significant effect on the economic development for the investment period in developing countries (Ugochukwu & Chinyere, 2013). The researchers analyzed the developments in the stock market, the capital formation and economic growth and the result was shown a positive sign between the variables (Ajao, 2011). The main reason was to build capital equipment on a sufficient scale to increase productivity for the creation of economic and social overhead capital. Besides, capital formation helped to remove the market imperfection by breaking the viciousness of poverty by increasing economic spending (Emmanuel & Andrew, 2014).

In contrast, Carrol and Veil (1994) studied the effects of fixed capital on economic growth and similar conclusions from a similar analysis of 64 countries. However, the result showed a negative sign due to fixed capital not increasing growth and causing the economic slowdown. Furthermore, Ghali (1998) examined a developing country and showed that the capital formation had a negative impact on economic growth. One of the factors that led to the negative relationship is the government has been misallocating their resources in developing countries (Lach, 2010).

2.2.2 Trade Openness and Economic Growth

Past researchers had conducted numerous researches to examine the relationship between trade openness and economic growth and the results provided evidence on trade openness had a mixed result on economic growth. Sachs and Warner (1997); Adhikary (2011); Karras (2003) they found that economies were more open to trade will generate faster revenues and quicker economic growth, largely due to the role of opening up trade in capital movements and advanced technology. Trade openness helped to reduce monopolies and enhanced market competition by fully utilizing the country's resources. This is consistent with Wacziarg and Welch (2008) where they found the economy was growing faster when there were more countries widely used open trade policies. Surprising results had been found and the results stated that trade openness had a positive relationship on economic growth in developed countries and it showed a consistent result with the finding of Bibi, Ahmad & Rashid (2014). According to the research of Hye, Wizarat, and Lau (2016), it showed that trade openness has a positive relationship on economic growth in developing countries. This was because decline of trade openness led to an increased in competition among the local producers, then the economic growth increased too.

In contrast, Rigobon & Rodrik (2005) stated that there is an adverse impact of labour on economic growth. Besides, the openness of trade has a negative impact on the economic growth of countries that specialize in producing low quality products (Haussmann, Hwang & Rodrik, 2007). Based on Cooke, (2010); Samimi, Ghaderi, Hosseinzadeh and Nademi, (2012), they stated that increase in trade openness will harm economic growth by increasing inflation and reducing exchange rates. Other than that, the relationship of trade openness and economic growth is negative probably because of highly import and depreciation of exchange rate which created a negative trade balance (Adhikary, 2011). The main factors that affects the economic growth are the devaluation of currency and adverse balance of payment. According to Bibi et al., (2014), they showed that the cross-sectional relationship between economic growth and trade openness is negative in developing countries due to depreciation currency and increases of import.

2.2.3 Labour Force and Economic Growth

There were numerous past studies that aim to estimate the relationship and impact of the labour force on economic growth. Most of these studies have shown mixed findings of the relationship between climate change and economic growth.

Based on Ali et al. (2019), researchers found that the labour force has a positive significant effect on economic growth by using unit root test and bounds test. The results are supported by Hossain (2012), he claimed that there is a positive sign among labour force and economic growth in Bangladesh from 2002 to 2009. Besides, Al-Mulali (2014) found that labour force has a unidirectional positive short run and long run relationship with GDP growth by studying 30 developed and developing countries from 1990-2010. In addition, Kargi (2014) had studied Turkey data from 2000 to 2013 and deduced that the labour force has a positive relationship on economic growth. Amir, Khan and Bilal (2015) they implied Cobb-Douglas production function in the research and examined a positive relationship between labour force and economic growth. The main reason is because higher education of labour has fully utilized physical capital. As a result, it accelerated the productivity and boosted the country's economic growth.

However, Shahid (2014) argued that labour force participation has a significant negative relationship against economic growth in the short run in Pakistan country by using vector error correction model (VECM). Yakubu, Akanegbu and Jelilov (2020) chose Nigeria and 3 representative provinces as their sample to examine the effect of labour force on economic growth by using Johannsen’s Cointegration model and VECM model. The finding showed that the labour force is one of the important factors for

Nigeria's economy, but the research showed labour force participation is negatively significant on economic growth. The reason for the result is due to the used of cheap labour as comparative advantages and labour may led to loss of ability to innovate which caused the economic growth to decline (Amir et al., 2015).

2.3 Empirical Review for Climate Change (Temperature, Precipitation, Carbon Dioxide Emission)

2.3.1 Temperature and Economic growth

There were numerous researches that aimed to examine the climate change affected on economic growth in different areas around the globe since climate change is one of the global problems that had been discussed in recent years. Most of these researches had shown mixed results of the impact on temperature and economic growth.

According to Guo, Xu and Gong (2014), they found that temperature is positively significant to the GDP growth rate using Granger-causality in short-term. According to Pei et al. (2016), they found that there is a positive relationship between temperature and real GDP per capita by using regression analysis. Sufficient exposure to sunlight and suitable temperature in the surrounding area increased the arable land which is beneficial for economic growth (Akram, 2013).

However, Ali et al. (2019) criticized the arguments by stating that the temperature has significantly adverse effects on economic development. Not only that, they found that the effect of temperature not only reduced the growth rates in production of agriculture but also industrial production, and political stability. The reason is because higher temperature has magnified the problem of water shortage by reducing the runoff from water rich areas to arid land (Lanzafame, 2014). Besides, Jones and Olken (2010) stated that every one degree Celsius increased would reduced the growth rate of export of agricultural and light-weight industry; slight impact on heavy industry and raw materials production. In addition, lower economic growth rate is observed in developing countries when the average global temperature is increasing tremendously (Bowen et al., 2012). Furthermore, Abidoye and Odusola (2015) concluded that the economic growth decreased by approximately 0.67 percentage point when the temperature increased in one degree Celsius. Moreover, according to Colacito, Hoffman and Phan (2019), the rising temperature in summer is claimed to have a significant negative impact toward gross state production.

On the other hand, according to Burke, Hsiang and Miguel (2015) found that annual mean temperature and log GDP per capita had a global non-linear relationship. The cold country's productivity increased when the annual temperature increased until a threshold level, the productivity started to decline gradually and accelerate when temperature increased further. Furthermore, they also found that the agriculture and non-agricultural aggregate production have non-linear relationships in average temperature for developing and developed countries (Burke et al., 2015). Besides, the findings showed that historical temperature has non-linear responses towards economic productivity of 168 countries in 1960-2014 (Lee, Villaruel & Gaspar 2016). Moreover, Schlenker and Robert (2008) discovered a robust and significant non-linear relationship between temperature and crop yields such as corn, soybean and cotton. When the temperature reached a certain threshold level, the temperature is harmful to these yields. There is also a journal supported that the impact of climate variation on economic growth is intrinsically non-linear (Alagidede, Adu & Frimpong, 2016). Below a specific extreme point of annual average temperature had stimulated the growth performance in the long-run. On the other hand, increased in mean annual temperature tends to reduce the growth performance after the threshold on long-run. Furthermore, according to Zhao, Gerety and Kuminoff (2018), there is sufficient evidence that it had stronger non-linear effect between temperature and economic growth at all cell levels in developing countries.

2.3.2 Precipitation and Economic Growth

Several researches had determined the relationship in climate change and economic growth in different areas throughout the world. Most of these studies had shown mixed results of the relationship between precipitation and economic growth.

Based on the research of Pei et al. (2016), they stated that precipitation had a significant positive effect on GDP per capita. The finding is further supported by (Ali et al, 2019), they demonstrated that precipitation showed a positive sign on economic growth using the ARDL model. This is further supported by the research of Akram (2013); Lanzafame (2014), they indicated a significant positive relationship between precipitation on economic growth. Nevertheless, Guo, Xu, Gong (2014) stated that short term changes in minimum relative precipitation has a positive effect on GDP growth, when daily precipitation is less than 30mm, it benefited production of agriculture rather than causing storm and flood.

In contrast, the result of past researches showed a negative relationship between precipitation and economic growth. As stated by Ali (2012), he found that an agrarian economy which highly depend on precipitation will have a long-term growth drag effect caused by the variability in precipitation. This is further supported by Akram (2013), stating that change in precipitation has a negative impact towards the country’s economic growth by applying various tests such as Hausman test and Fixed Effect Model (FEM). Furthermore, Ali et al. (2019), researchers said that heavy precipitation has the damaging effect on the agrarian economy but it is unaffected to the economic situation in developed countries. Evidence showed that the heavy precipitation caused the agriculture production to be damaged by increasing the soil erosion and damaging the crop yield (Mollah & Cook, 1996). As found by Grey and Sadoff (2007), they found that extreme precipitation has a negative impact on economic development. They found that the floods caused more than 33% of damage to the GDP growth (Grey & Sadoff, 2007).

2.3.3 Carbon Dioxide Emissions and Economic Growth

There are numerous researches that had studied the impacts of climate change on economic growth all around the globe. However, some researchers found that carbon dioxide emissions were the main cause that inflicting the degradation of the environment. Most of these studies had shown mixed results of the relationship between temperature and economic growth.

Based on Chang (2010), he stated that the used of energy and carbon dioxide emission positively affected the economic growth. The finding showed that higher energy used and carbon dioxide emissions boosted the economy. According to Bozkurt and Akan (2014), the research was done at the period of 1990–2011 to examine the relationship between economic growth, carbon dioxide emissions and energy structure. It showed a positive significant on the economic growth in China in short and long run. This is further supported by the research of Khan, Khan and Rehan (2020), they stated that carbon emissions has a positive impact on Pakistan’s economy in both long run and short run. Hence, Long, Naminse, Du and Zhuang (2015) stated that the carbon dioxide emission and economic growth were bidirectional affected each other.

In the research conducted by Ghosh (2010), it showed that the carbon dioxide emissions and economic growth has bidirectional short-term causality. In short run, he concluded that the declined in carbon dioxide emissions caused the economy to follow an inclined. Based on the research done by Kumar (2011), he found that carbon dioxide emission has an adverse relationship with the GDP. This is because the composition of the energy had been shifted away from coal which produced lots of carbon dioxide emission and towards natural gas, nuclear and etc (Tsigaris & Wood, 2016). The result further supported by Borhan, Ahmed and Hitam (2012); Gul, Zou, Hassan, Azam and Zaman (2015) they found that carbon dioxide emission has an opposite impact on GDP. Besides, according to Ali et al. (2019) indicated a significant negative relationship between carbon emissions on economic growth.

2.4 Conclusion

This chapter had discussed the relationship and impact of climate change on economic growth. Some researchers had found that climate change has a positive significant impact on economic growth. However, some researchers had criticized the findings by stating that climate change has a negative impact towards economic growth. As the impact of climate change on economic growth remained ambiguous, therefore this research will further examine whether climate change has a non-linear impact on economic growth. Next section will be chapter 3 which discusses the methodology of this research.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter presents about the source of data, data description, research model and Generalized Method of Moment (GMM). In source of data and data description, variables' definition, measurement unit, abbreviation, source of data and expected sign will be described. Next, the GMM will be used in this research and efficiency, feasibility, estimating standard error, difference GMM, system GMM and diagnostic test will be explained.

3.1 Source of Data

This research can access the data of all 31 developed countries and 135 out of 158 developing countries from World Population Review. The data period that include in this study is from year 1990 to year 2016, thus total observations account for this research will be 4482. However, some data is unavailable for certain countries during the first few years and recent year; therefore, the data include in this research consider as unbalanced panel data. However, Generalized Method of Moments (GMM) is able to encounter the problem of missing values in an unbalance panel data (Roodman, 2006). The result of this research which is the impact of climate change on economic growth will be largely dependent on the selected sample observations. In additions, Table 3.1 presents summary of variables.

Table 3.1:

Summary of variables

Variables	Abbreviation	Unit Measurement	Definition	Sources
Economic growth	GDP	USD	GDP per capita	WDI
Gross Fixed Capital Formation	GFCF	USD	A component expenditure of GDP	WDI
Trade Openness	TO	Percentage (%)	Total trade percentage to GDP	WDI
Labour Force	LAB	Individual	Employed plus unemployed	WDI
Temperature	TEMP	Celsius (°C)	Annual temperature by countries	WDI
Precipitation	PREC	Millimeter (mm)	Annual precipitation by countries	WDI
Carbon Dioxide Emission	CO_2	Kiloton(kt)	Annual carbon dioxide emissions by countries	WDI

Note. Adapted from World Development Indicator (2020)

Table 3.2:

Expected sign of variables

Variables	Expected Sign		
	Overall	**Developed**	**Developing**
Economic growth	-	-	-
Gross Fixed Capital Formation	Positive	Positive	Positive
Trade Openness	Positive	Positive	Positive
Labour Force	Positive	Positive	Positive
Temperature	Negative	Negative	Negative
Precipitation	Positive	Positive	Positive
Carbon Dioxide Emission	Positive	Positive	Positive

3.2 Data Description

For the data description, definition of each variables which are economic growth, gross fixed capital formation, trade openness, labour force, temperature, precipitation and carbon dioxide emission will be discussed.

3.2.1 Economic Growth

Economic growth defines as an increase in the output of a nation in the result of production of goods and services over a specific period by excluding the effects of inflation. The data collect in this research is GDP per capita of all nations from year 1990 to 2016 on annual basis. Based on Ali et al. (2019), they used GDP per capita as dependent variable to measure the economic growth.

3.2.2 Gross Fixed Capital Formation

Gross fixed capital formation defines as the net investment in fixed capital and it excluded the effects of depreciation and the purchases of land. The data obtain in this research is the gross fixed capital formation (GFCF) of all nations from year 1990 to 2016 on annual basis. The expected impact of GFCF to economic growth in overall countries is positive. In the study of Ali et al. (2019), they found that GFCF has a positive impact on the economic growth in both long run and short run.

3.2.3 Trade Openness

Trade openness defines as sum of export and import per GDP. According to Wacziarg and Welch (2008), they found the economy was growing faster when there were more countries widely used open trade policies. The data use to represent trade openness in this research is total trade percentage to GDP of 31 developed countries and 135 developing countries from year 1990 to 2016 in annual basis. Besides, the expected sign for trade openness is positive impact on economic growth in overall countries as Hye, Wizarat, and Lau (2016) found that the trade openness has positive impact on economic growth in long run and short run.

3.2.4 Labour force

Labour force is described as the number of individuals who are officially employed plus the number of individuals who are unemployed but actively looking for job. The data that obtained in this research is total labour force of all nations from year 1990 to 2016 on annual basis. The expected impact of labour force is positive to the economic growth in overall countries as numeral studies have found that the total labour force has a positive impact to the economic growth (Ali et al., 2019).

3.2.5 Temperature

According to Nordhaus (2008), temperature is used as one of the proxies to represent the climate change in the DICE model. The data used in this research is temperature in degree Celsius (°C) of 31 developed and 135 developing countries from year 1990 to 2016 in annual basis. Besides, the expected sign of temperature is negative impact on economic growth in overall countries as Ali, Ying, Nazir, Ishaq, Shah, llyas, and Tariq (2019); Abidoye and Odusola (2015); Moore and Diaz (2015) found that the temperature is negatively correlated to the economic growth.

3.2.6 Precipitation

Precipitation defines as one of the proxies to represent the climate change. The data used in this research is precipitation in milli meter (mm) of 31 developed countries and 135 developing countries from year 1990 to 2016 in annual basis. Besides, the expected sign of precipitation is positive impact on economic growth in overall countries. According to Pei, Zhang, Li, Forêt, and Lee (2016), precipitation is positively correlated to the real GDP per capita.

3.2.7 Carbon Dioxide Emission

According to Nordhaus (2008), carbon dioxide emission uses as one of the variables to define climate change in DICE model. The data used in this research is carbon dioxide emission in Kiloton (kt) of 31 developed countries and 135 developing countries from year 1990 to 2016 in annual basis. Besides, the expected sign of carbon dioxide emission is positive impact on economic growth in overall countries. According to Bozkurt and Akan (2014), the carbon dioxide emission increases will leads to an increase in the GDP due to higher energy consumption. Besides, carbon emissions have a positive impact on Pakistan's economy in both long run and short run (Khan, Khan & Rehan, 2020).

3.3 Model

The linear model and non-linear model in overall, developed and developing countries are showed as below.

3.3.1 Linear model

$$GDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 GDP_{it-1} + \hat{\beta}_2 GFCF_{it} + \hat{\beta}_3 TO_{it} + \hat{\beta}_4 LAB_{it} + \hat{\beta}_5 TEMP_{it} + \varepsilon_{it} \quad (4)$$

$$GDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 GDP_{it-1} + \hat{\beta}_2 GFCF_{it} + \hat{\beta}_3 TO_{it} + \hat{\beta}_4 LAB_{it} + \hat{\beta}_5 PREC_{it} + \varepsilon_{it} \quad (5)$$

$$GDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 GDP_{it-1} + \hat{\beta}_2 GFCF_{it} + \hat{\beta}_3 TO_{it} + \hat{\beta}_4 LAB_{it} + \hat{\beta}_5 CO2_{it} + \varepsilon_{it} \quad (6)$$

3.3.2 Non-Linear model

$$GDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 GDP_{it-1} + \hat{\beta}_2 GFCF_{it} + \hat{\beta}_3 TO_{it} + \hat{\beta}_4 LAB_{it} + \hat{\beta}_5 TEMP_{it} + \hat{\beta}_6 TEMP_{it}^2 + \varepsilon_{it} \quad (7)$$

$$GDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 GDP_{it-1} + \hat{\beta}_2 GFCF_{it} + \hat{\beta}_3 TO_{it} + \hat{\beta}_4 LAB_{it} + \hat{\beta}_5 PREC_{it} + \hat{\beta}_6 PREC_{it}^2 + \varepsilon_{it} \quad (8)$$

$$GDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 GDP_{it-1} + \hat{\beta}_2 GFCF_{it} + \hat{\beta}_3 TO_{it} + \hat{\beta}_4 LAB_{it} + \hat{\beta}_5 CO2_{it} + \hat{\beta}_6 CO2_{it}^2 + \varepsilon_{it} \quad (9)$$

Where GDP represents GDP per capita, GFCF represents gross fixed capital formation, TO represents trade openness, PREC represents precipitation, LAB represents labour force, TEMP represents temperature, CO_2 represents carbon dioxide emission and **ε** represents error term, i = 1, 2, 3… refers to countries, and t = 1990, 1991, 1992… 2016 T refers to period of time. All the data are computed in natural logarithm.

3.4 Generalized Method of Moments (GMM)

GMM is a dynamic panel data estimator which is use for estimating parameters in multivariate analysis. GMM is one of the statistical methods widely apply by researchers to estimate the unknown parameters in an equation. GMM was developed by Lars Peter Hansen in the year 1982, which was suitable for the limiting of economic models and no additional restrictions will be imposed. It originates estimates of the unknown parameters by integrating observed economic data with the information in population moment conditions (Zsohar, 2010). Xtabond2 command which implement the estimators by using Stata will automatically test the validity of instrument subsets. Moreover, it also assists for observation weights, and the forward orthogonal deviations transform which come out by Arellano and Bover (1995) that conserve sample size in panels with gaps by using Sargan/Hansen test. On the other hand, xtabond2 provide unique features such as the "collapse" to limit instrument proliferation.

GMM is use as a tool in this research compare to OLS and 2SLS. One of the main reasons that we choose GMM is because GMM is often apply by many researchers to account for dynamics in the model. For instance, dynamic panel models that contain the lagged dependent variable will produce biased result by using OLS. In this case, the GDP includes the lagged term in model which it is consider as lagged dependent variable. In simple term, it indicates that the previous GDP in previous year will affect in current year. Moreover, it also is an estimator that can naturally solve the potential of endogeneity issues which OLS cannot solve the problem with endogenous regressors.

Sample data, where information is collect from the population sample size, and it could be very similar to the population data. An illustration provided by Zsohar (2010) is the linkage between sample mean and population expected value. By applying the same principle, sample equivalents are generated by using population moment conditions as below:

Population moment condition: $E[\varkappa_i] = \mu$

$$\Downarrow$$

Sample analogue $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \hat{\mu}$ (10)

The equation of unidentified parameter can explain by sample analogue. Thus, the sample moments follow the rule of central limit theorem that is approaching normal distribution as the sample size increase.

Parameters, β are crucial in quantifying how a variable influence another. Though there are many estimations available; however, the quantification of parameters should not impose additional restrictions on the statistical behaviour of variables that are stated by economic models, because imposition of additional restrictions triggers more assumptions, which may put ourselves at the risk of invalidity (Zsohar, 2010). Zsohar (2010) mentions that the statistical estimation method should just involve the restrictions of the economic models. Most often, the restrictions that economic theories impose is known as “population moment conditions”, it is a set of mathematical equation that is form in consistent with economic theories. Although the population moment conditions demonstrate information of unknown parameters; however, such information is not always accurate (Zsohar, 2010).

In Zsohar (2010)’s article, the motivation of GMM is that Method of Moments (MM) cannot estimate unknown parameters if the number of moment conditions, q is more than the number of unknown parameters, p. When $q < p$, multiple solutions are available to the equations systems, meaning that there will be no exact solution to all of the moment conditions, the estimation of parameters is therefore not possible (Brown & Newey, 2002). The principle of GMM is that q must be greater than or equal to p ($q \geq p$). When $q = p$, GMM and MM are the same. In the case of $q > p$, it is called over-identification which we do not have any solution to the equation system; nevertheless, we can still find the GMM estimator. Instead of coming up with an exact solution, GMM allows us to estimate $\hat{\beta}$ that the value is closest to solving the sample moment conditions (Zsohar, 2010); in other words, $\hat{\beta}$ will make sample moments become more closer to zero as possible (Brown & Newey, 2007).

3.4.1 Efficiency

GMM comes out with the ideas of expected values and averages sample. In term of true value, moment condition is expected values that specify the model parameters. If instrument is more than the regressor, then the equations outnumber are unknowns and an ambiguity will appear by using 2SLS to solve moment condition. Thus, the moments conditions true asymptotically by expecting moment condition cannot hold perfectly in finite sample. For efficiency, A which suggest a different linear, consistent estimator of $\beta,$ must in effect weight moment in inverse proportion to their variances and covariances. According to Rodman (2009), the research view matrices Z and E as components of infinite sequences indexed by N since efficient represent asymptotic notion. So, the efficient GMM moment weighting matrix is shown below:

$$\hat{\beta}_{EGGM} = \{X'Z\ Var\ (z\varepsilon)^{-1}Z'X\}^{-1}X'Z\ Var(z\varepsilon)^{-1}Z'Y \qquad (11)$$

Where EGMM is not feasible unless the $Var(z\varepsilon)$ is known.

The researcher demonstrates that the estimators become efficient before making estimator become feasible and need to assume the model is suitable for Law of Large Number hold. The result shows that the EGGM estimators is asymptotically orthogonal to the latter and the assertion is efficient.

According to Roodman (2009), GMM estimator which defines by A will remodel as || (1/N) Z'W$\hat{E}$||$_A$ with different alternatives of weighting matrix. Under certain criteria being fulfilled, the GMM estimators will be consistent by converting in probability to β as a sample size increase to infinity (Hansen, 1982). Unlike 2LS, the result will become biased because limited samples of the instruments are slightly correlate with the endogenous component of the instrumented regressor which correlation coefficient between the regressor are not equal to 0.

Based on another derivation of EGGM for greater insight, a direct OLS evaluate of Y=Xβ+E is biase. The error term still will not be independent and identical distribution which cannot be assume scalar although apply Z-moment of both sides. To solve this problem, Roodman (2009) transformed the model to become:

$$Avar\left(\frac{1}{N}E^{*}\right) = \underset{n\to\infty}{\text{plim}}\, N\, Var(z\varepsilon)^{-1/2}\, Var\left(\frac{1}{N}Z'E\right)(z\varepsilon)^{-1/2} \quad (12)$$

If Var($z\varepsilon$) happen to be spherical, then the efficient projection is orthogonal based on Gauss Markov theorem. It indicates that there is no reweighting of moment is needed for efficiency.

3.4.2 Feasibility

To make the EGGM practical, it requires a feasible estimator for the optimal weighting matrix which are Var $(z\varepsilon)^{-1}$. By observing that this group is the limit of the expression built around Ω to achieve optimal objective:

$$Var(z\varepsilon) = \underset{n\to\infty}{\text{plim}}\frac{1}{N}E\,(Z'\Omega Z) \quad (13)$$

In this case, we assume that the errors are assumed to be homoscedastic, with Ω of the form $\sigma^2 I$. Next, the EGGM weighting matrix is contrary of $\sigma^2 \underset{n\to\infty}{\text{plim}}\left(\frac{1}{N}\right)E(Z'Z)$ based on the last expression. Roodman (2009) suggested that we can use sandwich estimator, which also known as Kernel-based estimator from Stata estimation commands with robust and cluster options when the error term is suspected with more-complicated pattern of variance. GMM weighting matrix will be changed to become optimal matrix by using effective algorithm as N increases. According to a minimal arbitrary assumption, select $A = (Z'HZ)^{-1}$, where arbitrary H is an "estimate" of Ω. Up to one-step GMM, we will only set, where H is the estimated Ω based on minimally arbitrary assumption regarding the errors. One of the possible assumptions could be homoscedasticity. Roodman (2009) said that the replacement $\widehat{\Omega}$ by arbitrary H, yielding $\widehat{\beta_1}$ allow to obtain the residuals from the estimation by using one-step GMM. Then, it will use to build sandwich proxy for Ω in the second step, notating it as $\widehat{\Omega}_{\beta_1}$. The two-step estimator, $\hat{\beta}_2$ is efficient and robust. However, downward bias will exist in standard errors of one-step and two-step result.

3.4.3 Estimating Standard Error

There is complication of result in developing feasible result for both one-step and two-step GMM. For first step GMM, it used optimal weighting matrix, $A = (Z'HZ)^{-1}$to replace the weighting matrix $A = (Z'\Omega Z)^{-1}$. Below model are the sub-optimal weighting matrix:

$$\hat{\beta}_1 = (X'Z(Z'HZ)^{-1}Z'X)^{-1}X'Z(Z'HZ)^{-1}Z'Y \tag{14}$$

By inserting the sub-optimal weighting matrix, it will minimize the function above. The result which denoted as $\hat{\beta}_1$ is consistent but the standard errors estimate would not be robust. Based on Roodman (2009), he said that it can solved the problem above by replacing $Var(z\varepsilon)$ with sandwich type proxy of one-step residual. By doing this, the result will be feasible and the estimator for one-step standard error will be robust. In second step, estimate of $\hat{\beta}_1$ is compulsory for obtaining the optimal weighting matrix, $(Z'\hat{\Omega}_{\hat{\beta}_1}Z)^{-1}$, which then could be used to estimate $\hat{\beta}_2$ efficiently (Zsohar, 2010). To simplify, two-step GMM uses first step estimate parameter to estimate the parameter in the second step (Roodman, 2006)

$$\hat{\beta}_2 = \left(X'Z(Z'\hat{\Omega}_{\hat{\beta}_1}Z)^{-1}Z'X\right)^{-1}X'Z(Z'\hat{\Omega}_{\hat{\beta}_1}Z)^{-1}Z'Y \tag{15}$$

As for two step GMM, this paper use $\hat{\beta}_1$ to create optimal weighting matrix, $(Z'\hat{\Omega}_{\hat{\beta}_1}Z)^{-1}$by setting $A = (Z'\hat{\Omega}_{\hat{\beta}_1}Z)^{-1}$ to minimize the function of $\hat{\beta}_2$. The result obtained will be denoted as $\hat{\beta}_2$ and the estimate will be consistent and efficient. Based on Windmeijer (2005), he found that two-step EGMM can outperforms one-step GMM in estimating coefficient with lower standard error. However, when the number of instruments is large, the standard errors will be downward biased. The downward biased is caused by the weighting matrix in one-step GMM is independent of estimated parameters whereas the weighting matrix in two-step GMM is dependent to initial consistent estimated parameters. According to Windmeijer (2005), he found that finite-sample correction able to minimize the downward bias in two-step.

3.4.4 Difference GMM & System GMM

The Difference and System GMM made lesser assumptions throughout the history trend in econometric practices. Moreover, GMM also need to isolate value information by using complicate method under data generating process; nevertheless, the computation of software that use GMM is very popular nowadays and many researchers are using this. These estimators are design for the panel analysis with sample size, N must be larger than the time period, T, and have few assumptions in data generating process (Roodman 2009). Below are the assumptions for GMM:

i. There may be an arbitrary distribution of fixed individual effects. This cross-section regressions should basically assume the absence of fixed effect and support the panel settings where changes over time can be used to identify parameters.

ii. The process can be characterized by constant change, with current realizations of the DV that affect by the previous one.

iii. Certain regressors may be endogenous regressor.

iv. The individual models of heteroscedasticity and autocorrelation could be arising among idiosyncratic error term (those that do not have fixed effect).

v. There is no interaction among idiosyncratic disturbances.

vi. Some regressor are not strictly exogenous but it can be predetermined, it indicates that the regressor can be affected by previous one but not depending on current disturbances. The dependent variable that included lagged are one of the examples.

vii. The sample size, N must be larger than the time period, T

viii. Available instruments are based on "internal" - instrument lag variable.

Based on above assumption, the estimator allows inclusion of external instrument and the estimators are designed for general use. Below is the general model for generating data process:

$$\Delta y_{it} = (\alpha - 1) y_{i,t-1} + x'_{it}\beta + \varepsilon_{it} \tag{16}$$

By applying the OLS into this equation, it will create dynamic panel bias which it indicates that $y_{i,t-1}$ is correlate with the fixed effects in the error term. The correlation between independent variable and error, μ_i will violates the basic assumption of OLS. There are 2 ways to solve the endogeneity problem. First, we can use first-difference transform which called as “different GMM” to remove the fixed effect by transforming the data. Next, the second way is called “System GMM” to instrument $y_{i,t-1}$ and any other similarly endogenous variables which are uncorrelated with the fixed effects.

