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A STATISTICAL ANALYSIS OF THE RELATIONSHIP BETWEEN ENERGY AND ECONOMIC GROWTH: EMPIRICAL EVIDENCE FROM 66 COUNTRIES

by

Susan Sunila Sharma

A thesis submitted in fulfillment of the requirements
for a Master of Commerce in Official Statistics

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DECLARATION

Statement by Author

I, Susan Sunila Sharma, declare that this thesis is my own work and that, to the best of my knowledge, it contains no material previously published, or substantially overlapping with material submitted for the award of any other degree at any institution, except where due acknowledgement is made in the text.

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Statement by Supervisor

The research in this thesis was performed under my supervision and to my knowledge is the sole work of Miss. Susan Sunila Sharma.

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ABSTRACT

In this thesis, dynamic panel data models are used to determine the impact of electricity and non-electricity variables on economic growth for a global panel consisting of 66 countries. To make the panel data analysis more homogenous, the energy-economic growth relationships for a number of sub-panels are estimated. These panels are based on regional location of countries; hence, ending up with four regional panels, namely East/South Asian and the Pacific region, Europe and Central Asian region, Latin America and Caribbean region, and Sub-Saharan, North Africa and Middle Eastern region. In total, six proxies for energy are used, namely energy use (kg of oil equivalent per capita), energy use (kt of oil equivalent), electric power consumption (kWh), electricity production (kWh), energy production (kt of oil equivalent), and fossil fuel energy consumption (as a percentage of total consumption). The time component of my dataset is 1986-2005 inclusive.

The empirical analysis is performed using a sound theoretical framework that draws on growth theory and augment the classical growth model, which consists of inflation, capital stock, and trade, with energy.

The main findings of this thesis are that all six energy variables have positive effects on economic growth in all regional panels and also for the global panel regardless of their statistical significance. Electricity is found to be statistically significant only in East/South Asia and the Pacific panel and Europe and Central Asian panel. For the other three panels, electricity is found to be statistically insignificant. There is a significant impact of energy on economic growth for the Europe and Central Asian panel; four of the energy variables are statistically significant in this panel. Total energy use and energy use per capita is found to be statistically significant in three of the panels (namely, Europe and Central Asian panel, Latin America and Caribbean panel, and Global panel), whereas fossil fuel energy consumption is only found to be statistically significant in Sub-Saharan/North Africa and Middle East panel. In addition, it is also found that non-electricity type energy variables have greater influence on economic growth.

Furthermore, inflation is found to be statistically significant and has a negative impact on economic growth in all panels, except for the European and Central Asian panel. In the European and Central Asian panel, it is found that Inflation has a positive effect on the economic growth but it is found to be statistically insignificant. Capital stock is statistically significant and has a positive impact on the economic growth in all the five panels. In addition, trade openness is only found to be statistically significant in the European and Central Asian panel and the Sub-Saharan/North African and Middle Eastern panel, but it has a positive impact on economic growth except for the East/South Asian and the Pacific panel, where it is found to have a negative impact.

ABBREVIATIONS

ARDL – autoregression- distributed lag

ECM – error correction model

EGARCH – exponential generalized autoregressive conditional heteroskedasity

GDP – Gross domestic product

GFCF – gross fixed capital formation

OECD – organization for economic co-operation and development

OPEC – organization of the petroleum exporting countries

VEC – vector error correction

VECM – vector error correction model

VAR – vector autoregression

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CHAPTER 1
INTRODUCTION

1.0 INTRODUCTION

In this thesis, the relationship between energy and economic growth for a panel of 66 countries is examined. There is a large literature on this subject. However, the extant literature is focused more on deriving the causality relationship between various energy type variables and economic growth (see Chapter 2 for a detailed review of this literature).

The rest of this chapter is organized as follows. Section 1.1 provides an overview of the energy-economic growth relationship. Section 1.2 discusses the problem statement motivating this thesis. Section 1.3 outlines the main research question and the specific research aims and objectives. The penultimate section provides an outline of this thesis, and the final section provides some concluding remarks.

1.1 AN OVERVIEW OF THE ENERGY-ECONOMIC GROWTH RELATIONSHIP

This branch of research on energy-economic growth nexus has three strands. The first strand of the literature examines the relationship between electricity consumption and GDP (see, for example, Ho and Siu, 2007; Mozumder and Marathe, 2007; Yuan *et al*. 2007; Yoo, 2006; Shiu and Lam, 2004; and Ghosh, 2002). These studies have generally examined cointegration and Granger causality amongst the variables. Generally, they have found evidence of cointegration between electricity and GDP and there have been mixed evidence of causation, in that in some studies GDP Granger caused electricity (see, for example, Mozumder and Marathe, 2007; Yoo, 2006; Jumbe, 2004; Ghosh, 2002), while in other studies electricity Granger caused GDP (see, for example, Ho and Shiu, 2007; Yuan *et al*. 2007; Altinay and Karagol, 2005; Shiu and Lam, 2004). These studies are reviewed in detail in Chapter 2.