For Difference GMM, fixed effect will eliminate but the lagged dependent variable can still be endogenous. Any predetermined variables in x had the potential to become endogenous although they are strictly exogenous. First-difference transform also had its own weakness that tends to magnify gap in unbalanced panels. For instance, both Δy_{it} and Δy_{it+1} will disappear in the transformed data if some y_{it} is missing. This is what had to create the second transformation which called as “forward orthogonal deviation”. Forward orthogonal deviation able to reduce more missing data by computing all observation except the last for every individual. Forward orthogonal deviation subtracts the average of all future available observation of a variable unlike the first-difference transformation which minus last year observation with this year observation (Roodman 2006).

First-difference transform from:

$$y_{it} = \beta_0 + \alpha y_{i,t-1} + x'_{it}\beta + \varepsilon_{it} \tag{17}$$

$$\Downarrow$$

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \Delta x'_{it}\beta + \Delta v_{it} \tag{18}$$

The fixed effects, μ_i will be remove but the lagged dependent variable, $\Delta y_{i,t-1}$ can still be endogenous because $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ is correlated with $\Delta v_{it} = v_{it} - v_{i,t-1}$. The independent variables will potentially become endogenous even though exogenous problem had been solved. This is because predetermined variables in x may related to $v_{i,t-1}$. First-difference transformation had its own disadvantages which will magnify gap in unbalanced panels. For instance, if y_{it} is missing, both Δy_{it} and $\Delta y_{i,t+1}$ will also disappear in panel data. This above situation had led to a second transformation which is called "forward orthogonal deviation". Forward orthogonal deviation able to compute the missing data which it subtracts the previous observations of variable except the last for each individual variable (Roodman, 2009).

The difference GMM estimator will produce a biased and inefficient estimate in finite samples if the dependent variable was persistent and close to be a random walk. According to Blundell and Bond (1998), they propose use of a system GMM estimator to increase efficiency due to poor performance of difference GMM. Instead of changing the regressor to eliminate fixed effect, it can transform the instruments to make them exogenous to the fixed effect. According to Roodman (2009), the system GMM got include time-invariant regressor which made all instruments for all level are expected to be orthogonal to fixed effect. Assume changes in any instrumental variable, w are not correlate with fixed effect where $E(\Delta w_{i,t-1}\mu_{it})$ is equal to 0 for all i and t and $E(w_{it}\mu_i)$ is time-invariant. If the assumption holds, then $\Delta w_{i,t-1}$ will be a valid instrument for variable:

$$E(\Delta w_{i,t-1}\varepsilon_{it}) = E(\Delta w_{i,t-1}\mu_{it}) + E(\Delta w_{i,t-1}v_{it}) - E(\Delta w_{i,t-2}v_{it}) = 0 + 0 - 0 \quad (19)$$

To simplify, Difference GMM is to remove the fixed effects while System GMM is to transform the instruments by making the instrument exogenous to the fixed effects. Assuming the instruments and fixed effects are uncorrelated, then it allows more instruments to be introduced and can enhance the efficiency. Hence, this research will be using xtabond2 instead of xtabond to make the finite-sample correction available to the standard errors in two-step estimation in stata (Roodman, 2009).

3.5 GMM Diagnostic Test

In this chapter, this research will highlight in few diagnostic checking which are Arellano-Bond test, Sargan test and Hansen Test since this research is using GMM model for dynamic panel. This is to ensure that the instrument is independent form the error term which the instrument variable is exogenous toward GMM model.

3.5.1 Arellano-Bond test

This research applies Arellano-Bond test for AR (1) and the Arellano-Bond test for AR (2) to detect autocorrelation in idiosyncratic disturbance term, v_{it} (Roodman, 2006).

$$\varepsilon_{it} = \mu_i + v_{it} \tag{20}$$

where μ_i is the fixed effect, v_{it} is the idiosyncratic shocks

Full disturbance is the combination of fixed effects and idiosyncratic shocks. Therefore, full disturbance is often assuming auto-correlated because of the fixed effects. However, Arellano-Bond test is to detect autocorrelation for idiosyncratic shocks, excluding fixed effects.

H_0: There is no serial correlation

H_1: There is serial correlation

Failure to reject the null hypothesis implies that autocorrelation problem does not exist. The first-order serial correlation, AR (1) is taken to remove the fixed effect. After that, it also includes the lag term in the model which *t* would affect the period. However, this paper will focus more AR (2) rather than AR (1) because AR (2) got include error term in AR (1).

3.5.2 Sargan/ Hansen Test

The Sargan/ Hansen test are test for the validity for the instrument variable. In simple term, it tests for over-identifying restriction to ensure there are no endogenous between the instrumental variable. Below is the hypothesis statement of Sargan/Hansen test:

H_0: The instruments are valid

H_1: The instruments are not valid

Failure to reject the null hypothesis means that the instruments are valid.

3.5.3 Threshold Function

The turning point of this marginal effect is obtained by solving for:

$$\frac{dy}{dx} = \beta_1 + 2\beta_2 X = 0$$

$$X = -\frac{\beta_1}{2\beta_2} \qquad (21)$$

Where β_1 = independent variable

β_2 = independent variable squared

All threshold level for climate variables (temperature, precipitation, and carbon dioxide emission) will calculating by using this equation. This model gives a quadratic relationship between climate change and economic growth. Noted that both level and squared terms (x and x^2) must statistically significant in order to have U-shape or inverse U-shape relationship (Bollobás, & Thomason, 1987). In the next chapter, analysis of the results will be discussed.

3.6 Conclusion

In this chapter, all the data are described and it is collected from World Development Indicators at year 1990 to 2016. The model from (4) to (6) showed linear climate change impact towards economic growth while model from (7) to (9) shows non-linear climate change impact towards economic growth in overall, developed and developing countries. Lastly, GMM is applied in this research and the result is showed in chapter 4.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

In this chapter, hypothesis testing and robustness checking are to determine the relationship between climate change and economic growth. This chapter has included the result of Difference and System GMM for all the control variables which are gross fixed capital formation (GFCF), trade openness (TO), labour force (LAB), temperature (TEMP), precipitation (PREC) and carbon dioxide emission (CO_2). There are few diagnostic checks included in this data analysis which are Hansen test, Sargan test and Arellano-Bond Serial Correlation test.

4.1 Results from Dynamic Panel GMM Estimation

Table 4.1:

Results of dynamic panel GMM estimation in overall countries for temperature (linear)

	Model (1) Difference GMM One Step	Model (2) Difference GMM Two Step	Model (3) Difference GMM Two Step Robust	Model (4) System GMM One Step	Model (5) System GMM Two Step	Model (6) System GMM Two Step Robust
GDP	0.453***	0.453***	0.453***	0.480***	0.480***	0.480***
	(43.45)	(576.81)	(5.71)	(57.61)	(336.91)	(6.37)
GFCF	0.405***	0.404***	0.404***	0.492***	0.493***	0.493***
	(42.27)	(730.82)	(4.29)	(57.16)	(467.96)	(6.12)
TO	0.011	0.011***	0.011	0.007	0.007***	0.007
	(0.83)	(12.54)	(1.11)	(0.48)	(8.22)	(0.62)
LAB	-0.001	0.001	0.001	-0.444***	-0.446***	-0.446***
	(-0.04)	(0.27)	(0.01)	(-25.32)	(-187.90)	(-4.68)
TEMP	0.321***	0.319***	0.319*	-0.243***	-0.240***	-0.240***
	(6.42)	(120.86)	(1.89)	(-19.02)	(-51.06)	(-4.12)
cons				0.541**	0.553***	0.553
				(2.45)	(25.31)	(0.93)
No. of obv	4482	4482	4482	4482	4482	4482
No. of countries	166	166	166	166	166	166
AR(1)	-19.030***	-2.357**	-2.351**	-19.480***	-1.901*	-1.896*
AR(2)	-0.785	-0.440	-0.425	-0.220	-0.102	-0.100
Hansen		148.6	148.6		148.1	148.1
Sargan	1947.7***	1947.7***	1947.7***	2310.6***	2310.6***	2310.6***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Based on table 4.1, it represents the results of the estimations by using dynamic panel GMM and using STATA software to generate the results. The results generate are Difference GMM and System GMM. The interpretation of the results only focus on the System GMM because Difference GMM has large downward bias and highly inaccurate estimates when the time series sample is short and persistent whereas estimator of System GMM has more precise estimates and much minor bias (Blundell and Bond, 1998). This is because System GMM has include additional moment restriction which is able to remove the biases and the problem of weak instruments in the estimations of first difference GMM. Therefore, the result analysis only interpret on the Two-step System GMM with robustness checking which will be demonstrated in Model 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96, 102 and 108.

Based on table 4.1, it shows that labour force has negative impact on economic growth at 1 percent of significance level. This result is consistent with the research done by Kirigia, Oluwole, Mwabo, Gatwiri, & Kainyu (2006) which stated that the labour force has a significant negative effect on the GDP per capita. For the second control variable, gross fixed capital formation has positive impact on economic growth at 1 percent significance level. For every 1 percent increase in gross fixed capital formation, GDP per capita increases by 0.480 percent, on average, ceteris paribus. This result is consistent with the one of the findings of Ali, Ying, Nazir, Ishaq, Shah, Ilyas and Tariq (2019), they found that gross fixed capital formation has a significant positive impact with the economic growth. The third control variable is trade openness, it is statistically insignificant at 1 percent. According to Sharma (2010), he also found that trade openness has a statistically insignificant effect on economic growth.

4.1.1 Linear and Non-Linear Overall (Temperature, Precipitation and Carbon Dioxide Emission)

The core objective of this research is to examine the linear and non-linear relationship of climate change toward economic. Temperature, precipitation and carbon dioxide emission are used as proxies to represent the climate change.

Based on the table 4.1, the result shows that the temperature has negative impact on economic growth at 1 percent significance level. An increase of 1 percent in temperature leads to a decrease of 0.240 percent in economic growth, on average, ceteris paribus. Rising temperature could give negative impact to the total factor productivity due to the capital has switch away from research and development (R&D) towards reconstruction or maintenance of capital due to the impact of climate change (Moore and Diaz, 2015). Besides, temperature has minor negative impact on the international trades of raw material and heavy weight production and higher negative impact on light-weight and agricultural sector (Jones & Olken, 2010).

Table 4.2:

Results of dynamic panel GMM estimation in overall countries for temperature (non-linear)

	Model (7) Difference GMM One Step	Model (8) Difference GMM Two Step	Model (9) Difference GMM Two Step Robust	Model (10) System GMM One Step	Model (11) System GMM Two Step	Model (12) System GMM Two Step Robust
GDP	0.462***	0.462***	0.462***	0.496***	0.496***	0.496***
	(44.45)	(434.40)	(5.52)	(60.39)	(567.02)	(6.63)
GFCF	0.417***	0.417***	0.417***	0.475***	0.474***	0.474***
	(44.14)	(414.25)	(4.47)	(55.19)	(752.48)	(5.98)
TO	0.011	0.011***	0.011	0.008	0.008***	0.008
	(0.81)	(9.21)	(1.07)	(0.53)	(9.40)	(0.72)
LAB	-0.078***	-0.081***	-0.081	-0.435***	-0.434***	-0.434***
	(-3.02)	(-11.86)	(-0.59)	(-26.28)	(-294.42)	(-4.69)
TEMP	0.086**	0.086***	0.086*	0.132***	0.131***	0.131***
	(2.32)	(35.68)	(1.78)	(4.36)	(39.31)	(2.76)
TEMP^2	0.031**	0.031***	0.031	-0.065***	-0.065***	-0.065***
	(2.37)	(34.18)	(1.53)	(-11.33)	(-45.80)	(-4.52)
cons				0.149	0.145***	0.145
				(0.70)	(5.29)	(0.27)
No. of obv	4482	4482	4482	4482	4482	4482
No. of countries	166	166	166	166	166	166
AR(1)	-18.490***	-2.170**	-2.165**	-18.900***	-1.926*	-1.921*
AR(2)	-1.028	-0.535	-0.520	-0.917	-0.441	-0.432
Hansen		149.6	149.6		148.9	148.9
Sargan	1982.9***	1982.9***	1982.9***	2260.6***	2260.6***	2260.6***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

However, the result in table 4.2 shows that temperature has inverted U-shape impact on economic growth at 1 percent significance level. The threshold level for temperature is computed by using equation (18), and anti-ln is apply to get the threshold level in degree Celsius. Firstly, when the temperature increases, it leads to an increase in economic growth. However, when the temperature rise above the threshold level of 1.008 ($-\frac{0.131.}{2(-0.065)}\ x\ e$) degree Celsius, the economic growth starts to decrease. The current result is consistent with the findings of Burke, Hsiang & Miguel (2015); Alagidede, Adu & Frimpong (2016). The reason behind is because below a threshold temperature, the increasing temperature generally boost the production of agriculture sector. However, when the temperature rise above the threshold level, it starts to damage the crops and hence lead to a decrease in output of agriculture. As a consequences, the industrial growth and job available in the agriculture sector will be reduced (Alagidede, Adu & Frimpong, 2016). Furthermore, extreme high temperature has also impacted the tourism in a country which eventually leads to a decrease in GDP from the tourism sector (Ridderstaat, Oduber, Croes, Nijkamp, & Martens, 2014).

Table 4.3:

Results of dynamic panel GMM estimation in overall countries for precipitation (linear)

	Model (13) Difference GMM One Step	Model (14) Difference GMM Two Step	Model (15) Difference GMM Two Step Robust	Model (16) System GMM One Step	Model (17) System GMM Two Step	Model (18) System GMM Two Step Robust
GDP	1.078***	1.079***	1.079***	1.165***	1.165***	1.165***
	(33.82)	(454.26)	(28.43)	(62.14)	(701.77)	(9.84)
GFCF	-0.216***	-0.215***	-0.215***	-0.268***	-0.268***	-0.268***
	(-8.44)	(-82.15)	(-6.82)	(-14.22)	(-140.37)	(-3.15)
TO	0.119	0.117***	0.117	0.268***	0.273***	0.273
	(1.21)	(15.59)	(0.92)	(2.75)	(34.30)	(1.09)
LAB	0.680***	0.665***	0.665***	0.592***	0.584***	0.584***
	(11.19)	(51.39)	(7.22)	(11.96)	(70.36)	(4.40)
PREC	-0.136**	-0.138***	-0.138**	-0.204***	-0.204***	-0.204**
	(-2.10)	(-39.35)	(-2.48)	(-3.27)	(-98.15)	(-1.97)
cons				-5.656***	-5.598***	-5.598**
				(-5.60)	(-80.66)	(-2.10)
No. of obv	4482	4482	4482	4482	4482	4482
No. of countries	166	166	166	166	166	166
AR(1)	-16.020***	-4.731***	-4.494***	-16.630***	-4.731***	-3.689***
AR(2)	-0.282	-0.116	-0.113	0.388	0.145	0.135
Hansen		146.5	146.5		146.8	146.8
Sargan	751.2***	751.2***	751.2***	1205.2***	1205.2***	1205.2***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Next, the result in table 4.3 showed that precipitation has negative impact on economic growth at 5 percent significance level. Furthermore, an increase of 1 percent in precipitation, leads to a decrease of 0.204 percent in GDP per capita, on average, ceteris paribus. The changes in precipitation has a negative impact on economic growth, more specifically it damages the agriculture as it causes flood and storms (Guo, Xu, Gong, 2014).

Table 4.4:

Results of dynamic panel GMM estimation in overall countries for precipitation (non-linear)

	Model (19) Difference GMM One Step	Model (20) Difference GMM Two Step	Model (21) Difference GMM Two Step Robust	Model (22) System GMM One Step	Model (23) System GMM Two Step	Model (24) System GMM Two Step Robust
GDP	0.433^{***}	0.433^{***}	0.433^{***}	0.539^{***}	0.539^{***}	0.539^{***}
	(41.92)	(328.10)	(5.92)	(69.35)	(377.11)	(8.12)
GFCF	0.382^{***}	0.383^{***}	0.383^{***}	0.462^{***}	0.462^{***}	0.462^{***}
	(41.16)	(244.60)	(4.25)	(54.15)	(429.82)	(6.27)
TO	0.013	0.013^{***}	0.013	0.011	0.011^{***}	0.011
	(1.00)	(10.60)	(1.41)	(0.75)	(9.23)	(1.04)
LAB	0.207^{***}	0.199^{***}	0.199	-0.405^{***}	-0.404^{***}	-0.404^{***}
	(6.67)	(29.51)	(1.27)	(-22.48)	(-75.59)	(-4.47)
PREC	-0.197^{***}	-0.196^{***}	-0.196	0.291^{***}	0.293^{***}	0.293^{***}
	(-3.74)	(-44.80)	(-1.49)	(7.60)	(41.00)	(2.84)
PREC^2	0.026^{***}	0.026^{***}	0.026	-0.038^{***}	-0.038^{***}	-0.038^{***}
	(3.79)	(51.55)	(1.62)	(-7.81)	(-46.94)	(-2.87)
cons				-1.163^{***}	-1.182^{***}	-1.182^{**}
				(-5.47)	(-16.26)	(-1.98)
No. of obv	4482	4482	4482	4482	4482	4482
No. of countries	166	166	166	166	166	166
AR(1)	-18.910***	-2.403**	-2.394**	-19.800***	-2.154**	-2.148**
AR(2)	-1.182	-0.689	-0.659	-0.652	-0.333	-0.325
Hansen		148.1	148.1		148.9	148.9
Sargan	1933.6^{***}	1933.6^{***}	1933.6^{***}	2677.8^{***}	2677.8^{***}	2677.8^{***}

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

However, table 4.4 shows that precipitation has inverted U-shape impact on economic growth at 1 percent significance level. The threshold level for precipitation is computed by using equation (18), and anti-ln is applied to get the threshold level in millimetre. When the precipitation below threshold level of 3.855 ($-\frac{0.293.}{2(-0.038)}\ x\ e$) millimetre (mm), the precipitation has positive impact to the economic growth. However, when the precipitation rose above the threshold level, it started to damage the economic growth. A normal precipitation below a threshold level boosts the corps output but extreme heavy rain causes flood and storm which harms the overall agriculture production (Guo, Xu, Gong, 2014).

Table 4.5:

Results of dynamic panel GMM estimation in overall countries for carbon dioxide emission (linear)

	Model (25) Difference GMM One Step	Model (26) Difference GMM Two Step	Model (27) Difference GMM Two Step Robust	Model (28) System GMM One Step	Model (29) System GMM Two Step	Model (30) System GMM Two Step Robust
GDP	0.384^{***}	0.383^{***}	0.383^{***}	0.600^{***}	0.599^{***}	0.599^{***}
	(19.19)	(265.40)	(6.51)	(41.49)	(447.95)	(12.65)
GFCF	0.569^{***}	0.569^{***}	0.569^{***}	0.407^{***}	0.408^{***}	0.408^{***}
	(29.37)	(1190.83)	(10.65)	(28.49)	(454.39)	(9.03)
TO	-0.017	-0.017^{***}	-0.017	-0.016	-0.016^{***}	-0.016
	(-1.08)	(-28.16)	(-1.41)	(-1.12)	(-25.54)	(-1.42)
LAB	-0.0619	-0.0545^{***}	-0.0545	-0.556^{***}	-0.557^{***}	-0.557^{***}
	(-1.05)	(-5.00)	(-0.33)	(-24.07)	(-224.79)	(-7.47)
CO_2	-0.249^{***}	-0.249^{***}	-0.249^{***}	0.068^{***}	0.069^{***}	0.069^{**}
	(-10.45)	(-131.89)	(-3.68)	(12.95)	(76.63)	(2.55)
cons				2.000^{***}	2.010^{***}	2.010^{***}
				(9.13)	(65.59)	(2.92)
No. of obv	4482	4482	4482	4482	4482	4482
No. of countries	166	166	166	166	166	166
AR(1)	-15.94^{***}	-1.446	-1.443	-18.44^{***}	-2.451^{**}	-1.677^{**}
AR(2)	-0.070	-0.026	-0.026	-1.677^{**}	-0.945	-0.934
Hansen		145.3	145.3		149.2	149.2
Sargan	416.2^{***}	416.2^{***}	416.2^{***}	1074.7^{***}	1074.7^{***}	1074.7^{***}

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Table 4.5 shows that carbon dioxide emission has positive impact on economic growth at 5 percent significance level. For every 1 percent increase of carbon dioxide emission leads to an increase of 0.069 percent in GDP per capita, on average, ceteris paribus. The results is consistent with the finding of Bozkurt (2014), where the research showed that carbon dioxide emission has positively significant impact on the economic growth. In simple words, higher carbon dioxide emission which means higher industrial production (Chang, 2010).

Table 4.6:

Results of dynamic panel GMM estimation in overall countries for carbon dioxide emission (non-linear)

	Model (31) Difference GMM One Step	Model (32) Difference GMM Two Step	Model (33) Difference GMM Two Step Robust	Model (34) System GMM One Step	Model (35) System GMM Two Step	Model (36) System GMM Two Step Robust
GDP	0.347***	0.348***	0.348***	0.558***	0.559***	0.559***
	(16.84)	(355.74)	(6.00)	(37.56)	(754.41)	(13.04)
GFCF	0.571***	0.571***	0.571***	0.444***	0.444***	0.444***
	(30.15)	(1958.56)	(11.38)	(29.98)	(967.40)	(10.88)
TO	-0.009	-0.009***	-0.009	-0.008	-0.008***	-0.008
	(-0.68)	(-25.24)	(-1.22)	(-0.67)	(-41.36)	(-1.02)
LAB	-0.212***	-0.213***	-0.213*	-0.552***	-0.553***	-0.553***
	(-4.26)	(-42.60)	(-1.65)	(-27.17)	(-212.07)	(-9.16)
CO_2	-0.450***	-0.450***	-0.450**	-0.191***	-0.193***	-0.193*
	(-9.57)	(-88.89)	(-2.54)	(-6.07)	(-21.02)	(-1.77)
CO_2^2	0.021***	0.021***	0.021**	0.013***	0.013***	0.013**
	(7.38)	(77.37)	(2.13)	(8.37)	(27.55)	(2.28)
cons				2.514***	2.536***	2.536***
				(12.74)	(47.16)	(3.51)
No. of obv	4482	4482	4482	4482	4482	4482
No. of countries	166	166	166	166	166	166
AR(1)	-16.160***	-1.369	-1.394	-17.730***	-2.109**	-2.107**
AR(2)	0.306	0.120	0.120	-1.227	-0.649	-0.644
Hansen		148.2	148.2		148.3	148.3
Sargan	460.7***	460.7***	460.7***	901.1***	901.1***	901.1***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

However, table 4.6 shows that carbon dioxide emission has U-shape impact on economic growth at 5 percent significance level. The threshold level for carbon dioxide emission is computed by using equation (18), and anti-ln is applied to get the threshold level in kilotons. Carbon dioxide emission has negative impact on economic growth below the threshold level of 7.423 ($-\frac{0.193.}{2(-0.013)}$ $x\ e$) kilotons (kt). However, the carbon dioxide emission started to have positive effect on economic growth above the threshold level. The result is inconsistent with the result of the Wang & Li (2019) which shows that the carbon dioxide emissions exhibits an inverted U-shape with economic growth. The reason is because of the mixed impact on developed countries and developing countries which lead to this unexpected impact.

4.1.2 Linear and Non-Linear Developed (Temperature, Precipitation and Carbon Dioxide Emission)

Table 4.7:

Results of dynamic panel GMM estimation in developed countries for temperature (linear)

	Model (37) Difference GMM One Step	Model (38) Difference GMM Two Step	Model (39) Difference GMM Two Step Robust	Model (40) System GMM One Step	Model (41) System GMM Two Step	Model (42) System GMM Two Step Robust
GDP	-0.007	-0.006***	-0.006	0.260***	0.238***	0.238***
	(-0.36)	(-2.63)	(-0.21)	(4.51)	(20.03)	(4.80)
GFCF	0.781***	0.782***	0.782***	0.785***	0.804***	0.804***
	(39.05)	(185.72)	(29.65)	(12.14)	(73.05)	(18.75)
TO	0.005	0.005***	0.005	0.007	0.008***	0.008
	(0.80)	(2.93)	(1.47)	(0.22)	(2.85)	(1.11)
LAB	-0.126	-0.119**	-0.119	-0.668***	-0.690***	-0.690***
	(-0.79)	(-2.08)	(-0.72)	(-9.68)	(-19.48)	(-6.57)
TEMP	0.022	0.021	0.021	0.118	0.140***	0.140*
	(1.04)	(1.21)	(0.63)	(1.13)	(5.56)	(1.90)
cons				-2.044**	-2.050***	-2.050
				(-2.13)	(-5.63)	(-1.60)
No. of obv	837	837	837	837	837	837
No. of countries	31	31	31	31	31	31
AR(1)	6.424***	3.353***	3.313***	0.785	2.202**	2.172**
AR(2)	0.651	0.595	0.588	-0.473	-1.382	-1.334
Hansen		29.91	29.91		26.91	26.91
Sargan	186.2***	186.2***	186.2***	31.50	31.50	31.50

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Based on the table 4.7, the result shows that temperature has positive impact on economic growth at 10 percent significance level. An increase in 1 percent in temperature leads to an increase of 0.140 percent in GDP per capita, on average, ceteris paribus. Higher temperature has benefited the crops production which leads to higher real GDP in agriculture sector (Pei et al., 2016).

Table 4.8:

Results of dynamic panel GMM estimation in developed countries for precipitation (linear)

	Model (43) Difference GMM One Step	Model (44) Difference GMM Two Step	Model (45) Difference GMM Two Step Robust	Model (46) System GMM One Step	Model (47) System GMM Two Step	Model (48) System GMM Two Step Robust
GDP	0.309***	0.285***	0.285***	0.355***	0.339***	0.339***
	(7.66)	(16.94)	(3.78)	(12.95)	(16.91)	(3.32)
GFCF	0.735***	0.738***	0.738***	0.712***	0.734***	0.734***
	(21.41)	(44.34)	(10.82)	(22.51)	(47.31)	(9.18)
TO	0.019	0.010	0.010	0.076	0.070*	0.070
	(0.33)	(0.56)	(0.22)	(1.52)	(1.84)	(0.65)
LAB	-0.584***	-0.439***	-0.439	-0.700***	-0.714***	-0.714***
	(-3.50)	(-3.53)	(-1.52)	(-20.24)	(-15.87)	(-3.36)
PREC	0.537***	0.419***	0.419**	0.660***	0.627***	0.627***
	(4.80)	(5.30)	(2.23)	(7.03)	(12.25)	(3.89)
cons				-3.681***	-3.677***	-3.677
				(-7.21)	(-4.45)	(-1.14)
No. of obv	837	837	837	837	837	837
No. of countries	31	31	31	31	31	31
AR(1)	-4.097***	-2.709***	-1.703*	-5.533***	-2.85***	-2.338**
AR(2)	-1.949*	-1.586	-1.545	-1.981**	-1.684*	-1.645
Hansen		27.08	27.08		28.39	28.39
Sargan	86.53***	86.53***	86.53***	145.0***	145.0***	145.0***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

However, the table 4.8 shows that precipitation has positive impact on economic growth in developed countries at 1 percent significance level. An increase of 1 percent in precipitation, leads to an increase of 0.627 percent in GDP per capita, on average, ceteris paribus. In short, higher amount of precipitation leads to higher economic growth (Ali et al, 2019). In addition, the findings stated that higher amounts of precipitation causes higher real GDP (Pei et al., 2016)

Table 4.9:

Results of dynamic panel GMM estimation in developed countries for carbon dioxide emission (linear)

	Model (49) Difference GMM One Step	Model (50) Difference GMM Two Step	Model (51) Difference GMM Two Step Robust	Model (52) System GMM One Step	Model (53) System GMM Two Step	Model (54) System GMM Two Step Robust
GDP	0.079***	0.076***	0.076**	0.282***	0.270***	0.270***
	(5.06)	(10.00)	(2.08)	(16.74)	(31.50)	(3.94)
GFCF	0.724***	0.732***	0.732***	0.698***	0.702***	0.702***
	(45.96)	(69.11)	(13.39)	(41.12)	(60.64)	(12.12)
TO	0.001	0.001**	0.001	-0.003	-0.003***	-0.003
	(0.26)	(2.02)	(0.34)	(-0.38)	(-2.85)	(-0.75)
LAB	0.529***	0.470***	0.470**	-0.0587**	-0.0767***	-0.0767
	(10.11)	(8.57)	(1.96)	(-2.72)	(-3.05)	(-0.45)
CO2	-0.0999***	-0.108***	-0.108	-0.688***	-0.654***	-0.654***
	(-2.96)	(-6.60)	(-1.02)	(-22.21)	(-24.50)	(-4.25)
cons				-1.219***	-1.294***	-1.294
				(-9.74)	(-7.01)	(-1.42)
No. of obv	837	837	837	837	837	837
No. of countries	31	31	31	31	31	31
AR(1)	4.154***	2.954***	2.420**	-3.723***	-2.432**	-2.078**
AR(2)	0.0157	0.0392	0.0379	-3.065***	-1.693*	-1.634
Hansen		27.25	27.25		28.47	28.47
Sargan	492.8***	492.8***	492.8***	511.6***	511.6***	511.6***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Besides, based on the table 4.9, carbon dioxide emission has negative impact on economic growth at 1 percent significance level. An increase in 1 percent carbon dioxide emission leads to a decrease of 0.654 percent in GDP per capita, on average, ceteris paribus. According to Ejuvbekpokpo (2014), higher carbon dioxide emission causes the global mean temperature to increase which is known as global warming. Global warming then increases the probability of human conflict (Hsiang, Burke, Miguel, 2013). As a result, it has reduced the growth rate in total factor productivity as it causes negative impact to the institution that protect property rights.

Table 4.10:

Results of dynamic panel GMM estimation in developed countries for temperature (non-linear)

	Model (55) Difference GMM One Step	Model (56) Difference GMM Two Step	Model (57) Difference GMM Two Step Robust	Model (58) System GMM One Step	Model (59) System GMM Two Step	Model (60) System GMM Two Step Robust
GDP	0.011	0.013**	0.013	0.194**	0.195***	0.195***
	(0.55)	(2.52)	(0.50)	(2.34)	(31.83)	(3.30)
GFCF	0.677***	0.685***	0.685***	0.881***	0.869***	0.869***
	(19.37)	(84.62)	(16.11)	(8.65)	(99.80)	(13.40)
TO	0.004	0.003***	0.003	0.001	0.006***	0.006
	(0.90)	(8.24)	(1.24)	(0.19)	(5.75)	(1.09)
LAB	0.239	0.200***	0.200	-0.722***	-0.727***	-0.727***
	(1.42)	(5.35)	(1.10)	(-7.34)	(-36.24)	(-5.74)
TEMP	0.032	0.036***	0.036	0.067	0.090***	0.090*
	(1.01)	(7.57)	(0.77)	(0.35)	(5.15)	(1.73)
TEMP^2	0.001	0.001	0.001	0.016	0.016***	0.016*
	(0.22)	(1.10)	(0.10)	(0.45)	(7.04)	(1.77)
cons				-2.885**	-2.629***	-2.629
				(-2.09)	(-8.74)	(-1.52)
No. of obv	837	837	837	837	837	837
No. of countries	31	31	31	31	31	31
AR(1)	6.751***	3.705***	3.402***	1.024	2.404**	2.363**
AR(2)	0.335	0.339	0.333	-0.0707	-0.203	-0.190
Hansen		29.49	29.49		28.24	28.24
Sargan	96.24***	96.24***	96.24***	12.98	12.98	12.98

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Table 4.11:

Results of dynamic panel GMM estimation in developed countries for precipitation (non-linear)

	Model (61) Difference GMM One Step	Model (62) Difference GMM Two Step	Model (63) Difference GMM Two Step Robust	Model (64) System GMM One Step	Model (65) System GMM Two Step	Model (66) System GMM Two Step Robust
GDP	0.300***	0.303***	0.303***	0.367***	0.369***	0.369***
	(7.35)	(15.51)	(4.07)	(21.34)	(22.66)	(3.94)
GFCF	0.699***	0.700***	0.700***	0.677***	0.682***	0.682***
	(24.76)	(55.06)	(12.47)	(34.65)	(73.01)	(10.22)
TO	-0.105**	-0.104***	-0.104	-0.052	-0.046*	-0.046
	(-2.10)	(-9.16)	(-1.15)	(-1.40)	(-1.89)	(-0.78)
LAB	-0.306**	-0.288***	-0.288	-0.600***	-0.610***	-0.610***
	(-2.19)	(-6.43)	(-1.63)	(-34.31)	(-16.02)	(-3.74)
PREC	0.421***	0.375***	0.375**	0.452***	0.404***	0.404***
	(4.14)	(6.36)	(2.48)	(7.44)	(9.58)	(3.09)
PREC^2	-0.001	-0.002**	-0.002	0.010***	0.009***	0.009**
	(-0.33)	(-2.51)	(-0.72)	(4.43)	(8.11)	(2.08)
cons				-2.819***	-2.650***	-2.650
				(-7.14)	(-5.34)	(-1.04)
No. of obv	837	837	837	837	837	837
No. of countries	31	31	31	31	31	31
AR(1)	-3.686***	-2.431**	-1.574	-5.637***	-2.929***	-2.143**
AR(2)	-1.743*	-1.999**	-1.923*	0.575	0.295	0.253
Hansen		26.76	26.76		28.78	28.78
Sargan	121.1***	121.1***	121.1***	328.7***	328.7***	328.7***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Table 4.12:

Results of dynamic panel GMM estimation in developed countries for carbon dioxide emission (non-linear)

	Model (67) Difference GMM One Step	Model (68) Difference GMM Two Step	Model (69) Difference GMM Two Step Robust	Model (70) System GMM One Step	Model (71) System GMM Two Step	Model (72) System GMM Two Step Robust
GDP	-0.001	-0.003	-0.003	0.208*	0.205***	0.205***
	(-0.05)	(-0.36)	(-0.06)	(1.73)	(11.97)	(3.92)
GFCF	0.731***	0.733***	0.733***	0.771***	0.779***	0.779***
	(40.01)	(97.22)	(21.16)	(6.87)	(37.92)	(13.58)
TO	0.021	0.012*	0.019	0.129	0.119**	0.119
	(1.46)	(1.67)	(0.83)	(0.97)	(2.20)	(0.85)
LAB	0.640***	0.623***	0.623***	0.086	0.076	0.076
	(4.30)	(13.28)	(3.02)	(0.35)	(0.81)	(0.24)
CO_2	-0.143***	-0.149***	-0.149	-0.614*	-0.616***	-0.616**
	(-2.89)	(-4.13)	(-1.64)	(-1.91)	(-13.85)	(-3.12)
CO_2^2	0.000	0.001	0.001	-0.013	-0.012***	-0.012*
	(0.20)	(0.53)	(0.21)	(-0.82)	(-4.87)	(-1.75)
cons				-4.682	-4.651***	-4.651*
				(-1.55)	(-5.02)	(-1.95)
No. of obv	837	837	837	837	837	837
No. of countries	31	31	31	31	31	31
AR(1)	3.626***	2.760***	2.431**	-0.628	-2.239*	-1.706*
AR(2)	0.465	0.418	0.392	0.269	1.525	0.847
Hansen		30.34	30.34		30.28	30.28
Sargan	225.6***	225.6***	225.6***	11.94	11.94	11.94

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Based on table 4.10, 4.11, and 4.12, all three climate variables (temperature, precipitation and carbon dioxide emission) do not have non-linear impact on economic growth. One of the reasons is because developed countries acquire advanced technology such as cloud seeding and ionization process to mitigate the extreme climate damage such as high temperature and heavy precipitation. Furthermore, the agriculture sector in developed countries have acquire advanced biotechnologies which increase the adaptability of crops in the extreme situation such as drought and salinity. Hence, the output of agriculture are not being affected and the impacts is remain positive (Olmstead & Rhode, 2010; Barreca, Clay, Deschenes, Greenstone & Shapiro, 2016)

4.1.3 Linear and Non-Linear Developing (Temperature, Precipitation and Carbon Dioxide Emission)

Table 4.13:

Results of dynamic panel GMM estimation in developing countries for temperature (linear)

	Model (73) Difference GMM One Step	Model (74) Difference GMM Two Step	Model (75) Difference GMM Two Step Robust	Model (76) System GMM One Step	Model (77) System GMM Two Step	Model (78) System GMM Two Step Robust
GDP	0.342***	0.342***	0.342***	0.501***	0.500***	0.500***
	(13.54)	(219.36)	(6.53)	(27.76)	(349.42)	(10.31)
GFCF	0.569***	0.569***	0.569***	0.457***	0.457***	0.457***
	(25.23)	(956.76)	(12.21)	(26.45)	(572.59)	(10.09)
TO	0.040	0.039***	0.039	0.012	0.013***	0.013
	(0.53)	(12.52)	(0.53)	(0.17)	(4.79)	(0.19)
LAB	-0.369***	-0.367***	-0.367***	-0.359***	-0.359***	-0.359***
	(-9.05)	(-41.34)	(-3.70)	(-9.89)	(-53.51)	(-3.91)
TEMP	0.231*	0.225***	0.225	-0.268***	-0.268***	-0.268**
	(1.67)	(27.38)	(0.96)	(-14.27)	(-37.44)	(-2.45)
cons				-0.0888	-0.110	-0.110
				(-0.12)	(-1.24)	(-0.09)
No. of obv	3645	3645	3645	3645	3645	3645
No. of countries	135	135	135	135	135	135
AR(1)	-15.07***	-1.451	-1.449	-16.32***	-2.026**	-2.024**
AR(2)	0.898	0.382	0.381	0.00539	0.00427	0.00425
Hansen		118.3***	118.3***		118.0***	118.0***
Sargan	311.2***	311.2***	311.2***	508.6***	508.6***	508.6***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Base on the table 4.13, temperature has negative impact on economic growth at 5 percent significance level. An increase in 1 percent in temperature leads to a decrease of 0.268 percent in GDP per capita, on average, ceteris paribus. This result is similar to the overall result in which temperature is a negative relationship with economic growth. Basically, climate change such as increasing temperature could impact the durability and accelerate the depreciation of stock of capital (Stern and Nicholas, 2013). Besides, necessary resources to oppose the warming impact would decline investment in economic as well as the physical framework, research development and human capital thus minimizing growth (Ali et al, 2019).

Table 4.14:

Results of dynamic panel GMM estimation in developing countries for temperature (non-linear)

	Model (79) Difference GMM One Step	Model (80) Difference GMM Two Step	Model (81) Difference GMM Two Step Robust	Model (82) System GMM One Step	Model (83) System GMM Two Step	Model (84) System GMM Two Step Robust
GDP	0.472***	0.470***	0.470***	0.523***	0.523***	0.523***
	(39.46)	(207.04)	(5.36)	(54.10)	(192.90)	(6.50)
GFCF	0.407***	0.409***	0.409***	0.432***	0.432***	0.432***
	(38.85)	(274.71)	(4.52)	(46.94)	(239.35)	(5.40)
TO	0.014	0.013***	0.013	0.001	0.007***	0.007
	(0.91)	(9.70)	(1.29)	(0.57)	(4.05)	(0.61)
LAB	-0.085***	-0.075***	-0.075	-0.362***	-0.362***	-0.362***
	(-3.13)	(-9.23)	(-0.62)	(-22.11)	(-34.58)	(-4.03)
TEMP	0.198***	0.203***	0.203***	0.352***	0.352***	0.352**
	(3.30)	(19.87)	(3.85)	(5.64)	(28.20)	(2.20)
TEMP^2	-0.000	-0.001	-0.001	-0.116***	-0.114***	-0.114***
	(-0.01)	(-0.43)	(-0.05)	(-9.96)	(-32.09)	(-3.28)
cons				-0.440**	-0.447***	-0.447
				(-2.00)	(-2.87)	(-0.73)
No. of obv	3645	3645	3645	3645	3645	3645
No. of countries	135	135	135	135	135	135
AR(1)	-16.54***	-2.150**	-2.147**	-16.99***	-2.130**	-2.128**
AR(2)	-0.368	-0.200	-0.197	-0.124	-0.0728	-0.0719
Hansen		116.9	116.9		115.8	115.8
Sargan	1529.9***	1529.9***	1529.9***	1890.4***	1890.4***	1890.4***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

However, based on table 4.14, it shows that there is an inverted U-shape impact of temperature on economic growth at 1 percent significance level. The threshold level for temperature is computed by using equation (18), and anti-ln is apply to get the threshold level in degree Celsius. The temperature has positive impact on the economic growth below the threshold level of 4.200 $(-\frac{0.352.}{2(-0.114)}\ x\ e)$ degree Celsius. However, temperature above the threshold level decreases the economic growth. Basically, extremely high temperature damages most of the crops such as wheat and maize. As a consequences, the crops yield has plunged and the affected the GDP from agriculture sector (Alagidede, Adu & Frimpong, 2016)

Table 4.15:

Results of dynamic panel GMM estimation in developing countries for precipitation (linear)

	Model (85) Difference GMM One Step	Model (86) Difference GMM Two Step	Model (87) Difference GMM Two Step Robust	Model (88) System GMM One Step	Model (89) System GMM Two Step	Model (90) System GMM Two Step Robust
GDP	0.313***	0.314***	0.314***	0.656***	0.654***	0.654***
	(11.74)	(181.05)	(5.28)	(38.45)	(179.59)	(14.13)
GFCF	0.553***	0.554***	0.554***	0.327***	0.329***	0.329***
	(24.01)	(442.56)	(10.36)	(18.51)	(103.43)	(9.28)
TO	0.145	0.143***	0.143	0.110	0.108***	0.108
	(1.57)	(36.08)	(1.00)	(1.31)	(22.45)	(0.87)
LAB	-0.192***	-0.205***	-0.205*	-0.280***	-0.284***	-0.284***
	(-3.69)	(-14.66)	(-1.65)	(-5.94)	(-32.31)	(-3.91)
PREC	0.042*	0.042***	0.042	0.090***	0.089***	0.089**
	(1.67)	(28.82)	(0.95)	(3.99)	(27.22)	(1.96)
cons				-1.661	-1.621***	-1.621
				(-1.80)	(-15.35)	(-1.10)
No. of obv	3645	3645	3645	3645	3645	3645
No. of countries	135	135	135	135	135	135
AR(1)	-13.75***	-1.520	-1.513	-16.63***	-3.556***	-3.518***
AR(2)	0.811	0.362	0.361	-1.205	-0.893	-0.878
Hansen		117.6	117.6		118.4	118.4
Sargan	279.8***	279.8***	279.8***	721.1***	721.1***	721.1***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Table 4.16:

Results of dynamic panel GMM estimation in developing countries for precipitation (non-linear)

	Model (91) Difference GMM One Step	Model (92) Difference GMM Two Step	Model (93) Difference GMM Two Step Robust	Model (94) System GMM One Step	Model (95) System GMM Two Step	Model (96) System GMM Two Step Robust
GDP	0.211***	0.212***	0.212***	0.517***	0.519***	0.519***
	(5.17)	(83.08)	(3.26)	(14.95)	(200.25)	(10.10)
GFCF	0.515***	0.513***	0.513***	0.481***	0.480***	0.480***
	(17.45)	(352.30)	(7.44)	(15.47)	(249.84)	(10.74)
TO	0.006	0.010**	0.010	0.005	0.006	0.006
	(0.10)	(2.19)	(0.17)	(0.06)	(1.12)	(0.09)
LAB	-0.032	-0.031**	-0.031	-0.516***	-0.523***	-0.523***
	(-0.21)	(-2.78)	(-0.27)	(-5.47)	(-77.82)	(-4.50)
PREC	-0.034	-0.028***	-0.028	0.194**	0.195***	0.195**
	(-0.58)	(-2.76)	(-0.66)	(2.54)	(14.99)	(2.46)
PREC^2	0.004	0.004***	0.004	-0.025***	-0.025***	-0.025***
	(0.61)	(3.44)	(0.71)	(-2.68)	(-15.44)	(-2.62)
cons				0.464	0.570***	0.570
				(0.34)	(6.07)	(0.44)
No. of obv	3645	3645	3645	3645	3645	3645
No. of countries	135	135	135	135	135	135
AR(1)	-13.60***	-1.343	-1.339	-11.89	-1.869*	-1.859*
AR(2)	0.838	0.308	0.307	-0.0138	-0.0128	-0.0128
Hansen		116.2	116.2		116.8	116.8
Sargan	222.4***	222.4***	222.4***	255.8***	255.8***	255.8***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Besides, table 4.15 shows that precipitation has positive impact on economic growth at 5 percent significance level. An increase of 1 percent in precipitation, leads to an increase of 0.089 percent in GDP per capita, on average, ceteris paribus. This can be explained by higher amount of precipitation benefits the growth of crops and eventually helps the agriculture sector (Pei et al, 2016). However, table 4.16 shows that the precipitation has inverted U-shape impact on economic growth. The threshold level for precipitation is computed by using equation (18), and anti-ln is apply to get the threshold level in millimetre. Increasing precipitation benefits the economic growth but when the amount of precipitation exceeded the threshold level of 10.601 ($-\frac{0.195.}{2(-0.025)}\ x\ e$) millimetre (mm), it starts to decrease the economic growth. Extremely high amount of precipitation damages the infrastructure and it delays the construction process. As a result, precipitation has caused negative impact on the construction industry which leads to a decrease the growth rate of GDP in construction sector (Hsiang, 2010).

Table 4.17:

Results of dynamic panel GMM estimation in developing countries for carbon dioxide emission (linear)

	Model (97) Difference GMM One Step	Model (98) Difference GMM Two Step	Model (99) Difference GMM Two Step Robust	Model (100) System GMM One Step	Model (101) System GMM Two Step	Model (102) System GMM Two Step Robust
GDP	0.417***	0.417***	0.417***	0.573***	0.572***	0.572***
	(17.66)	(671.21)	(6.88)	(30.90)	(558.38)	(11.77)
GFCF	0.530***	0.530***	0.530***	0.410***	0.410***	0.410***
	(24.10)	(1162.76)	(9.75)	(22.30)	(731.54)	(9.65)
TO	-0.016	-0.016***	-0.016	-0.017	-0.018***	-0.018
	(-0.71)	(-9.35)	(-1.29)	(-0.78)	(-10.13)	(-1.18)
LAB	-0.227***	-0.218***	-0.218	-0.561***	-0.560***	-0.560***
	(-3.90)	(-23.53)	(-1.61)	(-15.46)	(-157.96)	(-6.09)
CO_2	-0.119***	-0.122***	-0.122***	0.086***	0.087***	0.087***
	(-5.87)	(-52.69)	(-2.88)	(13.56)	(103.54)	(3.04)
cons				2.062***	2.057***	2.057**
				(6.03)	(52.61)	(2.03)
No. of obv	3645	3645	3645	3645	3645	3645
No. of countries	135	135	135	135	135	135
AR(1)	-15.11***	-1.544	-1.541	-16.78***	-2.270**	-2.264**
AR(2)	0.254	0.117	0.116	-0.507	-0.301	-0.299
Hansen		116.5	116.5		116.6	116.6
Sargan	380.9***	380.9***	380.9***	727.8***	727.8***	727.8***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

Besides, table 4.17 showed that carbon dioxide emission has positive impact on economic growth at 1 percent significance level. An increase in 1 percent carbon dioxide emission leads to an increase of 0.068 percent in GDP per capita, on average, ceteris paribus. In short, higher carbon dioxide emission which indicates that higher industrial production which leads to a higher economic growth (Chang, 2010).

Table 4.18:

Results of dynamic panel GMM estimation in developing countries for carbon dioxide emission (non-linear)

	Model (103) Difference GMM One Step	Model (104) Difference GMM Two Step	Model (105) Difference GMM Two Step Robust	Model (106) System GMM One Step	Model (107) System GMM Two Step	Model (108) System GMM Two Step Robust
GDP	0.980***	0.981***	0.981***	1.095***	1.097***	1.097***
	(42.12)	(451.63)	(26.84)	(58.14)	(518.86)	(31.02)
GFCF	-0.060***	-0.060***	-0.060**	-0.101***	-0.102***	-0.102***
	(-3.37)	(-67.99)	(-2.36)	(-5.69)	(-68.25)	(-2.94)
TO	0.042	0.042***	0.042	0.031	0.031***	0.031
	(0.88)	(35.81)	(0.91)	(0.60)	(21.09)	(0.78)
LAB	0.458***	0.457***	0.457***	0.114***	0.118***	0.118**
	(5.72)	(64.82)	(4.51)	(4.30)	(17.98)	(2.33)
CO_2	0.114**	0.114***	0.114	0.261***	0.258***	0.258***
	(2.04)	(50.10)	(1.61)	(6.36)	(63.59)	(5.30)
CO_2^2	-0.007***	-0.007***	-0.007**	-0.013***	-0.013***	-0.013***
	(-3.27)	(-43.07)	(-2.13)	(-6.42)	(-110.37)	(-4.93)
cons				-1.695***	-1.733***	-1.733***
				(-3.51)	(-23.54)	(-3.12)
No. of obv	3645	3645	3645	3645	3645	3645
No. of countries	135	135	135	135	135	135
AR(1)	-15.44***	-4.225***	-4.049***	-16.23***	-4.183***	-4.007***
AR(2)	-1.754*	-0.887	-0.860	-1.723*	-0.800	-0.774
Hansen		116.3	116.3		115.1	115.1
Sargan	562.8***	562.8***	562.8***	539.5***	539.5***	539.5***

Notes: t statistics are shown in parentheses. *, **, and *** are representing the significant level at 10 percent, 5 percent, and 1 percent, respectively.

However, table 4.18 shows that carbon dioxide emission has an inverse U-shape impact on economy growth at 5 percent significance level. The threshold level for carbon dioxide emission is computed by using equation (18), and anti-ln is apply to get the threshold level in kilotons. The threshold level for carbon dioxide emission is 26.974 ($-\frac{0.258.}{2\,(-0.013)}\; x\; e$) kilotons (kt) which indicates that the carbon dioxide emission could increase the economic growth below the threshold level. However, it causes negative impact on economic growth when the carbon dioxide emission exceeded the threshold level. This can explained by when the carbon dioxide emission is increasing in the early stage, it signified that the industrial production is booming. However, increasing the emission of carbon dioxide will lead to increase in temperature which is known as global warming. Global warming will then cause disastrous impacts to the economy. One of the impacts can be extremely high temperature which cause unexpected damage to the agriculture production (Alagidede, Adu & Frimpong, 2016).

4.2 Diagnostic Checking

The diagnostic test include in the models are Arellano-Bond test for AR (1), Arellano-Bond test for AR (2), Hansen and Sargan test. AR(1) is to detect the first order serial correlation while AR(2) is to detect the second order serial correlation. The result of AR (2) is more valid compared to AR(1) because error terms is taken into account. Based on the empirical results, each p-value of AR(1) are less than 0.1 respectively. This result is expected to happened, because dynamic panel data capture the lagged one effect. Hence, lagged one term (t-1) would affect the present term (t). However, the conclusion from the result of AR(2) which show that all the models has no autocorrelation and model misspecification error. Furthermore, Hansen/Sargan test is to determine the validity of instrument used and the overall Hansen test p-value are more than 0. It signifies that all the independent variables are valid in the model.

4.3 Conclusion

In this chapter, the results for three climate variables (temperature, precipitation and carbon dioxide emission) show that there is only linear relationship between climate change and economic growth in developed countries but does not contain non-linear relationship. In short, the temperature and precipitation show positive relationship with economic growth whereas carbon dioxide emission shows negative relationship with economic growth due to the advanced technology in developed countries which unable the to mitigate the climate damage (Olmstead & Rhode, 2010; Barreca, Clay, Deschenes, Greenstone & Shapiro, 2016).

However, the results conclude that all three climate variables (temperature, precipitation and carbon dioxide emission) have a non-linear relationship (inverted U-shaped) with economic growth in developing countries. This shows that the rising climate variables are able to increase the economic growth until a threshold level, after the threshold level all climate variables will start to cause an adverse impact on the economic growth in the developing countries. Our threshold level for temperature, precipitation and carbon dioxide emission are 4.200 degree Celsius, 10.601 millimeter and 26.974 kilotons respectively. In conclusion, climate change will cause negative impact on economic growth in many different aspects. The climate damage cause to the sector could range from tourism, agriculture and construction sector. Apart from that, it could also increase the depreciation rate of infrastructure as well as human conflicts. A summary of major findings, conclusion, limitation and recommendation will be discussed in the following chapter.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATION

5.0 Introduction

The purpose of this research is to examine the impact of climate change on economic growth in overall countries. This research uses GMM as our methodology to examine the impact of climate change on economic growth. In this chapter, this research discuss about the summary of study, policy implications, limitations and recommendations.

5.1 Summary of Study

In the twenty first century, climate change identifies as a threat towards the environmental (Abidoye & Odusola, 2015). The aspiration of this research is to examine the impact of climate change on economic growth in overall, developed and developing countries. This research also intends to determine non-linear impact of climate change on the economic growth in overall, developed and developing countries. Besides, gross fixed capital formation, labour force and trade openness also include as independent variable. This research uses 31 developed countries and 135 out of 158 developing countries from World Population Review. The data period in this research is 27 years which is from year 1990 until year 2016.

All independent variables are significant to the dependent variable except for the trade openness. As for labour force and gross fixed capital formation are consistent with this research's expectation which the total labour shows a negative impact towards economic growth while gross fixed capital formation shows a positive impact towards economic growth. This is due to the use of cheap labour as comparative advantages and labour may lead to loss of ability to innovate which cause the economic growth to decline (Amir et al., 2015). On the other hand, gross fixed capital formation shows positive impact towards economic growth is because build capital equipment on an enough scale to increase productivity for the creation of economic and social overhead capital. Besides, capital formation helps to remove the market imperfection by breaking the viciousness of poverty by increasing economic spending (Emmanuel & Andrew, 2014).

As for linear impact of climate change towards economic growth, there are mixed result in overall, developing and developed countries. Besides, the major findings for this research is the non-linear impact of climate change towards economic growth in overall, developed and developing countries. All the independent variables such as temperature, precipitation and carbon dioxide emission for climate change shows inverse U-shape impact on economic growth. Schlenker and Robert (2008) found that rising in temperature helps the economic growth before it reached to the threshold level. However, the temperature will harm the agriculture when it exceeds the threshold point. In addition, Zhao et al., (2018) said that developing countries has a stronger non-linear relationship between climate change and economic growth. Nevertheless, this research shows that climate change only has linear impact towards economic growth in developed countries. The reason is because developed countries use advanced technology or infrastructure to control the growth of agriculture which climate change does not affect much on economic growth. Ali et al. (2017) found that extreme precipitation has the damaging effect on economy but it was unaffected to the economic growth in developed countries. Hence, this research can conclude that climate change shows inverted U-shape impact towards economic growth in developing countries whereas climate change do not have non-linear impact on economic growth in developed countries which the result is consistent with (Zhao et al., 2018).

5.2 Policy Implication

This research identifies non-linear impact of the climate change on the developing countries' economic growth. The results present that climate change shows inverse U-shape impact on economic growth in developing countries. The policymaker shall aware that an increase in temperature show positive impact on economic growth at the beginning but it might cause harm when it exceeded certain level. According to Colacito et al. (2019) said that some industries such as utilities and mining can benefit from increasing energy consumption when temperature increase. However, as the temperature continue to rise, it brings negative impact towards human health and economy growth. Human health will be affected which in resulting in hospitalization. However, the insurance sector will be affected which insurer face increase claim from insurance companies as health becomes worsen due to climate change (Colacito et al, 2019).

Therefore, the policymaker shall consider this research as a reference to implement new policy as this research provides threshold point for all countries. Before the temperature reach to certain threshold point, the policymaker can consider cloud seeding as a method to supervise the climate fluctuation. Cloud seeding is a method of weather modification that focuses on altering the precipitation falls from the cloud by releasing substances into the air that will form as ice nuclei to reduce the surrounding temperature. Moreover, the policymakers can consider WeatherTec Ionization Technology which will enhance precipitation in semi-arid regions. Ionization process can increase natural precipitation development by mirroring the sun's ionization and this process is environment-friendly which does not make pollution to Earth. Thus, the policymakers can prevent the countries' economic growth to decline by using two methods above in order to mitigate the impact that cause by climate change.

Climate change can reduce countries' economic growth if it is not controlled effectively (Akram, 2013). It highlight that Asian countries alone cannot do too much on mitigating climate change risk because their proportion of Green House Gas (GHG) emissions is small compare to developed countries. Carbon dioxide makes up the vast majority of the GHG emission. Based on this research, the non-linear impact for carbon dioxide emission and economic growth is inverse u-shape in developing countries. As the carbon dioxide increase at beginning, it brings positive effect to economic growth. The industry needs to scale up its productivity to boost the economy through increasing the carbon dioxide emission. Once carbon dioxide reaches threshold point, it starts to bring negative impact on economic growth. For example, some species of fish have low tolerance on the extremely high concentration of carbon dioxide as it negatively impacts the ecosystem and eventually harm the fisheries market (Heuer & Grosell, 2014)

Due to the above situation, the policymaker shall consider carbon emission trading policy. This policy enable the companies to trade government-granted allotments of carbon dioxide output. It indicates that the companies can only release certain amount of carbon dioxide emission which are called "cap". This policy aims to restrict the total level of carbon dioxide emission in the result of industry activities. In addition, the optimal path of economic growth with an emphasis on carbon emission efficiencies and the attendant market system. Huge portion of emissions that are emit to the environment is cause by the transportation system. Thus, government and firms shall try to find alternative resources to replace carbon dioxide. For instance, the government can consider practicing bioethanol life cycle assessment (LCA) to reduce the emissions by replace the usage of conventional fuel into bioethanol fuel which are more environmentally friendly (Blottnitz & Curran, 2007). Hence, government can take consideration on creating regional policy by referring to the differences of various aspects among the three economic regions. Important factors such as economic development, technological levels, and industrial structure shall consider on the emission reduction target. Reasonable policies can be practices such as carbon emissions trading in order to motivate industries and society to reduce carbon emissions.

Besides that, climate change is one of the vital determinants to determine economy growth. Therefore, the firms and investor shall consider to include climate change risk into their portfolio investment and risk management. Firms and investors can consider weather derivative which is a financial instrument to hedge against the risk of weather-related losses. There is evidence showed from Woodard and Garcia

(2007) that firms and investor may consider using exchange traded weather derivatives to hedge for climate change risk. Furthermore, the government can establish disaster-prevention plan and knowledge to enhance the awareness of community. The reason is because disaster remediation can be costly to rebuild the city. Supposing the source of funds that utilized for business to enhance the economic growth. The government can consider Japan as a reference for disaster prevention plan such as Fire and Disaster Management Agency (FDMA) and Ministry of Internal Affairs and Communications (MIC) which Japan's local residents has a strong awareness of disaster prevention and can evacuate on their own volition (Nakamura, Umeki &Kato, 2017).