The second strand of studies has examined the relationship between oil prices and GDP. This area of research is relatively less researched and can be considered as nascent. This area of research is topical in the sense that recent hikes in oil prices and ensuing recessions have re-invigorated the focus on oil-macroeconomic type relationship. Recent studies in this area include Hanabusa (2009), Lorde et al. (2009) and Prasad et al. (2007).

Hanabusa (2009) examined the impact of oil prices on Japan's economic growth using an EGARCH framework during the period 2000 to 2008. He found that economic growth rate Granger caused the change of oil prices in mean and variance and the change of oil price Granger caused the economic growth rate in mean and variance. Lorde *et al*. (2009) examined the macroeconomic effects of oil price fluctuations on Trinidad and Tobago using a VAR model and found that when oil prices rise (a positive shock), initially output falls but after a couple of years output starts to rise. Prasad *et al*. (2007) examined the impact of oil prices on Fiji's GDP and found that a rise in oil prices actually increases GDP.

The third strand of studies has examined the relationship between other forms of energy (such as fossil fuel, coal, petroleum, coke, gas, total energy, etc) and GDP. And again, it is found that there is cointegration between these energy type variables and GDP. In addition, evidence has been documented of causality running in different directions. In some studies, it is found that GDP Granger caused these energy type variables (see, for example, Lise and Montfort, 2007; Lee, 2006; Lee and Chang, 2005; Cheng and Lai, 1997), while in other studies it has been noted that energy variables Granger caused GDP (see, for example, Yuan *et al*. 2008; Lee and Chang, 2005; Morimoto and Hope, 2004; Wolde-Rufael, 2004; Stern, 2000).

1.2 PROBLEM STATEMENT AND INNOVATION

To-date, there are number of panel data based studies but these panel based studies are not inclusive of all the regions of the globe. This study is based on panel data, including panels constructed by region and the globe as a whole. In previous studies, basically the emphasis is given on one country or a group of countries from a particular region, but none of the studies are based on regional panels. A second issue is that, as a result of the above limitation, the behavior of energy on economic growth of the globe and various regions of the globe have not been studied.

Furthermore, panel based research on energy and economic growth is scarce. There are only seven studies (namely, Narayan and Smyth, 2009, 2008; Apergis and Payne, 2008; Lee and Chang, 2008; Chen *et al*., 2007; Al-Iriani, 2006; and Lee, 2005) that look at this relationship in a panel framework. This study adds to this group of studies by estimating growth models of energy for six different regions, including one for the globe as a whole; allowing results to be compared and contrasted by regions.

Moreover, this study does not use panel unit root and panel cointegration approach, as has been the case in this literature to-date. Rather, the study uses a dynamic panel data model, which follows the ‘growth model’ framework, ensuring that there is a strong theoretical foundation for my empirical analysis. The growth model is theoretically augmented with the traditional determinants of growth, such as inflation, trade, and capital stock (for detailed discussion refer Chapter 4; Pgs 78-88).

Lastly, in this study six energy type variables (namely, namely energy use (kg of oil equivalent per capita), energy use (kt of oil equivalent), electric power consumption (kWh), electricity production (kWh), energy production (kt of oil equivalent), and fossil fuel energy consumption (as a percentage of total consumption)) are used to proxy energy. This will allow us to judge the robustness of the relationship between energy and economic growth, not only for the globe as a whole but also for the various regions of the globe, as explained earlier.

1.3 OBJECTIVES AND AIMS

The main research question is: what is the impact of energy type variables on economic growth for various regions of the globe?

The specific aims are as follows:

1. To examine the role of electricity consumption and production on economic growth; and
2. To examine the role of non-electricity type variables on economic growth.

1.4 ORGANISATION OF THIS THESIS

In chapter 2, a detailed review of the literature on energy-economic growth nexus is undertaken. Here, altogether 54 published energy-economic growth papers are reviewed.

In chapter 3, a statistical analysis of the ten variables that are used in this study is undertaken. Basically, the growth of all the six energy type variables (namely, namely energy use (kg of oil equivalent per capita), energy use (kt of oil equivalent), electric power consumption (kWh), electricity production (kWh), energy production (kt of oil equivalent), and fossil fuel energy consumption (as a percentage of total consumption)), GDP and also the core variables, such as inflation, trade, and capital growth is analyzed and stylized features of the dataset is examined.

The main aim of Chapter 4 is to provide an estimable model on which the empirical analysis will be based. This chapter outlines the empirical model and provides a theoretical framework for better understanding the empirical work that is conducted in this thesis.

Chapter 5 discusses the methodology used in this study. The second part of the chapter reports the empirical findings. The chapter concludes with some discussions of the main findings.