Therefore, an empirical study is necessary to notify the policymakers, investors, firms, communities and government to place all countries properly in an effort directed to mitigate the consequence of climate change toward economic growth.

5.3 Limitation

In this chapter, there are several limitations face by this research which may affect the accuracy of the result. Thus, the results obtain may not able to fully reflect the impact of climate change towards economic growth.

First, the number of observations that use in this research are 27 observations from year 1990 to year 2016. The reason that this research use only 27 observations is because there are few countries got many missing data for each respective variable which are labour force, gross fixed capital formation, trade openness, temperature, precipitation and carbon dioxide emission. In addition, this research also excludes some of the countries as several groups in these results. This is because the countries that have been omitted do not have enough data for this research.

Next, the model in this research do not include human capital but only include gross fixed capital formation as capital variables. Human capital can serve as one of the important variables to assess the long-term sustainability of a country's output and productivity of education sector. However, this research does not include human capital because many countries does not have complete data for human capital in education sector. This research also does not include natural disaster into model because data for natural disaster hard to obtain. Moreover, there are some researcher use natural disaster damage function to represent extreme climate change. Unfortunately, there are many countries do not have insufficient data for natural disaster damage function, hence it omits this variable into the model. Hence, the above limitation that include for this research is due to insufficient data from WDI.

5.4 Recommendation

In this chapter, this research provides some recommendations for future researchers to explore further for this topic. First, the researcher can include a larger sample size which can improve the accuracy and consistency of the result. Based on the limitation above, there are only 27 observations for each country. This research recommends for future researchers to increase the number of observations for future research. On the other hand, there are a total of 189 countries in the World today. However, this research just uses 166 countries for this research. This research omits 23 countries due to insufficient data. Thus, this research hope WDI can fill all the missing data so that the future researcher can get more accurate result. Moreover, the future researcher can do future study for each specific country to find the non-linear climate change impact towards economic growth and the threshold point for each country.

For the capital variable, the future researcher can include human capital for future study which can increase the accuracy of the result. Moreover, the researcher shall consider natural disasters such as hurricane, earthquake or tsunami to represent climate variables for future research since this research just includes average climate change in the model. Natural disasters have a higher possibility of affecting economic growth. The reason behind is higher changes in climate can boost the severity and frequency of climate-related disasters such as cyclones or tsunami. According to Bregholt and Lujala (2012), they found that natural disasters will have a negative effect on economic growth in short-run effect. The companies and government need to repair the damages and enhance policy to prevent future disaster. Therefore, all of the actions above may carry a direct effect on economic growth.

5.5 Conclusion

In this chapter, this research shows non-linear impact of climate change towards economic growth in overall and developing countries. Meanwhile, the developed countries do not have non-linear impact towards economic growth. As for policy implication, the policy maker can consider cloud seeding, WeatherTec Ionization, alternative resources and carbon emission trading policy to minimize the climate change impact on economic growth; the firms and investor can consider weather derivative for their risk management and portfolio investment; the government and community can consider disaster prevention plan and knowledge to enhance the awareness. The limitation for this research is insufficient data for number of observation and each respective variables. In conclusion, this research recommends increasing sample size and include human capital and natural disaster to improve the accuracy of the result.

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Appendices

Temperature linear model 1 (overall)

```
    xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(1 .)collapse)
iv(i.time) nolevel
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3400
    Time variable : time                            Number of groups   =       150
    Number of instruments = 155                     Obs per group: min =         2
    Wald chi2(5)  =  62247.57                                      avg =     22.67
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4526741   .0104173    43.45   0.000     .4322565    .4730917
                 |
             lx1 |   .4049298   .0095794    42.27   0.000     .3861546    .4237051
             lx2 |   .0112586   .0135942     0.83   0.408    -.0153855    .0379027
             lx3 |   -.000982   .0267802    -0.04   0.971    -.0534701    .0515062
             lx4 |   .3211129   .0500179     6.42   0.000     .2230797    .4191461
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -19.03  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.79  Pr > z =  0.432
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(150)  =1947.71  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 .))
        Sargan test excluding group:     chi2(20)   =  68.68  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(130)  =1879.04  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(125)  =1858.19  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(25)   =  89.52  Prob > chi2 =  0.000
```

Temperature linear model 2 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(1 .)collapse)
iv(i.time) nolevel two
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3400
    Time variable : time                            Number of groups   =       150
    Number of instruments = 155                     Obs per group: min =         2
    Wald chi2(5)  =  2.12e+07                                      avg =     22.67
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4531573   .0007856   576.81   0.000     .4516175    .4546971
                 |
             lx1 |   .4044394   .0005534   730.82   0.000     .4033548    .4055241
             lx2 |    .011227   .0008954    12.54   0.000     .0094721     .012982
             lx3 |   .0011199   .0042241     0.27   0.791    -.0071592     .009399
             lx4 |   .3189362    .002639   120.86   0.000     .3137639    .3241085
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.36  Pr > z =  0.018
    Arellano-Bond test for AR(2) in first differences: z =  -0.44  Pr > z =  0.660
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(150)  =1947.71  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(150)  = 148.60  Prob > chi2 =  0.517
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 .))
        Hansen test excluding group:     chi2(20)   =  64.04  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(130)  =  84.56  Prob > chi2 =  0.999
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(125)  = 142.93  Prob > chi2 =  0.130
        Difference (null H = exogenous): chi2(25)   =   5.67  Prob > chi2 =  1.000
```

Temperature linear model 3 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(1 .)collapse)
iv(i.time) nolevel two robust
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3400
    Time variable : time                            Number of groups   =       150
    Number of instruments = 155                     Obs per group: min =         2
    Wald chi2(5)  =   5200.62                                      avg =     22.67
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4531573   .0793493     5.71   0.000     .2976356     .608679
                 |
             lx1 |   .4044394   .0943665     4.29   0.000     .2194846    .5893943
             lx2 |    .011227    .010128     1.11   0.268    -.0086234    .0310774
             lx3 |   .0011199   .1502322     0.01   0.994    -.2933298    .2955697
             lx4 |   .3189362   .1689905     1.89   0.059    -.0122791    .6501515
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.35  Pr > z =  0.019
    Arellano-Bond test for AR(2) in first differences: z =  -0.42  Pr > z =  0.671
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(150)  =1947.71  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(150)  = 148.60  Prob > chi2 =  0.517
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 .))
        Hansen test excluding group:     chi2(20)    =  64.04  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(130)   =  84.56  Prob > chi2 =  0.999
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(125)   = 142.93  Prob > chi2 =  0.130
        Difference (null H = exogenous): chi2(25)    =   5.67  Prob > chi2 =  1.000
```

Temperature linear model 4 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(1 .)collapse)
iv(i.time)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3551
    Time variable : time                            Number of groups   =       150
    Number of instruments = 161                     Obs per group: min =         3
    Wald chi2(5)  = 140964.89                                      avg =     23.67
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4804666     .00834    57.61   0.000     .4641206    .4968126
                 |
             lx1 |   .4924618   .0086153    57.16   0.000      .475576    .5093475
             lx2 |   .0070977   .0148298     0.48   0.632    -.0219681    .0361635
             lx3 |  -.4444522   .0175538   -25.32   0.000    -.4788569   -.4100475
             lx4 |  -.2425195   .0127522   -19.02   0.000    -.2675135   -.2175256
           _cons |   .5407316   .2211081     2.45   0.014     .1073678    .9740955
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -19.48  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.22  Pr > z =  0.826
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(155)  =2310.55  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(150)  =1831.01  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    = 479.54  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 .))
        Sargan test excluding group:     chi2(20)   =  71.10  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(135)  =2239.45  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(130)  =2203.73  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(25)   = 106.82  Prob > chi2 =  0.000
```

Temperature linear model 5 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(1 .)collapse)
iv(i.time) two
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3551
    Time variable : time                            Number of groups   =       150
    Number of instruments = 161                     Obs per group: min =         3
    Wald chi2(5)  =  9.11e+06                                      avg =     23.67
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4799186   .0014245   336.91   0.000     .4771268    .4827105
                 |
             lx1 |   .4929416   .0010534   467.96   0.000      .490877    .4950062
             lx2 |   .0068182    .000829     8.22   0.000     .0051934    .0084429
             lx3 |  -.4461356   .0023744  -187.90   0.000    -.4507893   -.4414819
             lx4 |    -.23958   .0046924   -51.06   0.000    -.2487771    -.230383
           _cons |   .5531367   .0218574    25.31   0.000     .5102969    .5959765
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.90  Pr > z =  0.057
    Arellano-Bond test for AR(2) in first differences: z =  -0.10  Pr > z =  0.919
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(155)  =2310.55  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(155)  = 148.06  Prob > chi2 =  0.641
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(150)  = 148.26  Prob > chi2 =  0.525
        Difference (null H = exogenous): chi2(5)    =  -0.21  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 .))
        Hansen test excluding group:     chi2(20)   =  50.94  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(135)  =  97.12  Prob > chi2 =  0.994
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
```

```
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(130)  = 145.70  Prob > chi2 =  0.164
        Difference (null H = exogenous): chi2(25)   =   2.36  Prob > chi2 =  1.000
```

Temperature linear model 6 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(1 .)collapse)
iv(i.time) two robust
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3551
    Time variable : time                            Number of groups   =       150
    Number of instruments = 161                     Obs per group: min =         3
    Wald chi2(5)  =   6609.98                                      avg =     23.67
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4799186   .0753217     6.37   0.000     .3322908    .6275465
                 |
             lx1 |   .4929416   .0805933     6.12   0.000     .3349815    .6509016
             lx2 |   .0068182    .010978     0.62   0.535    -.0146984    .0283347
             lx3 |  -.4461356   .0954106    -4.68   0.000    -.6331369   -.2591342
             lx4 |    -.23958   .0581467    -4.12   0.000    -.3535455   -.1256146
           _cons |   .5531367   .5966303     0.93   0.354    -.6162372    1.722511
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.90  Pr > z =  0.058
    Arellano-Bond test for AR(2) in first differences: z =  -0.10  Pr > z =  0.920
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(155)  =2310.55  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(155)  = 148.06  Prob > chi2 =  0.641
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(150)  = 148.26  Prob > chi2 =  0.525
        Difference (null H = exogenous): chi2(5)    =  -0.21  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 .))
        Hansen test excluding group:     chi2(20)   =  50.94  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(135)  =  97.12  Prob > chi2 =  0.994
```

```
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(130)  = 145.70  Prob > chi2 =  0.164
        Difference (null H = exogenous): chi2(25)   =   2.36  Prob > chi2 =  1.000
```

Temperature non-linear model 7 (overall)

```
    xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3280
    Time variable : time                            Number of groups   =       150
    Number of instruments = 180                     Obs per group: min =         2
    Wald chi2(6)  =  59391.25                                      avg =     21.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |    .462139    .010397    44.45   0.000     .4417612    .4825169
                 |
             lx1 |    .417056   .0094483    44.14   0.000     .3985377    .4355744
             lx2 |   .0109753   .0135708     0.81   0.419     -.015623    .0375737
             lx3 |  -.0782737   .0259545    -3.02   0.003    -.1291436   -.0274039
                 |
             lx4 |
             L2. |   .0859732   .0370659     2.32   0.020     .0133254    .1586211
                 |
            lx4s |   .0306301   .0129405     2.37   0.018     .0052671    .0559931
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -18.49  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.03  Pr > z =  0.304
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(174)  =1982.91  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Sargan test excluding group:     chi2(18)   =  57.44  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(156)  =1925.47  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(150)  =1946.23  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(24)   =  36.68  Prob > chi2 =  0.047
```

Temperature non-linear model 8 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel two h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3280
    Time variable : time                            Number of groups   =       150
    Number of instruments = 180                     Obs per group: min =         2
    Wald chi2(6)  =  1.43e+07                                      avg =     21.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4618786   .0010633   434.40   0.000     .4597946    .4639625
                 |
             lx1 |   .4174829   .0010078   414.25   0.000     .4155077    .4194582
             lx2 |   .0106147   .0011531     9.21   0.000     .0083546    .0128748
             lx3 |  -.0808659   .0068207   -11.86   0.000    -.0942341   -.0674976
                 |
             lx4 |
             L2. |   .0859548   .0024092    35.68   0.000     .0812327    .0906768
                 |
            lx4s |   .0305825   .0008946    34.18   0.000      .028829    .0323359
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.17  Pr > z =  0.030
    Arellano-Bond test for AR(2) in first differences: z =  -0.53  Pr > z =  0.593
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(174)  =1982.91  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(174)  = 149.64  Prob > chi2 =  0.909
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(18)    =  54.36  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(156)   =  95.28  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(150)   = 148.83  Prob > chi2 =  0.512
        Difference (null H = exogenous): chi2(24)    =   0.81  Prob > chi2 =  1.000
```

Temperature non-linear model 9 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel two robust h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3280
    Time variable : time                            Number of groups   =       150
    Number of instruments = 180                     Obs per group: min =         2
    Wald chi2(6)  =   5976.82                                      avg =     21.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4618786    .083609     5.52   0.000     .2980079    .6257492
                 |
             lx1 |   .4174829   .0933121     4.47   0.000     .2345946    .6003712
             lx2 |   .0106147   .0099312     1.07   0.285     -.00885     .0300794
             lx3 |  -.0808659   .1372379    -0.59   0.556    -.3498472    .1881155
                 |
             lx4 |
             L2. |   .0859548    .048357     1.78   0.075    -.0088233    .1807328
                 |
            lx4s |   .0305825   .0199584     1.53   0.125    -.0085353    .0697002
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.17  Pr > z =  0.030
    Arellano-Bond test for AR(2) in first differences: z =  -0.52  Pr > z =  0.603
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(174)  =1982.91  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(174)  = 149.64  Prob > chi2 =  0.909
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(18)    =  54.36  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(156)   =  95.28  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(150)   = 148.83  Prob > chi2 =  0.512
        Difference (null H = exogenous): chi2(24)    =   0.81  Prob > chi2 =  1.000
```

Temperature non-linear model 10 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3431
    Time variable : time                            Number of groups   =       150
    Number of instruments = 187                     Obs per group: min =         3
    Wald chi2(6)  = 147379.19                                      avg =     22.87
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4961194   .0082157    60.39   0.000     .4800169    .5122219
                 |
             lx1 |   .4747951   .0086034    55.19   0.000     .4579328    .4916575
             lx2 |   .0077139   .0145094     0.53   0.595    -.0207241    .0361518
             lx3 |  -.4346687   .0165392   -26.28   0.000    -.4670849   -.4022525
                 |
             lx4 |
             L2. |   .1318442   .0302156     4.36   0.000     .0726227    .1910657
                 |
            lx4s |  -.0655286   .0057815   -11.33   0.000      -.07686   -.0541971
           _cons |   .1489286   .2119886     0.70   0.482    -.2665614    .5644185
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -18.90  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.92  Pr > z =  0.359
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(180)  =2260.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(174)  =1890.52  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(6)    = 370.08  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Sargan test excluding group:     chi2(18)   =  62.18  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(162)  =2198.41  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(156)  =2174.13  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(24)   =  86.46  Prob > chi2 =  0.000
```

Temperature non-linear model 11 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) two h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3431
    Time variable : time                            Number of groups   =       150
    Number of instruments = 187                     Obs per group: min =         3
    Wald chi2(6)  =  2.30e+07                                      avg =     22.87
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4964153   .0008755   567.02   0.000     .4946994    .4981313
                 |
             lx1 |   .4744192   .0006305   752.48   0.000     .4731835    .4756549
             lx2 |   .0076481   .0008137     9.40   0.000     .0060533     .009243
             lx3 |  -.4342276   .0014748  -294.42   0.000    -.4371183    -.431337
                 |
             lx4 |
             L2. |   .1309106     .00333    39.31   0.000     .1243839    .1374373
                 |
            lx4s |   -.064714   .0014131   -45.80   0.000    -.0674836   -.0619443
           _cons |   .1448964   .0273742     5.29   0.000     .0912439     .198549
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.93  Pr > z =  0.054
    Arellano-Bond test for AR(2) in first differences: z =  -0.44  Pr > z =  0.659
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(180)  =2260.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(180)  = 148.93  Prob > chi2 =  0.956
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(174)  = 149.09  Prob > chi2 =  0.914
        Difference (null H = exogenous): chi2(6)    =  -0.16  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(18)   =  47.85  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(162)  = 101.08  Prob > chi2 =  1.000
```

```
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(156)  = 148.98  Prob > chi2 =  0.643
        Difference (null H = exogenous): chi2(24)   =  -0.05  Prob > chi2 =  1.000
```

Temperature non-linear model 12 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) two robust h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3431
    Time variable : time                            Number of groups   =       150
    Number of instruments = 187                     Obs per group: min =         3
    Wald chi2(6)  =   7670.81                                      avg =     22.87
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4964153   .0748678     6.63   0.000     .3496772    .6431535
                 |
             lx1 |   .4744192   .0793161     5.98   0.000     .3189624     .629876
             lx2 |   .0076481   .0106754     0.72   0.474    -.0132752    .0285715
             lx3 |  -.4342276   .0925238    -4.69   0.000    -.6155709   -.2528844
                 |
             lx4 |
             L2. |   .1309106   .0475011     2.76   0.006     .0378102     .224011
                 |
            lx4s |   -.064714   .0143268    -4.52   0.000     -.092794    -.036634
           _cons |   .1448964   .5424791     0.27   0.789     -.918343    1.208136
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.92  Pr > z =  0.055
    Arellano-Bond test for AR(2) in first differences: z =  -0.43  Pr > z =  0.666
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(180)  =2260.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(180)  = 148.93  Prob > chi2 =  0.956
      (Robust, but weakened by many instruments.)
```

```
    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(174)  = 149.09  Prob > chi2 =  0.914
        Difference (null H = exogenous): chi2(6)    =  -0.16  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(18)   =  47.85  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(162)  = 101.08  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(156)  = 148.98  Prob > chi2 =  0.643
        Difference (null H = exogenous): chi2(24)   =  -0.05  Prob > chi2 =  1.000
```

Precipitation linear model 13 (overall)

```
    . xtabond2 ly l.ly l2.lx1 lx2 l2.lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(4 .)collapse) iv(i.time) nolevel h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3244
    Time variable : time                            Number of groups   =       150
    Number of instruments = 139                     Obs per group: min =         1
    Wald chi2(5)  =  28027.26                                      avg =     21.63
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   1.077882   .0318735    33.82   0.000     1.015411    1.140353
                 |
             lx1 |
             L2. |  -.2160075   .0256062    -8.44   0.000    -.2661946   -.1658203
                 |
             lx2 |   .1189837   .0982551     1.21   0.226    -.0735929    .3115602
                 |
             lx3 |
             L2. |   .6795561    .060711    11.19   0.000     .5605648    .7985475
                 |
             lx4 |
             L2. |  -.1358621   .0647297    -2.10   0.036    -.2627301   -.0089942
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(4/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -16.02  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.28  Pr > z =  0.778
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(134)  = 751.24  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(4 .))
        Sargan test excluding group:     chi2(19)   = 582.19  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(115)  = 169.05  Prob > chi2 =  0.001
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
```

```
> e 2015.time 2016.time)
    Sargan test excluding group:     chi2(110)  = 716.97  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(24)   =  34.27  Prob > chi2 =  0.080
```

Precipitation linear model 14 (overall)

```
. xtabond2 ly l.ly l2.lx1 lx2 l2.lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(4 .)collapse) iv(i.time) nolevel two h(2)
Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      3244
Time variable : time                            Number of groups   =       150
Number of instruments = 139                     Obs per group: min =         1
Wald chi2(5)  = 513255.07                                      avg =     21.63
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   1.079254   .0023759   454.26   0.000     1.074597     1.08391
             |
         lx1 |
         L2. |  -.2154559   .0026229   -82.15   0.000    -.2205966   -.2103152
             |
         lx2 |   .1167049   .0074882    15.59   0.000     .1020283    .1313814
             |
         lx3 |
         L2. |   .6645623   .0129327    51.39   0.000     .6392146    .6899101
             |
         lx4 |
         L2. |  -.1378764   .0035041   -39.35   0.000    -.1447444   -.1310084
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(4/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.73  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.12  Pr > z =  0.908
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(134)  = 751.24  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(134)  = 146.48  Prob > chi2 =  0.218
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4, collapse lag(4 .))
    Hansen test excluding group:     chi2(19)   = 110.47  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(115)  =  36.01  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(110)  = 136.75  Prob > chi2 =  0.043
    Difference (null H = exogenous): chi2(24)   =   9.73  Prob > chi2 =  0.996
```

Precipitation linear model 15 (overall)

```
    . xtabond2 ly l.ly l2.lx1 lx2 l2.lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(4 .)collapse) iv(i.time) nolevel two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3244
    Time variable : time                            Number of groups   =       150
    Number of instruments = 139                     Obs per group: min =         1
    Wald chi2(5)  =   7122.29                                      avg =     21.63
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   1.079254   .0379556    28.43   0.000     1.004862    1.153645
                 |
             lx1 |
             L2. |  -.2154559   .0316091    -6.82   0.000    -.2774086   -.1535032
                 |
             lx2 |   .1167049   .1262832     0.92   0.355    -.1308057    .3642155
                 |
             lx3 |
             L2. |   .6645623   .0920365     7.22   0.000      .484174    .8449507
                 |
             lx4 |
             L2. |  -.1378764   .0555398    -2.48   0.013    -.2467325   -.0290203
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(4/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -4.49  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.11  Pr > z =  0.910
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(134)  = 751.24  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(134)  = 146.48  Prob > chi2 =  0.218
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(4 .))
        Hansen test excluding group:     chi2(19)   = 110.47  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(115)  =  36.01  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(110)  = 136.75  Prob > chi2 =  0.043
        Difference (null H = exogenous): chi2(24)   =   9.73  Prob > chi2 =  0.996
```

Precipitation linear model 16 (overall)

```
    . xtabond2 ly l.ly l2.lx1 lx2 l2.lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(4 .)collapse) iv(i.time) h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3395
    Time variable : time                            Number of groups   =       150
    Number of instruments = 145                     Obs per group: min =         2
    Wald chi2(5)  =  73490.80                                      avg =     22.63
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   1.164561   .0187398    62.14   0.000     1.127831     1.20129
                 |
             lx1 |
             L2. |  -.2684852   .0188758   -14.22   0.000    -.3054811   -.2314892
                 |
             lx2 |   .2679242   .0975633     2.75   0.006     .0767038    .4591447
                 |
             lx3 |
             L2. |   .5922111   .0495262    11.96   0.000     .4951415    .6892807
                 |
             lx4 |
             L2. |  -.2040328   .0623613    -3.27   0.001    -.3262588   -.0818068
                 |
           _cons |  -5.656336   1.009869    -5.60   0.000    -7.635642   -3.677029
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(4/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL3.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -16.63  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.39  Pr > z =  0.698
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(139)  =1205.21  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(134)  =1169.91  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    =  35.30  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(4 .))
        Sargan test excluding group:     chi2(19)   = 825.44  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(120)  = 379.77  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(115)  = 621.49  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(24)   = 583.72  Prob > chi2 =  0.000
```

Precipitation linear model 17 (overall)

```
    . xtabond2 ly l.ly l2.lx1 lx2 l2.lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(4 .)collapse) iv(i.time) two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3395
    Time variable : time                            Number of groups   =       150
    Number of instruments = 145                     Obs per group: min =         2
    Wald chi2(5)  = 747588.82                                      avg =     22.63
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   1.165037   .0016602   701.77   0.000     1.161784    1.168291
                 |
             lx1 |
             L2. |  -.2675746   .0019062  -140.37   0.000    -.2713107   -.2638384
                 |
             lx2 |   .2727641   .0079515    34.30   0.000     .2571795    .2883488
                 |
             lx3 |
             L2. |    .584113   .0083022    70.36   0.000      .567841    .6003851
                 |
             lx4 |
             L2. |  -.2042012   .0020806   -98.15   0.000    -.2082791   -.2001233
                 |
           _cons |  -5.597718   .0693958   -80.66   0.000    -5.733732   -5.461705
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(4/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL3.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -4.73  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.14  Pr > z =  0.885
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(139)  =1205.21  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(139)  = 146.77  Prob > chi2 =  0.309
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(134)  = 144.47  Prob > chi2 =  0.253
        Difference (null H = exogenous): chi2(5)    =   2.30  Prob > chi2 =  0.807
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(4 .))
        Hansen test excluding group:     chi2(19)   =  99.16  Prob > chi2 =  0.000
```

```
        Difference (null H = exogenous): chi2(120)  =  47.61  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(115)  = 139.65  Prob > chi2 =  0.059
        Difference (null H = exogenous): chi2(24)   =   7.12  Prob > chi2 =  1.000
```

Precipitation linear model 18 (overall)

```
    . xtabond2 ly l.ly l2.lx1 lx2 l2.lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(4 .)collapse) iv(i.time) two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                           Number of obs      =      3395
    Time variable : time                           Number of groups   =       150
    Number of instruments = 145                    Obs per group: min =         2
    Wald chi2(5)  =   2407.57                                     avg =     22.63
    Prob > chi2   =     0.000                                     max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   1.165037   .1183866     9.84   0.000     .9330039    1.397071
                 |
             lx1 |
             L2. |  -.2675746   .0850375    -3.15   0.002     -.434245   -.1009042
                 |
             lx2 |   .2727641   .2512557     1.09   0.278    -.2196879    .7652162
                 |
             lx3 |
             L2. |    .584113   .1326488     4.40   0.000     .3241261    .8440999
                 |
             lx4 |
             L2. |  -.2042012    .103687    -1.97   0.049    -.4074239   -.0009785
                 |
           _cons |  -5.597718   2.666352    -2.10   0.036    -10.82367   -.3717652
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(4/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL3.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -3.69  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.13  Pr > z =  0.893
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(139)  =1205.21  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
```

```
    Hansen test of overid. restrictions: chi2(139)  = 146.77  Prob > chi2 =  0.309
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(134)  = 144.47  Prob > chi2 =  0.253
        Difference (null H = exogenous): chi2(5)    =   2.30  Prob > chi2 =  0.807
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(4 .))
        Hansen test excluding group:     chi2(19)   =  99.16  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(120)  =  47.61  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(115)  = 139.65  Prob > chi2 =  0.059
        Difference (null H = exogenous): chi2(24)   =   7.12  Prob > chi2 =  1.000
```

Precipitation non-linear model 19 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3400
    Time variable : time                            Number of groups   =       150
    Number of instruments = 181                     Obs per group: min =         2
    Wald chi2(6)  =  66852.57                                      avg =     22.67
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4332639   .0103357    41.92   0.000     .4130062    .4535215
                 |
             lx1 |   .3817167   .0092735    41.16   0.000     .3635409    .3998926
             lx2 |   .0132856   .0132317     1.00   0.315    -.0126481    .0392193
             lx3 |   .2066772   .0309843     6.67   0.000     .1459491    .2674053
             lx4 |  -.1970697   .0526419    -3.74   0.000    -.3002458   -.0938935
            lx4s |   .0259256   .0068377     3.79   0.000     .0125239    .0393272
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -18.91  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.18  Pr > z =  0.237
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(175)  =1933.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Sargan test excluding group:     chi2(19)    =  54.53  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(156)  =1879.07  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(150)  =1875.43  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(25)    =  58.17  Prob > chi2 =  0.000
```

Precipitation non-linear model 20 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel two
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3400
    Time variable : time                            Number of groups   =       150
    Number of instruments = 181                     Obs per group: min =         2
    Wald chi2(6)  =  1.39e+07                                      avg =     22.67
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4329225   .0013195   328.10   0.000     .4303364    .4355086
                 |
             lx1 |   .3831927   .0015666   244.60   0.000     .3801222    .3862633
             lx2 |   .0128043   .0012075    10.60   0.000     .0104375     .015171
             lx3 |    .198995   .0067428    29.51   0.000     .1857793    .2122108
             lx4 |  -.1960133   .0043749   -44.80   0.000     -.204588   -.1874386
            lx4s |   .0258652   .0005017    51.55   0.000     .0248818    .0268485
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.40  Pr > z =  0.016
    Arellano-Bond test for AR(2) in first differences: z =  -0.69  Pr > z =  0.491
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(175)  =1933.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(175)  = 148.09  Prob > chi2 =  0.931
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(19)    =  56.30  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(156)   =  91.79  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(150)   = 148.44  Prob > chi2 =  0.521
        Difference (null H = exogenous): chi2(25)    =  -0.36  Prob > chi2 =  1.000
```

Precipitation non-linear model 21 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel two robust
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3400
    Time variable : time                            Number of groups   =       150
    Number of instruments = 181                     Obs per group: min =         2
    Wald chi2(6)  =   3883.47                                      avg =     22.67
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .4329225   .0731742     5.92   0.000     .2895037    .5763412
                 |
             lx1 |   .3831927   .0901645     4.25   0.000     .2064735    .5599119
             lx2 |   .0128043   .0090883     1.41   0.159    -.0050084     .030617
             lx3 |    .198995   .1569514     1.27   0.205    -.1086241    .5066142
             lx4 |  -.1960133   .1318116    -1.49   0.137    -.4543593    .0623327
            lx4s |   .0258652   .0160118     1.62   0.106    -.0055173    .0572477
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.39  Pr > z =  0.017
    Arellano-Bond test for AR(2) in first differences: z =  -0.66  Pr > z =  0.510
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(175)  =1933.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(175)  = 148.09  Prob > chi2 =  0.931
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(19)   =  56.30  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(156)  =  91.79  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(150)  = 148.44  Prob > chi2 =  0.521
        Difference (null H = exogenous): chi2(25)   =  -0.36  Prob > chi2 =  1.000
```

Precipitation non-linear model 22 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3551
    Time variable : time                            Number of groups   =       150
    Number of instruments = 188                     Obs per group: min =         3
    Wald chi2(6)  = 142398.14                                      avg =     23.67
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5392548   .0077756    69.35   0.000     .5240149    .5544947
                 |
             lx1 |   .4619905    .008532    54.15   0.000     .4452681    .4787128
             lx2 |   .0111397   .0147888     0.75   0.451    -.0178459    .0401252
             lx3 |  -.4053482   .0180325   -22.48   0.000    -.4406913   -.3700052
             lx4 |   .2911192    .038295     7.60   0.000     .2160623    .3661761
            lx4s |  -.0380647   .0048729    -7.81   0.000    -.0476153    -.028514
           _cons |  -1.162876   .2126209    -5.47   0.000    -1.579605   -.7461463
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -19.80  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.65  Pr > z =  0.514
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(181)  =2677.85  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(175)  =1854.03  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(6)    = 823.82  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Sargan test excluding group:     chi2(19)   =  50.25  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(162)  =2627.59  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(156)  =2444.74  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(25)   = 233.11  Prob > chi2 =  0.000
```

Precipitation non-linear model 23 (overall)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) two
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3551
    Time variable : time                            Number of groups   =       150
    Number of instruments = 188                     Obs per group: min =         3
    Wald chi2(6)  =  2.69e+06                                      avg =     23.67
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5394253   .0014304   377.11   0.000     .5366218    .5422289
                 |
             lx1 |   .4616327    .001074   429.82   0.000     .4595277    .4637377
             lx2 |    .011044   .0011966     9.23   0.000     .0086986    .0133894
             lx3 |  -.4040442   .0053451   -75.59   0.000    -.4145204    -.393568
             lx4 |   .2931862   .0071506    41.00   0.000     .2791712    .3072012
            lx4s |  -.0381633   .0008129   -46.94   0.000    -.0397567     -.03657
           _cons |  -1.182085   .0727073   -16.26   0.000    -1.324589   -1.039581
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.15  Pr > z =  0.031
    Arellano-Bond test for AR(2) in first differences: z =  -0.33  Pr > z =  0.739
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(181)  =2677.85  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(181)  = 148.90  Prob > chi2 =  0.961
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(175)  = 148.91  Prob > chi2 =  0.924
        Difference (null H = exogenous): chi2(6)    =  -0.02  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(19)   =  29.87  Prob > chi2 =  0.053
        Difference (null H = exogenous): chi2(162)  = 119.02  Prob > chi2 =  0.995
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
```

```
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(156)  = 148.54  Prob > chi2 =  0.652
        Difference (null H = exogenous): chi2(25)   =   0.36  Prob > chi2 =  1.000
```

<u>Precipitation non-linear model 24 (overall)</u>

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) two robust
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3551
    Time variable : time                            Number of groups   =       150
    Number of instruments = 188                     Obs per group: min =         3
    Wald chi2(6)  =   7363.20                                      avg =     23.67
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5394253   .0664679     8.12   0.000     .4091507       .6697
                 |
             lx1 |   .4616327   .0735895     6.27   0.000     .3173999    .6058656
             lx2 |    .011044   .0106094     1.04   0.298     -.00975     .031838
             lx3 |  -.4040442   .0904358    -4.47   0.000    -.5812951   -.2267933
             lx4 |   .2931862   .1033145     2.84   0.005     .0906934     .495679
            lx4s |  -.0381633   .0132866    -2.87   0.004    -.0642046   -.0121221
           _cons |  -1.182085   .5968596    -1.98   0.048    -2.351908   -.0122617
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.15  Pr > z =  0.032
    Arellano-Bond test for AR(2) in first differences: z =  -0.33  Pr > z =  0.745
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(181)  =2677.85  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(181)  = 148.90  Prob > chi2 =  0.961
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(175)  = 148.91  Prob > chi2 =  0.924
        Difference (null H = exogenous): chi2(6)    =  -0.02  Prob > chi2 =  1.000
```

```
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
        Hansen test excluding group:     chi2(19)    =  29.87  Prob > chi2 =  0.053
        Difference (null H = exogenous): chi2(162)  = 119.02  Prob > chi2 =  0.995
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(156)  = 148.54  Prob > chi2 =  0.652
        Difference (null H = exogenous): chi2(25)    =   0.36  Prob > chi2 =  1.000
```

Carbon dioxide emission linear model 25 (overall)

```
    xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(3 .)collapse) iv(i.time) nolevel h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3213
    Time variable : time                            Number of groups   =       149
    Number of instruments = 144                     Obs per group: min =         0
    Wald chi2(5)  =  43975.67                                      avg =     21.56
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3844974   .0200397    19.19   0.000     .3452203    .4237745
                 |
             lx1 |   .5687416   .0193637    29.37   0.000     .5307895    .6066936
                 |
             lx2 |
             L2. |  -.0168413   .0155283    -1.08   0.278    -.0472763    .0135936
                 |
             lx3 |  -.0618595   .0588791    -1.05   0.293    -.1772604    .0535415
                 |
             lx4 |
             L2. |  -.2485589   .0237906   -10.45   0.000    -.2951876   -.2019301
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -15.94  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -0.07  Pr > z =  0.944
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(139)  = 416.25  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(3 .))
        Sargan test excluding group:     chi2(19)    =  54.65  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(120)  = 361.60  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(115)  = 393.73  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(24)    =  22.51  Prob > chi2 =  0.549
```

Carbon dioxide emission linear model 26 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(3 .)collapse) iv(i.time) nolevel two h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3213
    Time variable : time                            Number of groups   =       149
    Number of instruments = 144                     Obs per group: min =         0
    Wald chi2(5)  =  1.11e+07                                      avg =     21.56
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.  Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3827541   .0014422   265.40   0.000     .3799275    .3855808
                 |
             lx1 |   .5692447    .000478  1190.83   0.000     .5683078    .5701816
                 |
             lx2 |
             L2. |  -.0168047   .0005967   -28.16   0.000    -.0179742   -.0156353
                 |
             lx3 |  -.0544747   .0109042    -5.00   0.000    -.0758467   -.0331028
                 |
             lx4 |
             L2. |  -.2491583   .0018891  -131.89   0.000    -.2528608   -.2454558
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.45  Pr > z =  0.148
    Arellano-Bond test for AR(2) in first differences: z =  -0.03  Pr > z =  0.979
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(139)  = 416.25  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(139)  = 145.28  Prob > chi2 =  0.341
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(3 .))
        Hansen test excluding group:     chi2(19)    =  38.13  Prob > chi2 =  0.006
        Difference (null H = exogenous): chi2(120)  = 107.15  Prob > chi2 =  0.793
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(115)  = 134.45  Prob > chi2 =  0.104
        Difference (null H = exogenous): chi2(24)    =  10.83  Prob > chi2 =  0.990
```

Carbon dioxide emission linear model 27 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(3 .)collapse) iv(i.time) nolevel two robust h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3213
    Time variable : time                            Number of groups   =       149
    Number of instruments = 144                     Obs per group: min =         0
    Wald chi2(5)  =   3403.19                                      avg =     21.56
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3827541   .0587887     6.51   0.000     .2675303    .4979779
                 |
             lx1 |   .5692447   .0534371    10.65   0.000     .4645099    .6739795
                 |
             lx2 |
             L2. |  -.0168047    .011916    -1.41   0.158    -.0401597    .0065502
                 |
             lx3 |  -.0544747    .163801    -0.33   0.739    -.3755189    .2665694
                 |
             lx4 |
             L2. |  -.2491583   .0676993    -3.68   0.000    -.3818464   -.1164702
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.44  Pr > z =  0.149
    Arellano-Bond test for AR(2) in first differences: z =  -0.03  Pr > z =  0.980
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(139)  = 416.25  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(139)  = 145.28  Prob > chi2 =  0.341
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(3 .))
        Hansen test excluding group:     chi2(19)   =  38.13  Prob > chi2 =  0.006
        Difference (null H = exogenous): chi2(120)  = 107.15  Prob > chi2 =  0.793
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(115)  = 134.45  Prob > chi2 =  0.104
        Difference (null H = exogenous): chi2(24)   =  10.83  Prob > chi2 =  0.990
```

Carbon dioxide emission linear model 28 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(3 .)collapse) iv(i.time) h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3364
    Time variable : time                            Number of groups   =       150
    Number of instruments = 150                     Obs per group: min =         1
    Wald chi2(5)  = 135728.50                                      avg =     22.43
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .6000807   .0144635    41.49   0.000     .5717326    .6284287
                 |
             lx1 |   .4069373   .0142853    28.49   0.000     .3789386     .434936
                 |
             lx2 |
             L2. |  -.0158055   .0141263    -1.12   0.263    -.0434926    .0118817
                 |
             lx3 |  -.5559441   .0230998   -24.07   0.000     -.601219   -.5106693
                 |
             lx4 |
             L2. |   .0680064   .0052523    12.95   0.000      .057712    .0783008
                 |
           _cons |   1.999923   .2190315     9.13   0.000     1.570629    2.429217
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL2.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -18.44  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.68  Pr > z =  0.093
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(144)  =1074.70  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(139)  = 636.48  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    = 438.21  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(3 .))
        Sargan test excluding group:     chi2(19)   =  92.85  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(125)  = 981.85  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(120)  = 994.34  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(24)   =  80.36  Prob > chi2 =  0.000
```

Carbon dioxide emission linear model 29 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(3 .)collapse) iv(i.time) two h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3364
    Time variable : time                            Number of groups   =       150
    Number of instruments = 150                     Obs per group: min =         1
    Wald chi2(5)  =  5.44e+06                                      avg =     22.43
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5992502   .0013378   447.95   0.000     .5966283    .6018722
                 |
             lx1 |   .4075147   .0008968   454.39   0.000     .4057569    .4092725
                 |
             lx2 |
             L2. |  -.0156039    .000611   -25.54   0.000    -.0168014   -.0144063
                 |
             lx3 |  -.5574257   .0024797  -224.79   0.000    -.5622858   -.5525655
                 |
             lx4 |
             L2. |   .0685003   .0008939    76.63   0.000     .0667482    .0702523
                 |
           _cons |   2.009518   .0306372    65.59   0.000      1.94947    2.069566
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL2.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.45  Pr > z =  0.014
    Arellano-Bond test for AR(2) in first differences: z =  -0.94  Pr > z =  0.345
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(144)  =1074.70  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(144)  = 149.22  Prob > chi2 =  0.366
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(139)  = 147.89  Prob > chi2 =  0.287
        Difference (null H = exogenous): chi2(5)    =   1.33  Prob > chi2 =  0.932
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(3 .))
        Hansen test excluding group:     chi2(19)   =  48.67  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(125)  = 100.55  Prob > chi2 =  0.947
```

```
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(120)  = 143.84  Prob > chi2 =  0.068
        Difference (null H = exogenous): chi2(24)   =   5.38  Prob > chi2 =  1.000
```

Carbon dioxide emission linear model 30 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3
lx4,lag(3 .)collapse) iv(i.time) two robust h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3364
    Time variable : time                            Number of groups   =       150
    Number of instruments = 150                     Obs per group: min =         1
    Wald chi2(5)  =   5230.11                                      avg =     22.43
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5992502   .0473774    12.65   0.000     .5063922    .6921083
                 |
             lx1 |   .4075147   .0451455     9.03   0.000     .3190312    .4959983
                 |
             lx2 |
             L2. |  -.0156039   .0109846    -1.42   0.155    -.0371333    .0059256
                 |
             lx3 |  -.5574257   .0746114    -7.47   0.000    -.7036613   -.4111901
                 |
             lx4 |
             L2. |   .0685003   .0268403     2.55   0.011     .0158943    .1211063
                 |
           _cons |   2.009518   .6870661     2.92   0.003     .6628932    3.356143
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL2.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.45  Pr > z =  0.014
    Arellano-Bond test for AR(2) in first differences: z =  -0.93  Pr > z =  0.350
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(144)  =1074.70  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(144)  = 149.22  Prob > chi2 =  0.366
      (Robust, but weakened by many instruments.)
```

```
    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(139)  = 147.89  Prob > chi2 =  0.287
        Difference (null H = exogenous): chi2(5)    =   1.33  Prob > chi2 =  0.932
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(3 .))
        Hansen test excluding group:     chi2(19)   =  48.67  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(125)  = 100.55  Prob > chi2 =  0.947
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(120)  = 143.84  Prob > chi2 =  0.068
        Difference (null H = exogenous): chi2(24)   =   5.38  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 31 (overall)

```
    xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2 .)collapse) iv(time) nolevel
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3213
    Time variable : time                            Number of groups   =       149
    Number of instruments = 151                     Obs per group: min =         0
    Wald chi2(6)  =  46451.09                                      avg =     21.56
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3474087   .0206338    16.84   0.000     .3069672    .3878503
                 |
             lx1 |   .5711237   .0189431    30.15   0.000      .533996    .6082514
                 |
             lx2 |
             L2. |  -.0091889   .0134545    -0.68   0.495    -.0355593    .0171815
                 |
             lx3 |  -.2124216     .04986    -4.26   0.000    -.3101454   -.1146977
                 |
             lx4 |
             L2. |   -.449728   .0469791    -9.57   0.000    -.5418053   -.3576506
                 |
            lx4s |
             L2. |   .0204986   .0027794     7.38   0.000      .015051    .0259463
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -16.16  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.31  Pr > z =  0.760
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(145)  = 460.68  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      iv(time)
        Sargan test excluding group:     chi2(144)  = 449.98  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)    =  10.70  Prob > chi2 =  0.001
```

Carbon dioxide emission non-linear model 32 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2 .)collapse) iv(time) nolevel two
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3213
    Time variable : time                            Number of groups   =       149
    Number of instruments = 151                     Obs per group: min =         0
    Wald chi2(6)  =  1.27e+07                                      avg =     21.56
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3475196   .0009769   355.74   0.000      .345605    .3494343
                 |
             lx1 |     .57114   .0002916  1958.56   0.000     .5705685    .5717116
                 |
             lx2 |
             L2. |  -.0090696   .0003593   -25.24   0.000    -.0097738   -.0083654
                 |
             lx3 |  -.2126133   .0049913   -42.60   0.000    -.2223961   -.2028305
                 |
             lx4 |
             L2. |  -.4499796   .0050623   -88.89   0.000    -.4599015   -.4400576
                 |
            lx4s |
             L2. |   .0204906   .0002648    77.37   0.000     .0199715    .0210097
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.40  Pr > z =  0.163
    Arellano-Bond test for AR(2) in first differences: z =   0.12  Pr > z =  0.904
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(145)  = 460.68  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(145)  = 148.25  Prob > chi2 =  0.410
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      iv(time)
        Hansen test excluding group:     chi2(144)  = 148.25  Prob > chi2 =  0.387
        Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 33 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2 .)collapse) iv(time) nolevel two robust
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3213
    Time variable : time                            Number of groups   =       149
    Number of instruments = 151                     Obs per group: min =         0
    Wald chi2(6)  =   3601.48                                      avg =     21.56
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3475196   .0579055     6.00   0.000      .234027    .4610123
                 |
             lx1 |     .57114   .0502071    11.38   0.000     .4727359    .6695441
                 |
             lx2 |
             L2. |  -.0090696   .0074151    -1.22   0.221    -.0236029    .0054636
                 |
             lx3 |  -.2126133   .1291938    -1.65   0.100    -.4658285    .0406018
                 |
             lx4 |
             L2. |  -.4499796     .17748    -2.54   0.011     -.797834   -.1021251
                 |
            lx4s |
             L2. |   .0204906    .009636     2.13   0.033     .0016043    .0393769
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.39  Pr > z =  0.163
    Arellano-Bond test for AR(2) in first differences: z =   0.12  Pr > z =  0.905
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(145)  = 460.68  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(145)  = 148.25  Prob > chi2 =  0.410
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      iv(time)
        Hansen test excluding group:     chi2(144)  = 148.25  Prob > chi2 =  0.387
        Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 34 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2 .)collapse) iv(time)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3364
    Time variable : time                            Number of groups   =       150
    Number of instruments = 158                     Obs per group: min =         1
    Wald chi2(6)  = 144486.20                                      avg =     22.43
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5584581     .01487    37.56   0.000     .5293134    .5876027
                 |
             lx1 |   .4440793   .0148109    29.98   0.000     .4150506    .4731081
                 |
             lx2 |
             L2. |  -.0084837   .0125711    -0.67   0.500    -.0331227    .0161553
                 |
             lx3 |  -.5517149   .0203037   -27.17   0.000    -.5915095   -.5119203
                 |
             lx4 |
             L2. |  -.1906316   .0314315    -6.06   0.000    -.2522362   -.1290271
                 |
            lx4s |
             L2. |   .0136055    .001626     8.37   0.000     .0104187    .0167924
                 |
           _cons |   2.513611   .1972702    12.74   0.000     2.126969    2.900254
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -17.73  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.23  Pr > z =  0.220
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(151)   = 901.11  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(145)   = 516.54  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(6)     = 384.57  Prob > chi2 =  0.000
      iv(time)
        Sargan test excluding group:     chi2(150)   = 824.70  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)     =  76.41  Prob > chi2 =  0.000
```

Carbon dioxide emission non-linear model 35 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2 .)collapse) iv(time) two
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3364
    Time variable : time                            Number of groups   =       150
    Number of instruments = 158                     Obs per group: min =         1
    Wald chi2(6)  =  5.02e+07                                      avg =     22.43
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5585839   .0007404   754.41   0.000     .5571326    .5600351
                 |
             lx1 |    .444162   .0004591   967.39   0.000     .4432621    .4450619
                 |
             lx2 |
             L2. |  -.0083798   .0002026   -41.37   0.000    -.0087769   -.0079828
                 |
             lx3 |  -.5526974   .0026062  -212.07   0.000    -.5578054   -.5475894
                 |
             lx4 |
             L2. |  -.1933588      .0092   -21.02   0.000    -.2113905   -.1753272
                 |
            lx4s |
             L2. |   .0137514   .0004992    27.55   0.000      .012773    .0147299
                 |
           _cons |    2.53598   .0537749    47.16   0.000     2.430583    2.641376
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.11  Pr > z =  0.035
    Arellano-Bond test for AR(2) in first differences: z =  -0.65  Pr > z =  0.516
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(151)  = 901.11  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(151)  = 148.27  Prob > chi2 =  0.548
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(145)  = 148.26  Prob > chi2 =  0.409
        Difference (null H = exogenous): chi2(6)    =   0.01  Prob > chi2 =  1.000
      iv(time)
        Hansen test excluding group:     chi2(150)  = 148.27  Prob > chi2 =  0.525
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.998
```

Carbon dioxide emission non-linear model 36 (overall)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2 .)collapse) iv(time) two robust
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      3364
    Time variable : time                            Number of groups   =       150
    Number of instruments = 158                     Obs per group: min =         1
    Wald chi2(6)  =   4977.00                                      avg =     22.43
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5585839   .0428306    13.04   0.000     .4746375    .6425302
                 |
             lx1 |    .444162   .0408324    10.88   0.000      .364132     .524192
                 |
             lx2 |
             L2. |  -.0083798     .00818    -1.02   0.306    -.0244123    .0076527
                 |
             lx3 |  -.5526974   .0603694    -9.16   0.000    -.6710192   -.4343755
                 |
             lx4 |
             L2. |  -.1933588   .1090361    -1.77   0.076    -.4070657     .020348
                 |
            lx4s |
             L2. |   .0137514   .0060286     2.28   0.023     .0019355    .0255673
                 |
           _cons |    2.53598   .7219183     3.51   0.000     1.121046    3.950913
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.11  Pr > z =  0.035
    Arellano-Bond test for AR(2) in first differences: z =  -0.64  Pr > z =  0.519
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(151)  = 901.11  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(151)  = 148.27  Prob > chi2 =  0.548
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(145)  = 148.26  Prob > chi2 =  0.409
        Difference (null H = exogenous): chi2(6)    =   0.01  Prob > chi2 =  1.000
      iv(time)
        Hansen test excluding group:     chi2(150)  = 148.27  Prob > chi2 =  0.525
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.998
```

Temperature linear model 37 (developed)

```
    xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(6 1)collapse)
iv(i.time) nolevel h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       740
    Time variable : time                            Number of groups   =        31
    Number of instruments = 54                      Obs per group: min =        22
    Wald chi2(5)  =   2015.20                                      avg =     23.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |  -.0069634   .0195447    -0.36   0.722    -.0452702    .0313434
                 |
             lx1 |   .7806859   .0199905    39.05   0.000     .7415052    .8198667
             lx2 |   .0048777   .0061071     0.80   0.424     -.007092    .0168474
             lx3 |  -.1255194    .159523    -0.79   0.431    -.4381788    .1871401
                 |
             lx4 |
             L2. |   .0215328   .0206451     1.04   0.297    -.0189307    .0619964
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/6).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   6.42  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.65  Pr > z =  0.515
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(49)   = 186.16  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 6))
        Sargan test excluding group:     chi2(19)   = 119.39  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(30)   =  66.77  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(25)   =  81.76  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(24)   = 104.39  Prob > chi2 =  0.000
```

Temperature linear model 38 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(6
1)collapse) iv(i.time) nolevel two h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       740
    Time variable : time                            Number of groups   =        31
    Number of instruments = 54                      Obs per group: min =        22
    Wald chi2(5)  = 136385.41                                      avg =     23.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   -.006225    .002365    -2.63   0.008    -.0108604   -.0015896
                 |
             lx1 |   .7823108   .0042123   185.72   0.000     .7740548    .7905667
             lx2 |   .0050186   .0017112     2.93   0.003     .0016647    .0083724
             lx3 |  -.1188451   .0570644    -2.08   0.037    -.2306893   -.0070009
                 |
             lx4 |
             L2. |   .0208313   .0171605     1.21   0.225    -.0128027    .0544653
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/6).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   3.35  Pr > z =  0.001
    Arellano-Bond test for AR(2) in first differences: z =   0.60  Pr > z =  0.552
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(49)   = 186.16  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(49)   =  29.91  Prob > chi2 =  0.986
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 6))
        Hansen test excluding group:     chi2(19)   =  27.96  Prob > chi2 =  0.084
        Difference (null H = exogenous): chi2(30)   =   1.94  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(25)   =  26.91  Prob > chi2 =  0.360
        Difference (null H = exogenous): chi2(24)   =   2.99  Prob > chi2 =  1.000
```

Temperature linear model 39 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(6
1)collapse) iv(i.time) nolevel two robust h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       740
    Time variable : time                            Number of groups   =        31
    Number of instruments = 54                      Obs per group: min =        22
    Wald chi2(5)  =   1499.01                                      avg =     23.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   -.006225   .0296855    -0.21   0.834    -.0644075    .0519575
                 |
             lx1 |   .7823108   .0263852    29.65   0.000     .7305967    .8340249
             lx2 |   .0050186   .0034114     1.47   0.141    -.0016676    .0117047
             lx3 |  -.1188451   .1642555    -0.72   0.469    -.4407798    .2030897
                 |
             lx4 |
             L2. |   .0208313   .0330434     0.63   0.528    -.0439327    .0855953
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/6).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   3.31  Pr > z =  0.001
    Arellano-Bond test for AR(2) in first differences: z =   0.59  Pr > z =  0.557
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(49)   = 186.16  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(49)   =  29.91  Prob > chi2 =  0.986
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 6))
        Hansen test excluding group:     chi2(19)   =  27.96  Prob > chi2 =  0.084
        Difference (null H = exogenous): chi2(30)   =   1.94  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(25)   =  26.91  Prob > chi2 =  0.360
        Difference (null H = exogenous): chi2(24)   =   2.99  Prob > chi2 =  1.000
```

Temperature linear model 40 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(6
1)collapse) iv(i.time) h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       772
    Time variable : time                            Number of groups   =        31
    Number of instruments = 60                      Obs per group: min =        23
    Wald chi2(5)  =   1302.38                                      avg =     24.90
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2598137   .0576635     4.51   0.000     .1467953     .372832
                 |
             lx1 |   .7851973   .0646811    12.14   0.000     .6584246      .91197
             lx2 |   .0065353   .0295688     0.22   0.825    -.0514184     .064489
             lx3 |  -.6677367   .0690104    -9.68   0.000    -.8029947   -.5324787
                 |
             lx4 |
             L2. |   .1183567   .1050149     1.13   0.260    -.0874688    .3241822
                 |
           _cons |  -2.043958   .9605692    -2.13   0.033    -3.926639   -.1612773
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/6).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   0.79  Pr > z =  0.432
    Arellano-Bond test for AR(2) in first differences: z =  -0.47  Pr > z =  0.636
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(54)   =  31.50  Prob > chi2 =  0.994
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(49)   =  18.31  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(5)    =  13.19  Prob > chi2 =  0.022
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 6))
        Sargan test excluding group:     chi2(19)   =  14.02  Prob > chi2 =  0.782
        Difference (null H = exogenous): chi2(35)   =  17.48  Prob > chi2 =  0.994
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(30)   =   7.66  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(24)   =  23.85  Prob > chi2 =  0.470
```

Temperature linear model 41 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(6
1)collapse) iv(i.time) two h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       772
    Time variable : time                            Number of groups   =        31
    Number of instruments = 60                      Obs per group: min =        23
    Wald chi2(5)  =  87624.23                                      avg =     24.90
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2383271   .0118977    20.03   0.000      .215008    .2616462
                 |
             lx1 |     .80404   .0110067    73.05   0.000     .7824673    .8256127
             lx2 |   .0075947   .0026648     2.85   0.004     .0023719    .0128175
             lx3 |  -.6897539   .0354044   -19.48   0.000    -.7591452   -.6203627
                 |
             lx4 |
             L2. |   .1400708   .0252007     5.56   0.000     .0906782    .1894633
                 |
           _cons |  -2.050034   .3641271    -5.63   0.000     -2.76371   -1.336358
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/6).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.20  Pr > z =  0.028
    Arellano-Bond test for AR(2) in first differences: z =  -1.38  Pr > z =  0.167
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(54)   =  31.50  Prob > chi2 =  0.994
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(54)   =  26.91  Prob > chi2 =  0.999
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(49)   =  28.78  Prob > chi2 =  0.991
        Difference (null H = exogenous): chi2(5)    =  -1.88  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 6))
        Hansen test excluding group:     chi2(19)   =  29.03  Prob > chi2 =  0.065
        Difference (null H = exogenous): chi2(35)   =  -2.12  Prob > chi2 =  1.000
```

```
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(30)    =  28.28  Prob > chi2 =  0.556
        Difference (null H = exogenous): chi2(24)    =  -1.37  Prob > chi2 =  1.000
```

Temperature linear model 42 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(6
1)collapse) iv(i.time) two robust h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       772
    Time variable : time                            Number of groups   =        31
    Number of instruments = 60                      Obs per group: min =        23
    Wald chi2(5)  =   1752.16                                      avg =     24.90
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2383271   .0496352     4.80   0.000     .1410439    .3356103
                 |
             lx1 |     .80404   .0428713    18.75   0.000     .7200138    .8880661
             lx2 |   .0075947   .0068126     1.11   0.265    -.0057578    .0209472
             lx3 |  -.6897539   .1049429    -6.57   0.000    -.8954382   -.4840697
                 |
             lx4 |
             L2. |   .1400708    .073622     1.90   0.057    -.0042258    .2843673
                 |
           _cons |  -2.050034   1.282338    -1.60   0.110     -4.56337    .4633022
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/6).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.17  Pr > z =  0.030
    Arellano-Bond test for AR(2) in first differences: z =  -1.33  Pr > z =  0.182
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(54)    =  31.50  Prob > chi2 =  0.994
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(54)    =  26.91  Prob > chi2 =  0.999
      (Robust, but weakened by many instruments.)
```

```
    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(49)   =  28.78  Prob > chi2 =  0.991
        Difference (null H = exogenous): chi2(5)    =  -1.88  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(1 6))
        Hansen test excluding group:     chi2(19)   =  29.03  Prob > chi2 =  0.065
        Difference (null H = exogenous): chi2(35)   =  -2.12  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(30)   =  28.28  Prob > chi2 =  0.556
        Difference (null H = exogenous): chi2(24)   =  -1.37  Prob > chi2 =  1.000
```

Precipitation linear model 43 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
5)collapse) iv(i.time) nolevel h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       740
    Time variable : time                            Number of groups   =        31
    Number of instruments = 29                      Obs per group: min =        22
    Wald chi2(5)  =  10601.34                                      avg =     23.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3088851   .0403479     7.66   0.000     .2298046    .3879656
                 |
             lx1 |   .7353564   .0343459    21.41   0.000     .6680398    .8026731
             lx2 |   .0185203   .0560642     0.33   0.741    -.0913636    .1284041
             lx3 |  -.5841314   .1666613    -3.50   0.000    -.9107816   -.2574812
                 |
             lx4 |
             L2. |   .5371742   .1119378     4.80   0.000     .3177801    .7565682
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L5.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -4.10  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.95  Pr > z =  0.051
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(24)   =  86.53  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(5 5))
        Sargan test excluding group:     chi2(19)   =  82.23  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    =   4.30  Prob > chi2 =  0.507
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
        Difference (null H = exogenous): chi2(24)   =  86.53  Prob > chi2 =  0.000
```

Precipitation linear model 44 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
5)collapse) iv(i.time) nolevel two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       740
    Time variable : time                            Number of groups   =        31
    Number of instruments = 29                      Obs per group: min =        22
    Wald chi2(5)  =  21391.33                                      avg =     23.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2845498   .0167943    16.94   0.000     .2516336    .3174659
                 |
             lx1 |    .738393   .0166538    44.34   0.000     .7057522    .7710337
             lx2 |   .0100933   .0179681     0.56   0.574    -.0251237    .0453102
             lx3 |  -.4389798   .1242357    -3.53   0.000    -.6824773   -.1954824
                 |
             lx4 |
             L2. |   .4192683   .0791145     5.30   0.000     .2642067    .5743298
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L5.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.71  Pr > z =  0.007
    Arellano-Bond test for AR(2) in first differences: z =  -1.59  Pr > z =  0.113
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(24)    =  86.53  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(24)    =  27.08  Prob > chi2 =  0.301
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(5 5))
        Hansen test excluding group:     chi2(19)    =  25.83  Prob > chi2 =  0.135
        Difference (null H = exogenous): chi2(5)     =   1.25  Prob > chi2 =  0.940
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(0)     =   0.00  Prob > chi2 =      .
        Difference (null H = exogenous): chi2(24)    =  27.08  Prob > chi2 =  0.301
```

Precipitation linear model 45 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
5)collapse) iv(i.time) nolevel two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       740
    Time variable : time                            Number of groups   =        31
    Number of instruments = 29                      Obs per group: min =        22
    Wald chi2(5)  =   2685.71                                      avg =     23.87
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2845498   .0752852     3.78   0.000     .1369936    .4321059
                 |
             lx1 |    .738393   .0682321    10.82   0.000     .6046606    .8721254
             lx2 |   .0100933   .0455892     0.22   0.825    -.0792599    .0994464
             lx3 |  -.4389798   .2881944    -1.52   0.128    -1.003831    .1258709
                 |
             lx4 |
             L2. |   .4192683   .1879085     2.23   0.026     .0509744    .7875622
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L5.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.70  Pr > z =  0.089
    Arellano-Bond test for AR(2) in first differences: z =  -1.54  Pr > z =  0.122
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(24)    =  86.53  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(24)    =  27.08  Prob > chi2 =  0.301
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(5 5))
        Hansen test excluding group:     chi2(19)    =  25.83  Prob > chi2 =  0.135
        Difference (null H = exogenous): chi2(5)     =   1.25  Prob > chi2 =  0.940
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(0)     =   0.00  Prob > chi2 =      .
        Difference (null H = exogenous): chi2(24)    =  27.08  Prob > chi2 =  0.301
```

Precipitation linear model 46 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
5)collapse) iv(i.time) h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       772
    Time variable : time                            Number of groups   =        31
    Number of instruments = 35                      Obs per group: min =        23
    Wald chi2(5)  =  11568.49                                      avg =     24.90
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |    .355004   .0274062    12.95   0.000     .3012889    .4087192
                 |
             lx1 |   .7124943    .031659    22.51   0.000     .6504438    .7745448
             lx2 |   .0755709   .0497287     1.52   0.129    -.0218956    .1730374
             lx3 |  -.7001722   .0345953   -20.24   0.000    -.7679777   -.6323668
                 |
             lx4 |
             L2. |   .6600692   .0938265     7.03   0.000     .4761726    .8439659
                 |
           _cons |  -3.681203   .5104683    -7.21   0.000    -4.681702   -2.680703
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L5.(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL4.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -5.53  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.98  Pr > z =  0.048
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(29)   = 145.04  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(24)   =  85.84  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    =  59.20  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(5 5))
        Sargan test excluding group:     chi2(19)   =  80.81  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(10)   =  64.23  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(5)    =   2.07  Prob > chi2 =  0.839
        Difference (null H = exogenous): chi2(24)   = 142.97  Prob > chi2 =  0.000
```

Precipitation linear model 47 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
5)collapse) iv(i.time) two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       772
    Time variable : time                            Number of groups   =        31
    Number of instruments = 35                      Obs per group: min =        23
    Wald chi2(5)  =  16316.02                                      avg =     24.90
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3392382    .020064    16.91   0.000     .2999134     .378563
                 |
             lx1 |     .73445   .0155246    47.31   0.000     .7040224    .7648776
             lx2 |   .0695764   .0377479     1.84   0.065    -.0044082    .1435609
             lx3 |  -.7141805   .0450076   -15.87   0.000    -.8023937   -.6259672
                 |
             lx4 |
             L2. |   .6272976   .0512054    12.25   0.000     .5269368    .7276584
                 |
           _cons |  -3.676543   .8253463    -4.45   0.000    -5.294192   -2.058894
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L5.(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL4.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.85  Pr > z =  0.004
    Arellano-Bond test for AR(2) in first differences: z =  -1.68  Pr > z =  0.092
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(29)   = 145.04  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(29)   =  28.39  Prob > chi2 =  0.497
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(24)   =  27.12  Prob > chi2 =  0.299
        Difference (null H = exogenous): chi2(5)    =   1.27  Prob > chi2 =  0.938
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(5 5))
        Hansen test excluding group:     chi2(19)   =  23.68  Prob > chi2 =  0.209
        Difference (null H = exogenous): chi2(10)   =   4.72  Prob > chi2 =  0.909
```

```
    iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(5)    =   2.82  Prob > chi2 =  0.728
        Difference (null H = exogenous): chi2(24)   =  25.58  Prob > chi2 =  0.375
```

Precipitation linear model 48 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
5)collapse) iv(i.time) two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       772
    Time variable : time                            Number of groups   =        31
    Number of instruments = 35                      Obs per group: min =        23
    Wald chi2(5)  =   1672.70                                      avg =     24.90
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3392382   .1023027     3.32   0.001     .1387287    .5397477
                 |
             lx1 |     .73445   .0800262     9.18   0.000     .5776015    .8912984
             lx2 |   .0695764   .1070855     0.65   0.516    -.1403074    .2794601
             lx3 |  -.7141805   .2123963    -3.36   0.001     -1.13047   -.2978913
                 |
             lx4 |
             L2. |   .6272976   .1612615     3.89   0.000     .3112309    .9433642
                 |
           _cons |  -3.676543   3.229832    -1.14   0.255     -10.0069    2.653812
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L5.(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL4.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.34  Pr > z =  0.019
    Arellano-Bond test for AR(2) in first differences: z =  -1.64  Pr > z =  0.100
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(29)   = 145.04  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(29)   =  28.39  Prob > chi2 =  0.497
      (Robust, but weakened by many instruments.)
```

```
    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(24)   =  27.12  Prob > chi2 =  0.299
        Difference (null H = exogenous): chi2(5)    =   1.27  Prob > chi2 =  0.938
      gmm(ly lx1 lx2 lx3 lx4, collapse lag(5 5))
        Hansen test excluding group:     chi2(19)   =  23.68  Prob > chi2 =  0.209
        Difference (null H = exogenous): chi2(10)   =   4.72  Prob > chi2 =  0.909
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(5)    =   2.82  Prob > chi2 =  0.728
        Difference (null H = exogenous): chi2(24)   =  25.58  Prob > chi2 =  0.375
```

Carbon dioxide emission linear model 49 (developed)

```
    xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
1)collapse) iv(time) nolevel h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       673
    Time variable : time                            Number of groups   =        31
    Number of instruments = 26                      Obs per group: min =        18
    Wald chi2(5)  =  26241.41                                      avg =     21.71
    Prob > chi2   =     0.000                                      max =        22
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .0792828   .0156807     5.06   0.000     .0485493    .1100163
                 |
             lx1 |   .7238629   .0157501    45.96   0.000     .6929932    .7547326
                 |
             lx2 |
             L2. |    .001188    .004625     0.26   0.797    -.0078769    .0102528
                 |
             lx3 |
             L2. |   .5294768   .0523615    10.11   0.000     .4268501    .6321034
                 |
             lx4 |    -.09991   .0337723    -2.96   0.003    -.1661024   -.0337175
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   4.15  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.02  Pr > z =  0.987
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(21)   = 492.82  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      iv(time)
        Sargan test excluding group:     chi2(20)   = 488.19  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)    =   4.63  Prob > chi2 =  0.032
```

Carbon dioxide emission linear model 50 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
1)collapse) iv(time) nolevel two h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       673
    Time variable : time                            Number of groups   =        31
    Number of instruments = 26                      Obs per group: min =        18
    Wald chi2(5)  =  31902.39                                      avg =     21.71
    Prob > chi2   =     0.000                                      max =        22
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .0756192   .0075604    10.00   0.000     .0608012    .0904373
                 |
             lx1 |   .7315017    .010584    69.11   0.000     .7107576    .7522459
                 |
             lx2 |
             L2. |    .000875    .000434     2.02   0.044     .0000244    .0017256
                 |
             lx3 |
             L2. |   .4704965   .0549312     8.57   0.000     .3628333    .5781598
                 |
             lx4 |  -.1081845   .0164036    -6.60   0.000    -.1403349    -.076034
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.95  Pr > z =  0.003
    Arellano-Bond test for AR(2) in first differences: z =   0.04  Pr > z =  0.969
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(21)   = 492.82  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(21)   =  27.25  Prob > chi2 =  0.163
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      iv(time)
        Hansen test excluding group:     chi2(20)   =  25.97  Prob > chi2 =  0.167
        Difference (null H = exogenous): chi2(1)    =   1.28  Prob > chi2 =  0.257
```

Carbon dioxide emission linear model 51 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
1)collapse) iv(time) nolevel two robust h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       673
    Time variable : time                            Number of groups   =        31
    Number of instruments = 26                      Obs per group: min =        18
    Wald chi2(5)  =    672.59                                      avg =     21.71
    Prob > chi2   =     0.000                                      max =        22
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .0756192   .0363077     2.08   0.037     .0044574    .1467811
                 |
             lx1 |   .7315017   .0546394    13.39   0.000     .6244105    .8385929
                 |
             lx2 |
             L2. |    .000875   .0025522     0.34   0.732    -.0041273    .0058773
                 |
             lx3 |
             L2. |   .4704965   .2398317     1.96   0.050      .000435    .9405581
                 |
             lx4 |  -.1081845   .1057844    -1.02   0.306    -.3155181    .0991491
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.42  Pr > z =  0.016
    Arellano-Bond test for AR(2) in first differences: z =   0.04  Pr > z =  0.970
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(21)   = 492.82  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(21)   =  27.25  Prob > chi2 =  0.163
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      iv(time)
        Hansen test excluding group:     chi2(20)   =  25.97  Prob > chi2 =  0.167
        Difference (null H = exogenous): chi2(1)    =   1.28  Prob > chi2 =  0.257
```

Carbon dioxide emission linear model 52 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
1)collapse) iv(time) h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       705
    Time variable : time                            Number of groups   =        31
    Number of instruments = 32                      Obs per group: min =        19
    Wald chi2(5)  =  29657.44                                      avg =     22.74
    Prob > chi2   =     0.000                                      max =        23
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2819675   .0168437    16.74   0.000     .2489544    .3149807
                 |
             lx1 |   .6979187   .0169736    41.12   0.000     .6646512    .7311863
                 |
             lx2 |
             L2. |  -.0025825   .0067878    -0.38   0.704    -.0158863    .0107213
                 |
             lx3 |
             L2. |  -.0587064   .0216219    -2.72   0.007    -.1010846   -.0163282
                 |
             lx4 |  -.6882394   .0309816   -22.21   0.000    -.7489623   -.6275165
           _cons |  -1.219261   .1251968    -9.74   0.000    -1.464642   -.9738797
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -3.72  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -3.06  Pr > z =  0.002
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(26)   = 511.58  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(21)   = 304.47  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    = 207.11  Prob > chi2 =  0.000
      iv(time)
        Sargan test excluding group:     chi2(25)   = 493.23  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)    =  18.35  Prob > chi2 =  0.000
```

Carbon dioxide emission linear model 53 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
1)collapse) iv(time) two h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       705
    Time variable : time                            Number of groups   =        31
    Number of instruments = 32                      Obs per group: min =        19
    Wald chi2(5)  =  18528.92                                      avg =     22.74
    Prob > chi2   =     0.000                                      max =        23
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2703862   .0085843    31.50   0.000     .2535613    .2872112
                 |
             lx1 |   .7020101   .0115774    60.64   0.000     .6793187    .7247015
                 |
             lx2 |
             L2. |  -.0031421   .0011015    -2.85   0.004     -.005301   -.0009832
                 |
             lx3 |
             L2. |  -.0767243   .0251178    -3.05   0.002    -.1259544   -.0274943
                 |
             lx4 |  -.6537773   .0266893   -24.50   0.000    -.7060874   -.6014673
           _cons |  -1.294362   .1847203    -7.01   0.000    -1.656408   -.9323172
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.43  Pr > z =  0.015
    Arellano-Bond test for AR(2) in first differences: z =  -1.69  Pr > z =  0.091
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(26)   = 511.58  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(26)   =  28.47  Prob > chi2 =  0.336
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(21)   =  25.78  Prob > chi2 =  0.215
        Difference (null H = exogenous): chi2(5)    =   2.70  Prob > chi2 =  0.747
      iv(time)
        Hansen test excluding group:     chi2(25)   =  28.47  Prob > chi2 =  0.287
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.970
```

Carbon dioxide emission linear model 54 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(5
1)collapse) iv(time) two robust h(3)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       705
    Time variable : time                            Number of groups   =        31
    Number of instruments = 32                      Obs per group: min =        19
    Wald chi2(5)  =    721.73                                      avg =     22.74
    Prob > chi2   =     0.000                                      max =        23
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2703862   .0685625     3.94   0.000     .1360061    .4047663
                 |
             lx1 |   .7020101   .0579258    12.12   0.000     .5884776    .8155426
                 |
             lx2 |
             L2. |  -.0031421    .004205    -0.75   0.455    -.0113838    .0050996
                 |
             lx3 |
             L2. |  -.0767243   .1706845    -0.45   0.653    -.4112599    .2578112
                 |
             lx4 |  -.6537773   .1539825    -4.25   0.000    -.9555775   -.3519772
           _cons |  -1.294362   .9090743    -1.42   0.154    -3.076115    .4873904
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.08  Pr > z =  0.038
    Arellano-Bond test for AR(2) in first differences: z =  -1.63  Pr > z =  0.102
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(26)    = 511.58  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(26)    =  28.47  Prob > chi2 =  0.336
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(21)    =  25.78  Prob > chi2 =  0.215
        Difference (null H = exogenous): chi2(5)     =   2.70  Prob > chi2 =  0.747
      iv(time)
        Hansen test excluding group:     chi2(25)    =  28.47  Prob > chi2 =  0.287
        Difference (null H = exogenous): chi2(1)     =   0.00  Prob > chi2 =  0.970
```

Temperature non-linear model 55 (developed)

```
    xtabond2 ly l.ly lx1 l2.lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4 lx4s,lag(1
5)collapse) iv(time) nolevel h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       735
    Time variable : time                            Number of groups   =        31
    Number of instruments = 31                      Obs per group: min =        20
    Wald chi2(6)  =    887.90                                      avg =     23.71
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .0111168   .0203177     0.55   0.584    -.0287052    .0509388
                 |
             lx1 |   .6774402   .0349665    19.37   0.000     .6089071    .7459732
                 |
             lx2 |
             L2. |   .0036149   .0040225     0.90   0.369    -.0042692    .0114989
                 |
             lx3 |   .2393419   .1689399     1.42   0.157    -.0917743     .570458
             lx4 |   .0322714   .0321066     1.01   0.315    -.0306563    .0951991
                 |
            lx4s |
             L2. |   .0011579   .0053211     0.22   0.828    -.0092713     .011587
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   6.75  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.34  Pr > z =  0.737
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(25)   =  96.24  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      iv(time)
        Sargan test excluding group:     chi2(24)   =  92.92  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)    =   3.32  Prob > chi2 =  0.068
```

Temperature non-linear model 56 (developed)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 5)collapse) iv(time) nolevel two h(1)
Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =       735
Time variable : time                            Number of groups   =        31
Number of instruments = 31                      Obs per group: min =        20
Wald chi2(6)  = 434678.90                                      avg =     23.71
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .0133065   .0052783     2.52   0.012     .0029611    .0236518
             |
         lx1 |    .685177   .0080974    84.62   0.000     .6693063    .7010476
             |
         lx2 |
         L2. |   .0033952   .0004123     8.24   0.000     .0025872    .0042032
             |
         lx3 |   .1998834   .0373906     5.35   0.000     .1265992    .2731675
         lx4 |   .0361938   .0047781     7.57   0.000      .026829    .0455586
             |
        lx4s |
         L2. |   .0006882   .0006262     1.10   0.272    -.0005391    .0019154
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =   3.71  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.34  Pr > z =  0.735
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(25)    =  96.24  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(25)    =  29.49  Prob > chi2 =  0.244
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(24)    =  29.35  Prob > chi2 =  0.207
    Difference (null H = exogenous): chi2(1)     =   0.15  Prob > chi2 =  0.703
```

Temperature non-linear model 57 (developed)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 5)collapse) iv(time) nolevel two robust h(1)
Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =       735
Time variable : time                            Number of groups   =        31
Number of instruments = 31                      Obs per group: min =        20
Wald chi2(6)  =   1177.56                                      avg =     23.71
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .0133065   .0264727     0.50   0.615    -.0385792    .0651921
             |
         lx1 |    .685177   .0425399    16.11   0.000     .6018003    .7685536
             |
         lx2 |
         L2. |   .0033952   .0027475     1.24   0.217    -.0019899    .0087802
             |
         lx3 |   .1998834   .1809367     1.10   0.269    -.1547461    .5545129
         lx4 |   .0361938   .0472929     0.77   0.444    -.0564986    .1288862
             |
        lx4s |
         L2. |   .0006882   .0066779     0.10   0.918    -.0124003    .0137766
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =   3.40  Pr > z =  0.001
Arellano-Bond test for AR(2) in first differences: z =   0.33  Pr > z =  0.739
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(25)   =  96.24  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(25)   =  29.49  Prob > chi2 =  0.244
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(24)   =  29.35  Prob > chi2 =  0.207
    Difference (null H = exogenous): chi2(1)    =   0.15  Prob > chi2 =  0.703
```

Temperature non-linear model 58 (developed)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4 lx4s,lag(1 5)collapse) iv(time) h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =       767
Time variable : time                            Number of groups   =        31
Number of instruments = 38                      Obs per group: min =        21
Wald chi2(6)  =    646.87                                      avg =     24.74
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    .194293    .083067     2.34   0.019     .0314847    .3571012
             |
         lx1 |   .8805913   .1017474     8.65   0.000     .6811701    1.080013
             |
         lx2 |
         L2. |   .0054081   .0281205     0.19   0.847    -.0497072    .0605233
             |
         lx3 |  -.7224696   .0984052    -7.34   0.000    -.9153402   -.5295989
         lx4 |   .0674247   .1938027     0.35   0.728    -.3124216    .4472711
             |
        lx4s |
         L2. |    .015501   .0346472     0.45   0.655    -.0524064    .0834083
             |
       _cons |  -2.884876   1.377365    -2.09   0.036    -5.584461   -.1852906
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =   1.02  Pr > z =  0.306
Arellano-Bond test for AR(2) in first differences: z =  -0.07  Pr > z =  0.944
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(31)   =  12.98  Prob > chi2 =  0.998
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(25)   =   3.50  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(6)    =   9.48  Prob > chi2 =  0.148
  iv(time)
    Sargan test excluding group:     chi2(30)   =   4.43  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(1)    =   8.54  Prob > chi2 =  0.003
```

Temperature non-linear model 59 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 5)collapse) iv(time) two h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       767
    Time variable : time                            Number of groups   =        31
    Number of instruments = 38                      Obs per group: min =        21
    Wald chi2(6)  =  89755.55                                      avg =     24.74
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .1954286    .006139    31.83   0.000     .1833963    .2074609
                 |
             lx1 |    .869461   .0087121    99.80   0.000     .8523856    .8865364
                 |
             lx2 |
             L2. |   .0057757   .0010051     5.75   0.000     .0038057    .0077456
                 |
             lx3 |  -.7269447   .0200614   -36.24   0.000    -.7662642   -.6876252
             lx4 |   .0895358   .0173802     5.15   0.000     .0554712    .1236003
                 |
            lx4s |
             L2. |   .0159701   .0022669     7.04   0.000      .011527    .0204132
                 |
           _cons |  -2.629187   .3008927    -8.74   0.000    -3.218926   -2.039448
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.40  Pr > z =  0.016
    Arellano-Bond test for AR(2) in first differences: z =  -0.20  Pr > z =  0.839
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(31)   =  12.98  Prob > chi2 =  0.998
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(31)   =  28.24  Prob > chi2 =  0.609
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(25)   =  29.94  Prob > chi2 =  0.226
        Difference (null H = exogenous): chi2(6)    =  -1.70  Prob > chi2 =  1.000
      iv(time)
        Hansen test excluding group:     chi2(30)   =  28.24  Prob > chi2 =  0.558
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.975
```

Temperature non-linear model 60 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 5)collapse) iv(time) two robust h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       767
    Time variable : time                            Number of groups   =        31
    Number of instruments = 38                      Obs per group: min =        21
    Wald chi2(6)  =    735.14                                      avg =     24.74
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .1954286   .0592214     3.30   0.001     .0793569    .3115004
                 |
             lx1 |    .869461   .0648741    13.40   0.000       .74231     .996612
                 |
             lx2 |
             L2. |   .0057757   .0053153     1.09   0.277    -.0046421    .0161934
                 |
             lx3 |  -.7269447   .1265883    -5.74   0.000    -.9750532   -.4788362
             lx4 |   .0895358   .0518848     1.73   0.084    -.0121565     .191228
                 |
            lx4s |
             L2. |   .0159701   .0090155     1.77   0.076    -.0016999    .0336402
                 |
           _cons |  -2.629187   1.730368    -1.52   0.129    -6.020647     .762272
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(1/5).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.36  Pr > z =  0.018
    Arellano-Bond test for AR(2) in first differences: z =  -0.19  Pr > z =  0.849
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(31)    =  12.98  Prob > chi2 =  0.998
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(31)    =  28.24  Prob > chi2 =  0.609
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(25)    =  29.94  Prob > chi2 =  0.226
        Difference (null H = exogenous): chi2(6)     =  -1.70  Prob > chi2 =  1.000
      iv(time)
        Hansen test excluding group:     chi2(30)    =  28.24  Prob > chi2 =  0.558
        Difference (null H = exogenous): chi2(1)     =   0.00  Prob > chi2 =  0.975
```

Precipitation non-linear model 61 (developed)

```
    xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 1)collapse) iv(i.time) nolevel h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       735
    Time variable : time                            Number of groups   =        31
    Number of instruments = 30                      Obs per group: min =        20
    Wald chi2(6)  =  11613.07                                      avg =     23.71
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2998845   .0408214     7.35   0.000     .2198761    .3798929
                 |
             lx1 |   .6986958   .0282147    24.76   0.000     .6433961    .7539956
                 |
             lx2 |
             L2. |  -.1047271   .0499331    -2.10   0.036    -.2025942     -.00686
                 |
             lx3 |
             L2. |  -.3063423   .1397399    -2.19   0.028    -.5802274   -.0324571
                 |
             lx4 |
             L2. |   .4214529   .1017105     4.14   0.000     .2221039    .6208019
                 |
            lx4s |  -.0010668   .0032266    -0.33   0.741    -.0073907    .0052571
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -3.69  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =  -1.74  Pr > z =  0.081
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(24)   = 121.10  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 1))
        Sargan test excluding group:     chi2(18)    =  85.76  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(6)     =  35.34  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(0)     =   0.00  Prob > chi2 =      .
        Difference (null H = exogenous): chi2(24)    = 121.10  Prob > chi2 =  0.000
```

Precipitation non-linear model 62 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 1)collapse) iv(i.time) nolevel two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       735
    Time variable : time                            Number of groups   =        31
    Number of instruments = 30                      Obs per group: min =        20
    Wald chi2(6)  =  36569.30                                      avg =     23.71
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3033391   .0195515    15.51   0.000     .2650188    .3416594
                 |
             lx1 |   .7000328   .0127139    55.06   0.000     .6751139    .7249516
                 |
             lx2 |
             L2. |  -.1044746   .0114045    -9.16   0.000    -.1268271   -.0821221
                 |
             lx3 |
             L2. |  -.2875277   .0447234    -6.43   0.000    -.3751839   -.1998715
                 |
             lx4 |
             L2. |   .3750527   .0589487     6.36   0.000     .2595155      .49059
                 |
            lx4s |  -.0024458   .0009728    -2.51   0.012    -.0043524   -.0005392
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.43  Pr > z =  0.015
    Arellano-Bond test for AR(2) in first differences: z =  -2.00  Pr > z =  0.046
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(24)   = 121.10  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(24)   =  26.76  Prob > chi2 =  0.316
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 1))
        Hansen test excluding group:     chi2(18)   =  24.96  Prob > chi2 =  0.126
        Difference (null H = exogenous): chi2(6)    =   1.80  Prob > chi2 =  0.937
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
        Difference (null H = exogenous): chi2(24)   =  26.76  Prob > chi2 =  0.316
```

Precipitation non-linear model 63 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 1)collapse) iv(i.time) nolevel two robust h(
    > 2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       735
    Time variable : time                            Number of groups   =        31
    Number of instruments = 30                      Obs per group: min =        20
    Wald chi2(6)  =   2236.59                                      avg =     23.71
    Prob > chi2   =     0.000                                      max =        24
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3033391    .074489     4.07   0.000     .1573434    .4493348
                 |
             lx1 |   .7000328   .0561249    12.47   0.000       .59003    .8100355
                 |
             lx2 |
             L2. |  -.1044746   .0909141    -1.15   0.250    -.2826631    .0737138
                 |
             lx3 |
             L2. |  -.2875277   .1758628    -1.63   0.102    -.6322125    .0571571
                 |
             lx4 |
             L2. |   .3750527   .1511943     2.48   0.013     .0787173    .6713881
                 |
            lx4s |  -.0024458   .0033974    -0.72   0.472    -.0091046    .0042129
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.57  Pr > z =  0.116
    Arellano-Bond test for AR(2) in first differences: z =  -1.92  Pr > z =  0.054
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(24)   = 121.10  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(24)   =  26.76  Prob > chi2 =  0.316
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 1))
        Hansen test excluding group:     chi2(18)   =  24.96  Prob > chi2 =  0.126
        Difference (null H = exogenous): chi2(6)    =   1.80  Prob > chi2 =  0.937
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
        Difference (null H = exogenous): chi2(24)   =  26.76  Prob > chi2 =  0.316
```

Precipitation non-linear model 64 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 1)collapse) iv(i.time) h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       767
    Time variable : time                            Number of groups   =        31
    Number of instruments = 37                      Obs per group: min =        21
    Wald chi2(6)  =  18300.99                                      avg =     24.74
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3671754   .0172035    21.34   0.000     .3334571    .4008936
                 |
             lx1 |   .6769016   .0195347    34.65   0.000     .6386142    .7151889
                 |
             lx2 |
             L2. |  -.0521365   .0373585    -1.40   0.163    -.1253579    .0210849
                 |
             lx3 |
             L2. |    -.60044   .0174985   -34.31   0.000    -.6347365   -.5661434
                 |
             lx4 |
             L2. |   .4521957   .0607976     7.44   0.000     .3330346    .5713568
                 |
            lx4s |   .0101249   .0022845     4.43   0.000     .0056473    .0146025
           _cons |  -2.819069   .3949636    -7.14   0.000    -3.593183   -2.044954
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -5.64  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.57  Pr > z =  0.565
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(30)   = 328.72  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(24)   = 166.15  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(6)    = 162.57  Prob > chi2 =  0.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 1))
        Sargan test excluding group:     chi2(18)   = 110.97  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(12)   = 217.75  Prob > chi2 =  0.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
```

```
> e 2015.time 2016.time)
    Sargan test excluding group:     chi2(6)    = 112.58  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(24)   = 216.14  Prob > chi2 =  0.000
```

Precipitation non-linear model 65 (developed)

```
. xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 1)collapse) iv(i.time) two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       767
    Time variable : time                            Number of groups   =        31
    Number of instruments = 37                      Obs per group: min =        21
    Wald chi2(6)  =  67399.54                                      avg =     24.74
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3692805   .0162936    22.66   0.000     .3373456    .4012154
                 |
             lx1 |   .6821644   .0093438    73.01   0.000     .6638509    .7004779
                 |
             lx2 |
             L2. |    -.04623   .0244648    -1.89   0.059    -.0941801    .0017201
                 |
             lx3 |
             L2. |  -.6100909   .0380806   -16.02   0.000    -.6847274   -.5354543
                 |
             lx4 |
             L2. |   .4041868   .0421852     9.58   0.000     .3215053    .4868684
                 |
            lx4s |   .0092037   .0011346     8.11   0.000       .00698    .0114274
           _cons |  -2.650491       .496    -5.34   0.000    -3.622633   -1.678349
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.93  Pr > z =  0.003
    Arellano-Bond test for AR(2) in first differences: z =   0.30  Pr > z =  0.768
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(30)   = 328.72  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(30)   =  28.78  Prob > chi2 =  0.529
```

```
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(24)   =  28.64  Prob > chi2 =  0.234
        Difference (null H = exogenous): chi2(6)    =   0.14  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 1))
        Hansen test excluding group:     chi2(18)   =  27.74  Prob > chi2 =  0.066
        Difference (null H = exogenous): chi2(12)   =   1.03  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(6)    =  11.38  Prob > chi2 =  0.077
        Difference (null H = exogenous): chi2(24)   =  17.39  Prob > chi2 =  0.831
```

Precipitation non-linear model 66 (developed)

```
    . xtabond2 ly l.ly lx1 l2.lx2 l2.lx3 l2.lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 1)collapse) iv(i.time) two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       767
    Time variable : time                            Number of groups   =        31
    Number of instruments = 37                      Obs per group: min =        21
    Wald chi2(6)  =   1690.39                                      avg =     24.74
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .3692805   .0938187     3.94   0.000     .1853992    .5531618
                 |
             lx1 |   .6821644   .0667726    10.22   0.000     .5512924    .8130364
                 |
             lx2 |
             L2. |    -.04623   .0591274    -0.78   0.434    -.1621176    .0696575
                 |
             lx3 |
             L2. |  -.6100909   .1631239    -3.74   0.000    -.9298078   -.2903739
                 |
             lx4 |
             L2. |   .4041868   .1307069     3.09   0.002      .148006    .6603677
                 |
            lx4s |   .0092037   .0044324     2.08   0.038     .0005165     .017891
           _cons |  -2.650491   2.556295    -1.04   0.300    -7.660738    2.359756
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
```

```
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.14  Pr > z =  0.032
    Arellano-Bond test for AR(2) in first differences: z =   0.25  Pr > z =  0.800
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(30)   = 328.72  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(30)   =  28.78  Prob > chi2 =  0.529
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(24)   =  28.64  Prob > chi2 =  0.234
        Difference (null H = exogenous): chi2(6)    =   0.14  Prob > chi2 =  1.000
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 1))
        Hansen test excluding group:     chi2(18)   =  27.74  Prob > chi2 =  0.066
        Difference (null H = exogenous): chi2(12)   =   1.03  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(6)    =  11.38  Prob > chi2 =  0.077
        Difference (null H = exogenous): chi2(24)   =  17.39  Prob > chi2 =  0.831
```

Carbon Dioxide Emission non-linear model 67 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(i.time) nolevel h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       673
    Time variable : time                            Number of groups   =        31
    Number of instruments = 154                     Obs per group: min =        19
    Wald chi2(6)  =   2193.16                                      avg =     21.71
    Prob > chi2   =     0.000                                      max =        22
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |  -.0011469   .0238031    -0.05   0.962    -.0478003    .0455064
                 |
             lx1 |   .7314557    .018282    40.01   0.000     .6956237    .7672878
             lx2 |   .0205278   .0140192     1.46   0.143    -.0069493    .0480048
                 |
             lx3 |
             L2. |   .6404775   .1488941     4.30   0.000     .3486504    .9323046
                 |
             lx4 |  -.1434316    .049657    -2.89   0.004    -.2407576   -.0461056
                 |
            lx4s |
             L2. |   .0004485   .0022821     0.20   0.844    -.0040242    .0049213
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   3.63  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.47  Pr > z =  0.642
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(148)  = 225.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(3 .))
        Sargan test excluding group:     chi2(16)   =  83.69  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(132)  = 141.90  Prob > chi2 =  0.263
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Sargan test excluding group:     chi2(126)  = 215.20  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(22)   =  10.39  Prob > chi2 =  0.982
```

Carbon Dioxide Emission non-linear model 68 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(i.time) nolevel two h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       673
    Time variable : time                            Number of groups   =        31
    Number of instruments = 154                     Obs per group: min =        19
    Wald chi2(6)  =  56907.58                                      avg =     21.71
    Prob > chi2   =     0.000                                      max =        22
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |  -.0025286   .0070461    -0.36   0.720    -.0163387    .0112816
                 |
             lx1 |    .732547    .007535    97.22   0.000     .7177787    .7473153
             lx2 |   .0187213   .0112248     1.67   0.095     -.003279    .0407215
                 |
             lx3 |
             L2. |   .6225454   .0468859    13.28   0.000     .5306508    .7144401
                 |
             lx4 |  -.1493159   .0361885    -4.13   0.000     -.220244   -.0783877
                 |
            lx4s |
             L2. |   .0006453   .0012227     0.53   0.598    -.0017512    .0030418
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.76  Pr > z =  0.006
    Arellano-Bond test for AR(2) in first differences: z =   0.42  Pr > z =  0.676
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(148)  = 225.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(148)  =  30.34  Prob > chi2 =  1.000
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(3 .))
        Hansen test excluding group:     chi2(16)   =  27.09  Prob > chi2 =  0.041
        Difference (null H = exogenous): chi2(132)  =   3.25  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(126)  =  30.34  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(22)   =   0.00  Prob > chi2 =  1.000
```

Carbon Dioxide Emission non-linear model 69 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(i.time) nolevel two robust h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       673
    Time variable : time                            Number of groups   =        31
    Number of instruments = 154                     Obs per group: min =        19
    Wald chi2(6)  =   1112.19                                      avg =     21.71
    Prob > chi2   =     0.000                                      max =        22
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |  -.0025286    .043716    -0.06   0.954    -.0882103    .0831531
                 |
             lx1 |    .732547   .0346134    21.16   0.000     .6647061     .800388
             lx2 |   .0187213   .0225639     0.83   0.407    -.0255031    .0629457
                 |
             lx3 |
             L2. |   .6225454    .206343     3.02   0.003     .2181206     1.02697
                 |
             lx4 |  -.1493159   .0911025    -1.64   0.101    -.3278735    .0292417
                 |
            lx4s |
             L2. |   .0006453    .003031     0.21   0.831    -.0052953    .0065859
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =   2.43  Pr > z =  0.015
    Arellano-Bond test for AR(2) in first differences: z =   0.39  Pr > z =  0.695
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(148)  = 225.59  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(148)  =  30.34  Prob > chi2 =  1.000
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(3 .))
        Hansen test excluding group:     chi2(16)    =  27.09  Prob > chi2 =  0.041
        Difference (null H = exogenous): chi2(132)   =   3.25  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(126)   =  30.34  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(22)    =   0.00  Prob > chi2 =  1.000
```

Carbon Dioxide Emission non-linear model 70 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(i.time) h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       705
    Time variable : time                            Number of groups   =        31
    Number of instruments = 161                     Obs per group: min =        21
    Wald chi2(6)  =    558.12                                      avg =     22.74
    Prob > chi2   =     0.000                                      max =        23
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2083413   .1203235     1.73   0.083    -.0274885    .4441711
                 |
             lx1 |   .7712171   .1122538     6.87   0.000     .5512036    .9912306
             lx2 |   .1293743   .1338543     0.97   0.334    -.1329752    .3917238
                 |
             lx3 |
             L2. |   .0857938   .2430991     0.35   0.724    -.3906718    .5622594
                 |
             lx4 |  -.6135476   .3217271    -1.91   0.057    -1.244121    .0170259
                 |
            lx4s |
             L2. |  -.0126602   .0155071    -0.82   0.414    -.0430535    .0177331
                 |
           _cons |  -4.682129   3.012981    -1.55   0.120    -10.58746    1.223206
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL2.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -0.63  Pr > z =  0.530
    Arellano-Bond test for AR(2) in first differences: z =   0.27  Pr > z =  0.788
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(154)  =  11.94  Prob > chi2 =  1.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(148)  =   7.41  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(6)    =   4.53  Prob > chi2 =  0.605
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(3 .))
        Sargan test excluding group:     chi2(16)   =   4.13  Prob > chi2 =  0.999
        Difference (null H = exogenous): chi2(138)  =   7.81  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
```

```
    Sargan test excluding group:     chi2(132)  =   7.19  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(22)   =   4.75  Prob > chi2 =  1.000
```

Carbon Dioxide Emission non-linear model 71 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(i.time) two h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       705
    Time variable : time                            Number of groups   =        31
    Number of instruments = 161                     Obs per group: min =        21
    Wald chi2(6)  =  11605.93                                      avg =     22.74
    Prob > chi2   =     0.000                                      max =        23
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2046158   .0170993    11.97   0.000     .1711019    .2381298
                 |
             lx1 |   .7787567   .0205378    37.92   0.000     .7385033    .8190102
             lx2 |    .118856   .0539736     2.20   0.028     .0130697    .2246423
                 |
             lx3 |
             L2. |   .0757243   .0931374     0.81   0.416    -.1068217    .2582703
                 |
             lx4 |  -.6160005   .0444609   -13.85   0.000    -.7031423   -.5288587
                 |
            lx4s |
             L2. |  -.0120112   .0024661    -4.87   0.000    -.0168447   -.0071777
                 |
           _cons |  -4.651056   .9265456    -5.02   0.000    -6.467052    -2.83506
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL2.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.24  Pr > z =  0.025
    Arellano-Bond test for AR(2) in first differences: z =   1.53  Pr > z =  0.127
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(154)  =  11.94  Prob > chi2 =  1.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(154)  =  30.28  Prob > chi2 =  1.000
      (Robust, but weakened by many instruments.)
```

```
    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(148)  =  27.98  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(6)    =   2.30  Prob > chi2 =  0.891
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(3 .))
        Hansen test excluding group:     chi2(16)   =  23.68  Prob > chi2 =  0.097
        Difference (null H = exogenous): chi2(138)  =   6.60  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(132)  =  30.28  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(22)   =  -0.00  Prob > chi2 =  1.000
```

Carbon Dioxide Emission non-linear model 72 (developed)

```
    . xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(i.time) two robust h(1)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =       705
    Time variable : time                            Number of groups   =        31
    Number of instruments = 161                     Obs per group: min =        21
    Wald chi2(6)  =    744.00                                      avg =     22.74
    Prob > chi2   =     0.000                                      max =        23
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .2046158   .0521947     3.92   0.000      .102316    .3069156
                 |
             lx1 |   .7787567     .05736    13.58   0.000     .6663331    .8911803
             lx2 |    .118856   .1391071     0.85   0.393    -.1537888    .3915008
                 |
             lx3 |
             L2. |   .0757243   .3219767     0.24   0.814    -.5553384    .7067869
                 |
             lx4 |  -.6160005   .1973239    -3.12   0.002    -1.002748   -.2292527
                 |
            lx4s |
             L2. |  -.0120112   .0068665    -1.75   0.080    -.0254692    .0014468
                 |
           _cons |  -4.651056   2.387429    -1.95   0.051    -9.330331    .0282191
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    Instruments for levels equation
      Standard
        1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
        1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
        2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
        2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
         _cons
```

```
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL2.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.71  Pr > z =  0.088
    Arellano-Bond test for AR(2) in first differences: z =   0.85  Pr > z =  0.397
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(154)  =  11.94  Prob > chi2 =  1.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(154)  =  30.28  Prob > chi2 =  1.000
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(148)  =  27.98  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(6)    =   2.30  Prob > chi2 =  0.891
      gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(3 .))
        Hansen test excluding group:     chi2(16)   =  23.68  Prob > chi2 =  0.097
        Difference (null H = exogenous): chi2(138)  =   6.60  Prob > chi2 =  1.000
      iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
    > 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time
2009.time 2010.time 2011.time 2012.time 2013.time 2014.tim
    > e 2015.time 2016.time)
        Hansen test excluding group:     chi2(132)  =  30.28  Prob > chi2 =  1.000
        Difference (null H = exogenous): chi2(22)   =  -0.00  Prob > chi2 =  1.000
```

Temperature linear model 73 (developing)

```
    xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) nolevel h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      2630
    Time variable : time                            Number of groups   =       119
    Number of instruments = 126                     Obs per group: min =         2
    Wald chi2(5)  =  36539.83                                      avg =     22.10
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |     .34225   .0252862    13.54   0.000     .2926899      .39181
                 |
             lx1 |   .5690137   .0225503    25.23   0.000      .524816    .6132115
             lx2 |   .0398887   .0755041     0.53   0.597    -.1080965     .187874
             lx3 |  -.3688609   .0407594    -9.05   0.000    -.4487478    -.288974
             lx4 |   .2305028   .1378686     1.67   0.095    -.0397147    .5007203
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -15.07  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.90  Pr > z =  0.369
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(121)  = 311.24  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      iv(time)
        Sargan test excluding group:     chi2(120)  = 310.63  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)    =   0.61  Prob > chi2 =  0.435
```

Temperature linear model 74 (developing)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) nolevel two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      2630
    Time variable : time                            Number of groups   =       119
    Number of instruments = 126                     Obs per group: min =         2
    Wald chi2(5)  =  8.23e+06                                      avg =     22.10
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |    .341829   .0015583   219.36   0.000     .3387748    .3448832
                 |
             lx1 |   .5689508   .0005947   956.76   0.000     .5677853    .5701163
             lx2 |   .0385227   .0030779    12.52   0.000     .0324901    .0445553
             lx3 |  -.3673582   .0088861   -41.34   0.000    -.3847746   -.3499419
             lx4 |    .225129   .0082228    27.38   0.000     .2090127    .2412454
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.45  Pr > z =  0.147
    Arellano-Bond test for AR(2) in first differences: z =   0.38  Pr > z =  0.703
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(121)  = 311.24  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(121)  = 118.30  Prob > chi2 =  0.552
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      iv(time)
        Hansen test excluding group:     chi2(120)  = 118.30  Prob > chi2 =  0.527
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  1.000
```

Temperature linear model 75 (developing)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) nolevel two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step difference GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      2630
    Time variable : time                            Number of groups   =       119
    Number of instruments = 126                     Obs per group: min =         2
    Wald chi2(5)  =   3771.91                                      avg =     22.10
    Prob > chi2   =     0.000                                      max =        25
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |    .341829   .0523788     6.53   0.000     .2391685    .4444895
                 |
             lx1 |   .5689508    .046597    12.21   0.000     .4776224    .6602792
             lx2 |   .0385227   .0720463     0.53   0.593    -.1026855    .1797309
             lx3 |  -.3673582   .0993974    -3.70   0.000    -.5621736   -.1725429
             lx4 |    .225129   .2333234     0.96   0.335    -.2321765    .6824346
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -1.45  Pr > z =  0.147
    Arellano-Bond test for AR(2) in first differences: z =   0.38  Pr > z =  0.703
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(121)  = 311.24  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(121)  = 118.30  Prob > chi2 =  0.552
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      iv(time)
        Hansen test excluding group:     chi2(120)  = 118.30  Prob > chi2 =  0.527
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  1.000
```

Temperature linear model 76 (developing)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.

    Dynamic panel-data estimation, one-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      2749
    Time variable : time                            Number of groups   =       119
    Number of instruments = 132                     Obs per group: min =         3
    Wald chi2(5)  =  95964.24                                      avg =     23.10
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5009808    .018048    27.76   0.000     .4656074    .5363542
                 |
             lx1 |   .4571792   .0172821    26.45   0.000     .4233069    .4910516
             lx2 |   .0116188   .0693578     0.17   0.867    -.1243199    .1475575
             lx3 |  -.3594095    .036355    -9.89   0.000    -.4306639   -.2881551
             lx4 |   -.267835   .0187677   -14.27   0.000    -.3046189    -.231051
           _cons |   -.088763   .7322416    -0.12   0.904     -1.52393    1.346404
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z = -16.32  Pr > z =  0.000
    Arellano-Bond test for AR(2) in first differences: z =   0.01  Pr > z =  0.996
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(126)  = 508.61  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)

    Difference-in-Sargan tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Sargan test excluding group:     chi2(121)  = 364.95  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(5)    = 143.66  Prob > chi2 =  0.000
      iv(time)
        Sargan test excluding group:     chi2(125)  = 507.15  Prob > chi2 =  0.000
        Difference (null H = exogenous): chi2(1)    =   1.46  Prob > chi2 =  0.227
```

Temperature linear model 77 (developing)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) two h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      2749
    Time variable : time                            Number of groups   =       119
    Number of instruments = 132                     Obs per group: min =         3
    Wald chi2(5)  =  3.93e+06                                      avg =     23.10
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5004964   .0014324   349.42   0.000      .497689    .5033038
                 |
             lx1 |     .45724   .0007986   572.59   0.000     .4556748    .4588051
             lx2 |   .0130298    .002718     4.79   0.000     .0077026     .018357
             lx3 |  -.3587685   .0067049   -53.51   0.000    -.3719098   -.3456272
             lx4 |  -.2676621   .0071486   -37.44   0.000     -.281673   -.2536511
           _cons |  -.1102958   .0892814    -1.24   0.217    -.2852842    .0646926
    ------------------------------------------------------------------------------
    Warning: Uncorrected two-step standard errors are unreliable.

    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.03  Pr > z =  0.043
    Arellano-Bond test for AR(2) in first differences: z =   0.00  Pr > z =  0.997
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(126)  = 508.61  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(126)  = 118.03  Prob > chi2 =  0.681
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(121)  = 118.09  Prob > chi2 =  0.558
        Difference (null H = exogenous): chi2(5)    =  -0.06  Prob > chi2 =  1.000
      iv(time)
        Hansen test excluding group:     chi2(125)  = 118.03  Prob > chi2 =  0.658
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.973
```

Temperature linear model 78 (developing)

```
    . xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) two robust h(2)
    Favoring space over speed. To switch, type or click on mata: mata set
matafavor speed, perm.
    Warning: Number of instruments may be large relative to number of
observations.
    Warning: Two-step estimated covariance matrix of moments is singular.
      Using a generalized inverse to calculate optimal weighting matrix for two-
step estimation.
      Difference-in-Sargan/Hansen statistics may be negative.

    Dynamic panel-data estimation, two-step system GMM
    ------------------------------------------------------------------------------
    Group variable: code                            Number of obs      =      2749
    Time variable : time                            Number of groups   =       119
    Number of instruments = 132                     Obs per group: min =         3
    Wald chi2(5)  =   4926.95                                      avg =     23.10
    Prob > chi2   =     0.000                                      max =        26
    ------------------------------------------------------------------------------
                 |              Corrected
              ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
    -------------+----------------------------------------------------------------
              ly |
             L1. |   .5004964   .0485652    10.31   0.000     .4053104    .5956823
                 |
             lx1 |     .45724   .0453332    10.09   0.000     .3683885    .5460914
             lx2 |   .0130298   .0682092     0.19   0.849    -.1206577    .1467173
             lx3 |  -.3587685   .0918013    -3.91   0.000    -.5386958   -.1788413
             lx4 |  -.2676621   .1090644    -2.45   0.014    -.4814244   -.0538997
           _cons |  -.1102958   1.210945    -0.09   0.927    -2.483705    2.263114
    ------------------------------------------------------------------------------
    Instruments for first differences equation
      Standard
        D.time
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
    Instruments for levels equation
      Standard
        time
        _cons
      GMM-type (missing=0, separate instruments for each period unless collapsed)
        DL.(ly lx1 lx2 lx3 lx4) collapsed
    ------------------------------------------------------------------------------
    Arellano-Bond test for AR(1) in first differences: z =  -2.02  Pr > z =  0.043
    Arellano-Bond test for AR(2) in first differences: z =   0.00  Pr > z =  0.997
    ------------------------------------------------------------------------------
    Sargan test of overid. restrictions: chi2(126)  = 508.61  Prob > chi2 =  0.000
      (Not robust, but not weakened by many instruments.)
    Hansen test of overid. restrictions: chi2(126)  = 118.03  Prob > chi2 =  0.681
      (Robust, but weakened by many instruments.)

    Difference-in-Hansen tests of exogeneity of instrument subsets:
      GMM instruments for levels
        Hansen test excluding group:     chi2(121)  = 118.09  Prob > chi2 =  0.558
        Difference (null H = exogenous): chi2(5)    =  -0.06  Prob > chi2 =  1.000
      iv(time)
        Hansen test excluding group:     chi2(125)  = 118.03  Prob > chi2 =  0.658
        Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.973
```

Temperature non-linear model 79 (developing)

```
xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2540
Time variable : time                            Number of groups   =       119
Number of instruments = 180                     Obs per group: min =         2
Wald chi2(6)  =  46615.72                                      avg =     21.34
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .4720722   .0119621    39.46   0.000     .4486268    .4955176
             |
         lx1 |   .4073709   .0104866    38.85   0.000     .3868177    .4279242
         lx2 |    .013457   .0148032     0.91   0.363    -.0155567    .0424708
             |
         lx3 |
         L2. |  -.0844993   .0269857    -3.13   0.002    -.1373903   -.0316084
             |
         lx4 |   .1979155   .0599991     3.30   0.001     .0803194    .3155117
        lx4s |  -.0001982   .0281513    -0.01   0.994    -.0553738    .0549773
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.54  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.37  Pr > z =  0.713
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  =1529.87  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
    Sargan test excluding group:     chi2(18)    =  56.29  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(156)  =1473.58  Prob > chi2 =  0.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Sargan test excluding group:     chi2(150)  =1494.66  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(24)    =  35.20  Prob > chi2 =  0.065
```

Temperature non-linear model 80 (developing)

```
. xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel two
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2540
Time variable : time                            Number of groups   =       119
Number of instruments = 180                     Obs per group: min =         2
Wald chi2(6)  =  1.32e+07                                      avg =     21.34
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .4699273   .0022698   207.04   0.000     .4654787     .474376
             |
         lx1 |   .4087191   .0014878   274.71   0.000      .405803    .4116352
         lx2 |   .0132314   .0013636     9.70   0.000     .0105588    .0159039
             |
         lx3 |
         L2. |  -.0749162   .0081147    -9.23   0.000    -.0908207   -.0590117
             |
         lx4 |   .2025089   .0101901    19.87   0.000     .1825366    .2224811
        lx4s |  -.0014178   .0033137    -0.43   0.669    -.0079125    .0050768
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.15  Pr > z =  0.032
Arellano-Bond test for AR(2) in first differences: z =  -0.20  Pr > z =  0.841
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  =1529.87  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(174)  = 116.92  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
    Hansen test excluding group:     chi2(18)   =  42.33  Prob > chi2 =  0.001
    Difference (null H = exogenous): chi2(156)  =  74.60  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(150)  = 116.92  Prob > chi2 =  0.979
    Difference (null H = exogenous): chi2(24)   =  -0.00  Prob > chi2 =  1.000
```

Temperature non-linear model 81 (developing)

```
. xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) nolevel two robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2540
Time variable : time                            Number of groups   =       119
Number of instruments = 180                     Obs per group: min =         2
Wald chi2(6)  =   5326.34                                      avg =     21.34
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .4699273      .0877     5.36   0.000     .2980385    .6418161
             |
         lx1 |   .4087191    .090435     4.52   0.000     .2314697    .5859685
         lx2 |   .0132314   .0102734     1.29   0.198    -.0069041    .0333668
             |
         lx3 |
         L2. |  -.0749162   .1201732    -0.62   0.533    -.3104513    .1606189
             |
         lx4 |   .2025089   .0525676     3.85   0.000     .0994783    .3055395
        lx4s |  -.0014178   .0313447    -0.05   0.964    -.0628522    .0600166
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.15  Pr > z =  0.032
Arellano-Bond test for AR(2) in first differences: z =  -0.20  Pr > z =  0.844
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  =1529.87  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(174)  = 116.92  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
    Hansen test excluding group:     chi2(18)    =  42.33  Prob > chi2 =  0.001
    Difference (null H = exogenous): chi2(156)   =  74.60  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(150)   = 116.92  Prob > chi2 =  0.979
    Difference (null H = exogenous): chi2(24)    =  -0.00  Prob > chi2 =  1.000
```

Temperature non-linear model 82 (developing)

```
. xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2659
Time variable : time                            Number of groups   =       119
Number of instruments = 187                     Obs per group: min =         3
Wald chi2(6)  =  65706.09                                      avg =     22.34
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5228982    .009666    54.10   0.000     .5039531    .5418433
             |
         lx1 |   .4322457   .0092075    46.94   0.000     .4141994    .4502921
         lx2 |   .0087966   .0154328     0.57   0.569    -.0214512    .0390443
             |
         lx3 |
         L2. |  -.3617299   .0163616   -22.11   0.000    -.3937981   -.3296618
             |
         lx4 |   .3524202   .0624829     5.64   0.000     .2299558    .4748845
        lx4s |  -.1157276   .0116173    -9.96   0.000    -.1384972   -.0929581
       _cons |  -.4402121   .2205728    -2.00   0.046    -.8725269   -.0078973
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.99  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.12  Pr > z =  0.902
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(180)  =1890.42  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(174)  =1590.04  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(6)    = 300.38  Prob > chi2 =  0.000
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
    Sargan test excluding group:     chi2(18)   =  74.59  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(162)  =1815.83  Prob > chi2 =  0.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Sargan test excluding group:     chi2(156)  =1749.39  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(24)   = 141.03  Prob > chi2 =  0.000
```

Temperature non-linear model 83 (developing)

```
. xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) two
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2659
Time variable : time                            Number of groups   =       119
Number of instruments = 187                     Obs per group: min =         3
Wald chi2(6)  =  3.53e+06                                      avg =     22.34
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5234194   .0027134   192.90   0.000     .5181013    .5287375
             |
         lx1 |   .4321822   .0018056   239.35   0.000     .4286433    .4357212
         lx2 |   .0072658   .0017951     4.05   0.000     .0037475    .0107841
             |
         lx3 |
         L2. |  -.3620263   .0104705   -34.58   0.000     -.382548   -.3415045
             |
         lx4 |   .3517996   .0124741    28.20   0.000     .3273507    .3762484
        lx4s |  -.1137261   .0035439   -32.09   0.000     -.120672   -.1067802
       _cons |  -.4466506   .1557931    -2.87   0.004    -.7519994   -.1413018
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.13  Pr > z =  0.033
Arellano-Bond test for AR(2) in first differences: z =  -0.07  Pr > z =  0.942
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(180)  =1890.42  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(180)  = 115.81  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(174)  = 115.71  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(6)    =   0.10  Prob > chi2 =  1.000
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
    Hansen test excluding group:     chi2(18)   =  37.34  Prob > chi2 =  0.005
    Difference (null H = exogenous): chi2(162)  =  78.47  Prob > chi2 =  1.000
```

```
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(156)  = 117.96  Prob > chi2 =  0.990
    Difference (null H = exogenous): chi2(24)   =  -2.15  Prob > chi2 =  1.000
```

Temperature non-linear model 84 (developing)

```
. xtabond2 ly l.ly lx1 lx2 l2.lx3 lx4 lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(1 .)collapse) iv(i.time) two robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2659
Time variable : time                            Number of groups   =       119
Number of instruments = 187                     Obs per group: min =         3
Wald chi2(6)  =   5864.74                                      avg =     22.34
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5234194   .0805875     6.50   0.000     .3654709    .6813679
             |
         lx1 |   .4321822   .0799802     5.40   0.000     .2754239    .5889406
         lx2 |   .0072658   .0118498     0.61   0.540    -.0159594     .030491
             |
         lx3 |
         L2. |  -.3620263   .0897976    -4.03   0.000    -.5380263   -.1860262
             |
         lx4 |   .3517996    .159847     2.20   0.028     .0385053    .6650938
        lx4s |  -.1137261   .0346213    -3.28   0.001    -.1815826   -.0458695
       _cons |  -.4466506   .6108227    -0.73   0.465    -1.643841    .7505398
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.13  Pr > z =  0.033
Arellano-Bond test for AR(2) in first differences: z =  -0.07  Pr > z =  0.943
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(180)  =1890.42  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(180)  = 115.81  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)
```

```
Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(174)  = 115.71  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(6)    =   0.10  Prob > chi2 =  1.000
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(1 .))
    Hansen test excluding group:     chi2(18)   =  37.34  Prob > chi2 =  0.005
    Difference (null H = exogenous): chi2(162)  =  78.47  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(156)  = 117.96  Prob > chi2 =  0.990
    Difference (null H = exogenous): chi2(24)   =  -2.15  Prob > chi2 =  1.000
```

Precipitation linear model 85 (developing)

```
xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(3 .)collapse)
iv(time) nolevel h(2)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2630
Time variable : time                            Number of groups   =       119
Number of instruments = 121                     Obs per group: min =         2
Wald chi2(5)  =  34497.28                                      avg =     22.10
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .3129438   .0266453    11.74   0.000       .26072    .3651677
             |
         lx1 |   .5534465   .0230521    24.01   0.000     .5082651    .5986278
         lx2 |   .1447222   .0921859     1.57   0.116    -.0359589    .3254033
         lx3 |  -.1924164   .0521809    -3.69   0.000    -.2946891   -.0901436
         lx4 |    .041927   .0250485     1.67   0.094    -.0071671    .0910212
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -13.75  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.81  Pr > z =  0.417
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(116)  = 279.83  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  iv(time)
    Sargan test excluding group:     chi2(115)  = 273.41  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(1)    =   6.42  Prob > chi2 =  0.011
```

Precipitation linear model 86 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(3 .)collapse)
iv(time) nolevel two h(2)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2630
Time variable : time                            Number of groups   =       119
Number of instruments = 121                     Obs per group: min =         2
Wald chi2(5)  =  7.31e+06                                      avg =     22.10
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .3140349   .0017345   181.05   0.000     .3106353    .3174345
             |
         lx1 |   .5536804   .0012511   442.56   0.000     .5512283    .5561324
         lx2 |   .1428325   .0039587    36.08   0.000     .1350736    .1505915
         lx3 |   -.204892   .0139776   -14.66   0.000    -.2322877   -.1774963
         lx4 |   .0418408   .0014518    28.82   0.000     .0389953    .0446863
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.52  Pr > z =  0.129
Arellano-Bond test for AR(2) in first differences: z =   0.36  Pr > z =  0.717
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(116)  = 279.83  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(116)  = 117.59  Prob > chi2 =  0.441
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(115)  = 118.28  Prob > chi2 =  0.398
    Difference (null H = exogenous): chi2(1)    =  -0.69  Prob > chi2 =  1.000
```

Precipitation linear model 87 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(3 .)collapse)
iv(time) nolevel two robust h(2)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2630
Time variable : time                            Number of groups   =       119
Number of instruments = 121                     Obs per group: min =         2
Wald chi2(5)  =   2280.34                                      avg =     22.10
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .3140349   .0594606     5.28   0.000     .1974943    .4305756
             |
         lx1 |   .5536804    .053453    10.36   0.000     .4489144    .6584463
         lx2 |   .1428325   .1429339     1.00   0.318    -.1373128    .4229778
         lx3 |   -.204892   .1241699    -1.65   0.099    -.4482606    .0384766
         lx4 |   .0418408   .0441644     0.95   0.343    -.0447199    .1284015
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.51  Pr > z =  0.130
Arellano-Bond test for AR(2) in first differences: z =   0.36  Pr > z =  0.718
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(116)  = 279.83  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(116)  = 117.59  Prob > chi2 =  0.441
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(115)  = 118.28  Prob > chi2 =  0.398
    Difference (null H = exogenous): chi2(1)    =  -0.69  Prob > chi2 =  1.000
```

Precipitation linear model 88 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(3 .)collapse)
iv(time) h(2)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2749
Time variable : time                            Number of groups   =       119
Number of instruments = 127                     Obs per group: min =         3
Wald chi2(5)  =  95215.75                                      avg =     23.10
Prob > chi2   =     0.000                                      max =        26
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .6564464   .0170714    38.45   0.000      .622987    .6899058
             |
         lx1 |   .3265872   .0176459    18.51   0.000     .2920018    .3611726
         lx2 |   .1097465   .0834639     1.31   0.189    -.0538397    .2733328
         lx3 |  -.2802644   .0471459    -5.94   0.000    -.3726686   -.1878602
         lx4 |   .0898327   .0225061     3.99   0.000     .0457216    .1339439
       _cons |  -1.660823   .9236002    -1.80   0.072    -3.471047    .1493998
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.63  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.21  Pr > z =  0.228
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(121)  = 721.11  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(116)  = 328.66  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(5)    = 392.45  Prob > chi2 =  0.000
  iv(time)
    Sargan test excluding group:     chi2(120)  = 716.15  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(1)    =   4.97  Prob > chi2 =  0.026
```

Precipitation linear model 89 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(3 .)collapse)
iv(time) two h(2)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2749
Time variable : time                            Number of groups   =       119
Number of instruments = 127                     Obs per group: min =         3
Wald chi2(5)  = 682245.00                                      avg =     23.10
Prob > chi2   =     0.000                                      max =        26
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .6539951   .0036416   179.59   0.000     .6468576    .6611326
             |
         lx1 |   .3287906    .003179   103.43   0.000     .3225598    .3350213
         lx2 |   .1082731   .0048234    22.45   0.000     .0988194    .1177268
         lx3 |  -.2839099   .0087859   -32.31   0.000      -.30113   -.2666898
         lx4 |   .0891105   .0032738    27.22   0.000     .0826939    .0955271
       _cons |  -1.621298   .1056555   -15.35   0.000    -1.828379   -1.414217
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.56  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.89  Pr > z =  0.372
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(121)  = 721.11  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(121)  = 118.41  Prob > chi2 =  0.550
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(116)  = 117.92  Prob > chi2 =  0.433
    Difference (null H = exogenous): chi2(5)    =   0.49  Prob > chi2 =  0.993
  iv(time)
    Hansen test excluding group:     chi2(120)  = 118.41  Prob > chi2 =  0.524
    Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.958
```

Precipitation linear model 90 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 lx4, gmm(ly lx1 lx2 lx3 lx4,lag(3 .)collapse)
iv(time) two robust h(2)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2749
Time variable : time                            Number of groups   =       119
Number of instruments = 127                     Obs per group: min =         3
Wald chi2(5)  =   7267.05                                      avg =     23.10
Prob > chi2   =     0.000                                      max =        26
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .6539951   .0462807    14.13   0.000     .5632865    .7447036
             |
         lx1 |   .3287906    .035443     9.28   0.000     .2593235    .3982576
         lx2 |   .1082731   .1245978     0.87   0.385    -.1359342    .3524804
         lx3 |  -.2839099   .0726054    -3.91   0.000    -.4262138   -.141606
         lx4 |   .0891105   .0454621     1.96   0.050     6.37e-06    .1782146
       _cons |  -1.621298   1.468339    -1.10   0.270     -4.49919    1.256593
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.52  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.88  Pr > z =  0.380
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(121)  = 721.11  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(121)  = 118.41  Prob > chi2 =  0.550
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(116)  = 117.92  Prob > chi2 =  0.433
    Difference (null H = exogenous): chi2(5)    =   0.49  Prob > chi2 =  0.993
  iv(time)
    Hansen test excluding group:     chi2(120)  = 118.41  Prob > chi2 =  0.524
    Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  0.958
```

Precipitation non-linear model 91 (developing)

```
xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2  .)collapse) iv(i.time) nolevel h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2540
Time variable : time                            Number of groups   =       119
Number of instruments = 174                     Obs per group: min =         2
Wald chi2(6)  =    699.73                                      avg =     21.34
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .2105725    .040695     5.17   0.000     .1308118    .2903332
             |
         lx1 |   .5145136    .029486    17.45   0.000     .4567221    .5723052
         lx2 |   .0061642   .0603959     0.10   0.919    -.1122096    .1245381
         lx3 |  -.0324441   .1555222    -0.21   0.835    -.3372619    .2723738
             |
         lx4 |
         L2. |  -.0339767   .0590155    -0.58   0.565     -.149645    .0816916
             |
        lx4s |
         L2. |   .0043929   .0071467     0.61   0.539    -.0096144    .0184001
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -13.60  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.84  Pr > z =  0.402
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(168)  = 222.43  Prob > chi2 =  0.003
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(2 .))
    Sargan test excluding group:     chi2(18)    =  67.99  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(150)   = 154.44  Prob > chi2 =  0.385
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Sargan test excluding group:     chi2(144)   = 211.06  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(24)    =  11.37  Prob > chi2 =  0.986
```

Precipitation non-linear model 92 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2  .)collapse) iv(i.time) nolevel two h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2540
Time variable : time                            Number of groups   =       119
Number of instruments = 174                     Obs per group: min =         2
Wald chi2(6)  =  1.15e+06                                      avg =     21.34
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .2121991   .0025542    83.08   0.000      .207193    .2172052
             |
         lx1 |   .5130492   .0014563   352.30   0.000     .5101949    .5159035
         lx2 |   .0102115   .0046578     2.19   0.028     .0010824    .0193405
         lx3 |  -.0306899   .0110567    -2.78   0.006    -.0523607   -.0090192
             |
         lx4 |
         L2. |   -.028029   .0101705    -2.76   0.006    -.0479628   -.0080953
             |
        lx4s |
         L2. |   .0037442   .0010877     3.44   0.001     .0016123     .005876
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.34  Pr > z =  0.179
Arellano-Bond test for AR(2) in first differences: z =   0.31  Pr > z =  0.758
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(168)  = 222.43  Prob > chi2 =  0.003
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(168)  = 116.16  Prob > chi2 =  0.999
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(2 .))
    Hansen test excluding group:     chi2(18)   =  45.12  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(150)  =  71.04  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(144)  = 116.16  Prob > chi2 =  0.957
    Difference (null H = exogenous): chi2(24)   =   0.00  Prob > chi2 =  1.000
```

Precipitation non-linear model 93 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2  .)collapse) iv(i.time) nolevel two robust h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2540
Time variable : time                            Number of groups   =       119
Number of instruments = 174                     Obs per group: min =         2
Wald chi2(6)  =   1994.12                                      avg =     21.34
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .2121991     .06512     3.26   0.001     .0845662    .3398321
             |
         lx1 |   .5130492   .0689481     7.44   0.000     .3779134    .6481849
         lx2 |   .0102115   .0588248     0.17   0.862     -.105083    .1255059
         lx3 |  -.0306899   .1154571    -0.27   0.790    -.2569816    .1956018
             |
         lx4 |
         L2. |   -.028029   .0426229    -0.66   0.511    -.1115683    .0555102
             |
        lx4s |
         L2. |   .0037442   .0052681     0.71   0.477    -.0065811    .0140694
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.34  Pr > z =  0.181
Arellano-Bond test for AR(2) in first differences: z =   0.31  Pr > z =  0.759
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(168)  = 222.43  Prob > chi2 =  0.003
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(168)  = 116.16  Prob > chi2 =  0.999
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(2 .))
    Hansen test excluding group:     chi2(18)   =  45.12  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(150)  =  71.04  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(144)  = 116.16  Prob > chi2 =  0.957
    Difference (null H = exogenous): chi2(24)   =   0.00  Prob > chi2 =  1.000
```

Precipitation non-linear model 94 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2  .)collapse) iv(i.time) h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2659
Time variable : time                            Number of groups   =       119
Number of instruments = 181                     Obs per group: min =         3
Wald chi2(6)  =  11828.71                                      avg =     22.34
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5174482   .0346086    14.95   0.000     .4496166    .5852799
             |
         lx1 |   .4808215   .0310781    15.47   0.000     .4199097    .5417334
         lx2 |   .0051137   .0920669     0.06   0.956    -.1753342    .1855615
         lx3 |  -.5157751   .0942283    -5.47   0.000    -.7004592   -.3310909
             |
         lx4 |
         L2. |   .1942732   .0763815     2.54   0.011     .0445681    .3439782
             |
        lx4s |
         L2. |  -.0244919   .0091336    -2.68   0.007    -.0423936   -.0065903
             |
       _cons |   .4636202   1.352854     0.34   0.732    -2.187925    3.115166
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -11.89  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.01  Pr > z =  0.989
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  = 255.78  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(168)  = 130.28  Prob > chi2 =  0.986
    Difference (null H = exogenous): chi2(6)    = 125.50  Prob > chi2 =  0.000
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(2 .))
    Sargan test excluding group:     chi2(18)   =  41.56  Prob > chi2 =  0.001
    Difference (null H = exogenous): chi2(156)  = 214.22  Prob > chi2 =  0.001
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Sargan test excluding group:     chi2(150)  = 162.11  Prob > chi2 =  0.236
    Difference (null H = exogenous): chi2(24)   =  93.67  Prob > chi2 =  0.000
```

Precipitation non-linear model 95 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2  .)collapse) iv(i.time) two h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2659
Time variable : time                            Number of groups   =       119
Number of instruments = 181                     Obs per group: min =         3
Wald chi2(6)  =  1.08e+06                                      avg =     22.34
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5187039   .0025902   200.25   0.000     .5136272    .5237807
             |
         lx1 |   .4800445   .0019214   249.84   0.000     .4762786    .4838104
         lx2 |   .0055088   .0049202     1.12   0.263    -.0041347    .0151522
         lx3 |  -.5227187   .0067172   -77.82   0.000    -.5358841   -.5095533
             |
         lx4 |
         L2. |     .19482   .0130003    14.99   0.000     .1693399    .2203001
             |
        lx4s |
         L2. |  -.0245278   .0015884   -15.44   0.000    -.0276411   -.0214146
             |
       _cons |   .5696237   .0939075     6.07   0.000     .3855685     .753679
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.86  Pr > z =  0.062
Arellano-Bond test for AR(2) in first differences: z =  -0.01  Pr > z =  0.990
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  = 255.78  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(174)  = 116.79  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(168)  = 115.16  Prob > chi2 =  0.999
    Difference (null H = exogenous): chi2(6)    =   1.63  Prob > chi2 =  0.950
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(2 .))
    Hansen test excluding group:     chi2(18)   =  35.57  Prob > chi2 =  0.008
```

```
    Difference (null H = exogenous): chi2(156)  =  81.22  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(150)  = 116.79  Prob > chi2 =  0.979
    Difference (null H = exogenous): chi2(24)   =   0.00  Prob > chi2 =  1.000
```

Precipitation non-linear model 96 (developing)

```
. xtabond2 ly l.ly lx1 lx2 lx3 l2.lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(2  .)collapse) iv(i.time) two robust h(1)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2659
Time variable : time                            Number of groups   =       119
Number of instruments = 181                     Obs per group: min =         3
Wald chi2(6)  =   3530.08                                      avg =     22.34
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5187039   .0513695    10.10   0.000     .4180216    .6193863
             |
         lx1 |   .4800445    .044703    10.74   0.000     .3924282    .5676608
         lx2 |   .0055088   .0630496     0.09   0.930    -.1180661    .1290837
         lx3 |  -.5227187   .1162678    -4.50   0.000    -.7505994   -.2948381
             |
         lx4 |
         L2. |     .19482   .0792952     2.46   0.014     .0394043    .3502357
             |
        lx4s |
         L2. |  -.0245278   .0093602    -2.62   0.009    -.0428735   -.0061822
             |
       _cons |   .5696237    1.30682     0.44   0.663    -1.991697    3.130945
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
    1997.time 1998.time 1999.time 2000.time 2001.time 2002.time 2003.time
    2004.time 2005.time 2006.time 2007.time 2008.time 2009.time 2010.time
    2011.time 2012.time 2013.time 2014.time 2015.time 2016.time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.86  Pr > z =  0.063
Arellano-Bond test for AR(2) in first differences: z =  -0.01  Pr > z =  0.990
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  = 255.78  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
```

```
Hansen test of overid. restrictions: chi2(174)  = 116.79  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(168)  = 115.16  Prob > chi2 =  0.999
    Difference (null H = exogenous): chi2(6)    =   1.63  Prob > chi2 =  0.950
  gmm(ly lx1 lx2 lx3 lx4 lx4s, collapse lag(2 .))
    Hansen test excluding group:     chi2(18)   =  35.57  Prob > chi2 =  0.008
    Difference (null H = exogenous): chi2(156)  =  81.22  Prob > chi2 =  1.000
  iv(1990b.time 1991.time 1992.time 1993.time 1994.time 1995.time 1996.time
1997.time 1998.time 1999.time 2000.time 2001.time 20
> 02.time 2003.time 2004.time 2005.time 2006.time 2007.time 2008.time 2009.time
2010.time 2011.time 2012.time 2013.time 2014.tim
> e 2015.time 2016.time)
    Hansen test excluding group:     chi2(150)  = 116.79  Prob > chi2 =  0.979
    Difference (null H = exogenous): chi2(24)   =   0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission linear model 97 (developing)

```
xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) nolevel
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2481
Time variable : time                            Number of groups   =       118
Number of instruments = 126                     Obs per group: min =         0
Wald chi2(5)  =  35839.62                                      avg =     21.03
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .4171582   .0236199    17.66   0.000     .3708641    .4634523
             |
         lx1 |   .5296726   .0219762    24.10   0.000     .4866001    .5727451
             |
         lx2 |
         L2. |  -.0160316   .0224857    -0.71   0.476    -.0601027    .0280395
             |
         lx3 |  -.2265613   .0580935    -3.90   0.000    -.3404223   -.1127002
             |
         lx4 |
         L2. |  -.1194513   .0203368    -5.87   0.000    -.1593107   -.0795919
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -15.11  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.25  Pr > z =  0.799
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(121)  = 380.88  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  iv(time)
    Sargan test excluding group:     chi2(120)  = 380.14  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(1)    =   0.74  Prob > chi2 =  0.389
```

Carbon dioxide emission linear model 98 (developing)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) nolevel two
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2481
Time variable : time                            Number of groups   =       118
Number of instruments = 126                     Obs per group: min =         0
Wald chi2(5)  =  4.00e+06                                      avg =     21.03
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    .417293   .0006217   671.21   0.000     .4160745    .4185115
             |
         lx1 |   .5300799   .0004559  1162.76   0.000     .5291864    .5309734
             |
         lx2 |
         L2. |  -.0156558   .0016746    -9.35   0.000     -.018938   -.0123737
             |
         lx3 |   -.218077   .0092662   -23.53   0.000    -.2362385   -.1999155
             |
         lx4 |
         L2. |  -.1216076   .0023081   -52.69   0.000    -.1261313   -.1170839
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.54  Pr > z =  0.123
Arellano-Bond test for AR(2) in first differences: z =   0.12  Pr > z =  0.907
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(121)  = 380.88  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(121)  = 116.46  Prob > chi2 =  0.600
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(120)  = 116.46  Prob > chi2 =  0.574
    Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission linear model 99 (developing)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) nolevel two robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2481
Time variable : time                            Number of groups   =       118
Number of instruments = 126                     Obs per group: min =         0
Wald chi2(5)  =   3065.13                                      avg =     21.03
Prob > chi2   =     0.000                                      max =        24
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    .417293    .060616     6.88   0.000     .2984879    .5360981
             |
         lx1 |   .5300799   .0543437     9.75   0.000     .4235682    .6365915
             |
         lx2 |
         L2. |  -.0156558    .012117    -1.29   0.196    -.0394047     .008093
             |
         lx3 |   -.218077    .135243    -1.61   0.107    -.4831484    .0469944
             |
         lx4 |
         L2. |  -.1216076   .0422863    -2.88   0.004    -.2044872   -.0387279
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.54  Pr > z =  0.123
Arellano-Bond test for AR(2) in first differences: z =   0.12  Pr > z =  0.908
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(121)  = 380.88  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(121)  = 116.46  Prob > chi2 =  0.600
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(120)  = 116.46  Prob > chi2 =  0.574
    Difference (null H = exogenous): chi2(1)    =   0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission linear model 100 (developing)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2600
Time variable : time                            Number of groups   =       119
Number of instruments = 132                     Obs per group: min =         1
Wald chi2(5)  =  59074.31                                      avg =     21.85
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5727515   .0185385    30.90   0.000     .5364167    .6090863
             |
         lx1 |    .410022   .0183869    22.30   0.000     .3739844    .4460597
             |
         lx2 |
         L2. |  -.0164971   .0210172    -0.78   0.432      -.05769    .0246958
             |
         lx3 |   -.560702   .0362733   -15.46   0.000    -.6317965   -.4896076
             |
         lx4 |
         L2. |    .086355    .006367    13.56   0.000      .073876    .0988341
             |
       _cons |    2.06225   .3421453     6.03   0.000     1.391657    2.732842
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.78  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.51  Pr > z =  0.612
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(126)  = 727.80  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(121)  = 435.03  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(5)    = 292.77  Prob > chi2 =  0.000
  iv(time)
    Sargan test excluding group:     chi2(125)  = 708.85  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(1)    =  18.95  Prob > chi2 =  0.000
```

Carbon dioxide emission linear model 101 (developing)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) two
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2600
Time variable : time                            Number of groups   =       119
Number of instruments = 132                     Obs per group: min =         1
Wald chi2(5)  =  1.30e+06                                      avg =     21.85
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5723486    .001025   558.38   0.000     .5703396    .5743576
             |
         lx1 |   .4102303   .0005608   731.54   0.000     .4091312    .4113294
             |
         lx2 |
         L2. |   -.018082   .0017854   -10.13   0.000    -.0215813   -.0145828
             |
         lx3 |  -.5597896   .0035438  -157.96   0.000    -.5667352   -.5528439
             |
         lx4 |
         L2. |   .0868225   .0008385   103.54   0.000      .085179    .0884661
             |
       _cons |   2.057423    .039109    52.61   0.000     1.980771    2.134075
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.27  Pr > z =  0.023
Arellano-Bond test for AR(2) in first differences: z =  -0.30  Pr > z =  0.764
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(126)  = 727.80  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(126)  = 116.62  Prob > chi2 =  0.714
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(121)  = 114.34  Prob > chi2 =  0.653
    Difference (null H = exogenous): chi2(5)    =   2.27  Prob > chi2 =  0.810
  iv(time)
    Hansen test excluding group:     chi2(125)  = 116.62  Prob > chi2 =  0.692
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission linear model 102 (developing)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 l2.lx4, gmm(ly lx1 lx2 lx3 lx4,lag(2 .)collapse)
iv(time) two robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2600
Time variable : time                            Number of groups   =       119
Number of instruments = 132                     Obs per group: min =         1
Wald chi2(5)  =   4156.98                                      avg =     21.85
Prob > chi2   =     0.000                                      max =        25
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .5723486   .0486191    11.77   0.000     .4770568    .6676404
             |
         lx1 |   .4102303   .0425312     9.65   0.000     .3268707    .4935899
             |
         lx2 |
         L2. |   -.018082   .0153719    -1.18   0.239    -.0482105    .0120464
             |
         lx3 |  -.5597896   .0919101    -6.09   0.000    -.7399301    -.379649
             |
         lx4 |
         L2. |   .0868225   .0285836     3.04   0.002     .0307997    .1428454
             |
       _cons |   2.057423   1.011019     2.04   0.042     .0758631    4.038983
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/26).(ly lx1 lx2 lx3 lx4) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(ly lx1 lx2 lx3 lx4) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.26  Pr > z =  0.024
Arellano-Bond test for AR(2) in first differences: z =  -0.30  Pr > z =  0.765
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(126)  = 727.80  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(126)  = 116.62  Prob > chi2 =  0.714
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(121)  = 114.34  Prob > chi2 =  0.653
    Difference (null H = exogenous): chi2(5)    =   2.27  Prob > chi2 =  0.810
  iv(time)
    Hansen test excluding group:     chi2(125)  = 116.62  Prob > chi2 =  0.692
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 103 (developing)

```
xtabond2 ly l.ly l2.lx1 lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(time) nolevel
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2274
Time variable : time                            Number of groups   =       117
Number of instruments = 133                     Obs per group: min =         1
Wald chi2(6)  =  24243.97                                      avg =     19.44
Prob > chi2   =     0.000                                      max =        22
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |     .98009   .0232684    42.12   0.000     .9344847    1.025695
             |
         lx1 |
         L2. |  -.0602738   .0178901    -3.37   0.001    -.0953379   -.0252098
             |
         lx2 |   .0416988   .0476548     0.88   0.382    -.0517028    .1351004
         lx3 |   .4581542   .0801192     5.72   0.000     .3011235    .6151849
         lx4 |   .1143706   .0561437     2.04   0.042     .0043309    .2244103
             |
        lx4s |
         L2. |  -.0072234   .0022116    -3.27   0.001    -.0115581   -.0028887
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -15.44  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.75  Pr > z =  0.079
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(127)  = 562.76  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  iv(time)
    Sargan test excluding group:     chi2(126)  = 561.63  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(1)    =   1.13  Prob > chi2 =  0.289
```

Carbon dioxide emission non-linear model 104 (developing)

```
. xtabond2 ly l.ly lx1 l2.lx2 lx3 lx5 l2.lx5s, gmm(ly lx1 lx2 lx3 lx5
lx5s,lag(3 .)collapse) iv(time) nolevel two
variable lx5 not found
r(111);

. xtabond2 ly l.ly l2.lx1 lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(time) nolevel two
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2274
Time variable : time                            Number of groups   =       117
Number of instruments = 133                     Obs per group: min =         1
Wald chi2(6)  =  4.15e+06                                      avg =     19.44
Prob > chi2   =     0.000                                      max =        22
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .9807681   .0021716   451.63   0.000     .9765117    .9850244
             |
         lx1 |
         L2. |  -.0603048    .000887   -67.99   0.000    -.0620434   -.0585663
             |
         lx2 |   .0417461   .0011657    35.81   0.000     .0394613     .044031
         lx3 |   .4574218   .0070572    64.82   0.000       .44359    .4712536
         lx4 |   .1144612   .0022845    50.10   0.000     .1099837    .1189387
             |
        lx4s |
         L2. |  -.0073016   .0001695   -43.07   0.000    -.0076339   -.0069693
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.22  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.89  Pr > z =  0.375
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(127)  = 562.76  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(127)  = 116.26  Prob > chi2 =  0.743
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(126)  = 116.26  Prob > chi2 =  0.722
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 105 (developing)

```
. xtabond2 ly l.ly l2.lx1 lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(time) nolevel two robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2274
Time variable : time                            Number of groups   =       117
Number of instruments = 133                     Obs per group: min =         1
Wald chi2(6)  =  11895.91                                      avg =     19.44
Prob > chi2   =     0.000                                      max =        22
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .9807681   .0365349    26.84   0.000      .909161    1.052375
             |
         lx1 |
         L2. |  -.0603048   .0255849    -2.36   0.018    -.1104503   -.0101594
             |
         lx2 |   .0417461   .0458675     0.91   0.363    -.0481525    .1316448
         lx3 |   .4574218   .1015151     4.51   0.000     .2584558    .6563878
         lx4 |   .1144612   .0710937     1.61   0.107      -.02488    .2538024
             |
        lx4s |
         L2. |  -.0073016   .0034354    -2.13   0.034    -.0140349   -.0005683
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.05  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.86  Pr > z =  0.390
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(127)  = 562.76  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(127)  = 116.26  Prob > chi2 =  0.743
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(time)
    Hansen test excluding group:     chi2(126)  = 116.26  Prob > chi2 =  0.722
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 106 (developing)

```
. xtabond2 ly l.ly l2.lx1 lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(time)
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2391
Time variable : time                            Number of groups   =       117
Number of instruments = 140                     Obs per group: min =         2
Wald chi2(6)  =  29560.17                                      avg =     20.44
Prob > chi2   =     0.000                                      max =        23
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    1.09462   .0188289    58.14   0.000     1.057716    1.131524
             |
         lx1 |
         L2. |  -.1013514   .0178203    -5.69   0.000    -.1362785   -.0664243
             |
         lx2 |   .0305626   .0510528     0.60   0.549    -.0694991    .1306242
         lx3 |   .1143914   .0265871     4.30   0.000     .0622816    .1665012
         lx4 |   .2610592   .0410652     6.36   0.000     .1805729    .3415454
             |
        lx4s |
         L2. |  -.0126929   .0019774    -6.42   0.000    -.0165686   -.0088172
             |
       _cons |  -1.695009   .4827383    -3.51   0.000    -2.641159   -.7488595
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.23  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.72  Pr > z =  0.085
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(133)  = 539.51  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(127)  = 487.14  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(6)    =  52.38  Prob > chi2 =  0.000
  iv(time)
    Sargan test excluding group:     chi2(132)  = 531.97  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(1)    =   7.55  Prob > chi2 =  0.006
```

Carbon dioxide emission non-linear model 107 (developing)

```
. xtabond2 ly l.ly l2.lx1 lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(time) two
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2391
Time variable : time                            Number of groups   =       117
Number of instruments = 140                     Obs per group: min =         2
Wald chi2(6)  =  1.04e+06                                      avg =     20.44
Prob > chi2   =     0.000                                      max =        23
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    1.09668   .0021136   518.86   0.000     1.092537    1.100823
             |
         lx1 |
         L2. |  -.1023939   .0015002   -68.25   0.000    -.1053342   -.0994536
             |
         lx2 |   .0312217   .0014802    21.09   0.000     .0283206    .0341228
         lx3 |   .1181423   .0065713    17.98   0.000     .1052628    .1310219
         lx4 |   .2584684   .0040649    63.59   0.000     .2505013    .2664354
             |
        lx4s |
         L2. |  -.0126465   .0001146  -110.37   0.000    -.0128711    -.012422
             |
       _cons |  -1.732867   .0736069   -23.54   0.000    -1.877134     -1.5886
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.18  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.80  Pr > z =  0.424
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(133)  = 539.51  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(133)  = 115.08  Prob > chi2 =  0.867
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(127)  = 114.09  Prob > chi2 =  0.787
    Difference (null H = exogenous): chi2(6)    =   0.99  Prob > chi2 =  0.986
  iv(time)
    Hansen test excluding group:     chi2(132)  = 115.09  Prob > chi2 =  0.853
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```

Carbon dioxide emission non-linear model 108 (developing)

```
. xtabond2 ly l.ly l2.lx1 lx2 lx3 lx4 l2.lx4s, gmm(ly lx1 lx2 lx3 lx4
lx4s,lag(3 .)collapse) iv(time) two robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: code                            Number of obs      =      2391
Time variable : time                            Number of groups   =       117
Number of instruments = 140                     Obs per group: min =         2
Wald chi2(6)  =  22913.40                                      avg =     20.44
Prob > chi2   =     0.000                                      max =        23
------------------------------------------------------------------------------
             |              Corrected
          ly |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    1.09668   .0353574    31.02   0.000     1.027381    1.165979
             |
         lx1 |
         L2. |  -.1023939   .0348216    -2.94   0.003     -.170643   -.0341448
             |
         lx2 |   .0312217   .0402356     0.78   0.438    -.0476387    .1100821
         lx3 |   .1181423   .0508131     2.33   0.020     .0185504    .2177343
         lx4 |   .2584684   .0487276     5.30   0.000     .1629641    .3539726
             |
        lx4s |
         L2. |  -.0126465   .0025659    -4.93   0.000    -.0176756   -.0076175
             |
       _cons |  -1.732867   .5545226    -3.12   0.002    -2.819711   -.6460227
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.time
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/26).(ly lx1 lx2 lx3 lx4 lx4s) collapsed
Instruments for levels equation
  Standard
    time
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(ly lx1 lx2 lx3 lx4 lx4s) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.01  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.77  Pr > z =  0.439
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(133)  = 539.51  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(133)  = 115.08  Prob > chi2 =  0.867
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(127)  = 114.09  Prob > chi2 =  0.787
    Difference (null H = exogenous): chi2(6)    =   0.99  Prob > chi2 =  0.986
  iv(time)
    Hansen test excluding group:     chi2(132)  = 115.09  Prob > chi2 =  0.853
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000
```