Finally, in the last Chapter, the study concludes with main findings and a discussion of some policy recommendations. The final part of this chapter provides some recommendations for further research.

1.5 CONCLUSION

In this chapter, the main research question and the aims and objectives of this study are outlined. It also discusses some limitations of the existing literature on energy-economic growth nexus, and discussed the main motivations for this study.

In the next chapter, a literature review on this subject matter is provided. This will be achieved by reviewing a total of 54 studies published so far in this field.

CHAPTER 2
LITERATURE REVIEW

2.0 INTRODUCTION

In this chapter, the aim is to review the literature that has considered the relationship between energy type variables and economic growth (or gross domestic product (GDP). The idea is to identify the work that has already been done. The approach in this chapter is twofold. First, studies by different regions are classified. Second, these studies are divided into two categories: one relating to studies on individual countries and two relating to studies on panel data models.

The rest of this chapter is organised as follows. In the next section, reviews of studies on individual countries are provided. In section 2.2, studies on panel data models are reviewed. In section 2.3, some key features from the extant literature are identified. In section 2.4, a discussion of how my proposed work will be different from the extant literature is provided.

2.1 STUDIES ON INDIVIDUAL COUNTRIES

This section is divided into six regions, namely the Asia and Pacific region, the Europe and Central Asian region, the Latin American and Caribbean region, the Middle-east and North African region, the Sub-Saharan African region, and the North American region. The idea behind this classification of studies is that at the end of this section, some broad comparisons of findings by regions can be made.

2.1.1 Studies on the Asian and the Pacific Region

Yuan *et al*. (2007) applies the Johansen and Juselius (1990) cointegration test to examine the causal relationship between electricity consumption and real GDP for

China. Time series data on real GDP and electricity consumption for the period 1978-2004 is used for modeling this relationship. Their results reveal evidence of a long-run relationship between real GDP and electricity consumption. Tests for Granger causality suggest that there is only unidirectional Granger causality running from electricity consumption to real GDP. The authors also use the Hodrick-Prescott (HP) filter to decompose the trend and cyclical component of the GDP and electricity consumption series. The estimation results indicate that there is cointegration not only between the trend components, but also the cyclical components of the two series, which implies that Granger causality is probably related with the business cycle. It should be noted that since the cyclical components are by definition stationary processes, expecting cointegration between cyclical components is most surprising.

Yuan et al. (2008) tested for the existence and direction of causality between output growth and energy use in China at both aggregated total energy and disaggregated levels (such as for coal, oil and electricity consumption). They use data for the period 1963-2005. Using the Johansen cointegration technique, the empirical findings indicate that there exists a long-run cointegration relationship among output, labor, capital, and energy use in China both at the aggregated and disaggregated levels. The authors employ a vector error correction (VEC) specification to estimate the short-run dynamics of the variables are tested, including any possible long-run Granger causation among the variables. Their results from the VEC indicate existence of Granger causality, running from electricity and oil consumption to GDP On the other hand, short-run Granger causality exists; causality runs from GDP to total energy, coal and oil consumption

Shiu and Lam (2004) examine the causal relationship between electricity consumption and real GDP for China using annual time series data for the period 1971-2000. By using the Johansen (1988) and Johansen and Juselius (1990) and Engle and Granger (1987) tests it was shown that real GDP and electricity consumption for China were cointegrated. Using tests for Granger causality, it was established that there exists unidirectional Granger causality running from electricity consumption to real GDP.

Ghosh (2002) examines Granger causality between electricity consumption and GDP for India using annual time series data covering the period 1950-51 to 1996-97. He used the VAR approach of Johansen (1988, 1991) and Johansen and Joselius (1990) to determine the cointegration between the variables. His study could not find any evidence of a long-run equilibrium relationship among the variables but he found evidence for unidirectional Granger causality running from economic growth (GDP) to electricity consumption without any feedback effect in the short-run.

Paul and Bhattacharaya (2004) examine the different directions of causal relationship between energy consumption and economic growth for India. Their empirical analysis is based on annual data and covers the period 1950-1996. The combined results of the standard Granger causality test and the Engle–Granger error correction approach imply bi-directional causal relation between energy consumption and economic growth. Moreover, long-run causality exists and runs from economic growth to energy consumption and the short-run bi-directional causality runs from energy consumption to economic growth.

Lee and Chang (2005) study the stability between energy consumption and GDP for Taiwan for the period 1954-2003. They use aggregate as well as various disaggregated data for energy consumption, including coal, oil, gas and electricity. In terms of econometric approach, they employ the unit root tests and the cointegration tests allowing for structural breaks. First, they find that energy consumption and its disaggregates are cointegrated with GDP. Second, they find that different directions of causality exist between GDP and various kinds of energy consumption. In other words, bi-directional causal linkages between GDP and both total energy and coal consumption are identified. For example, they find unidirectional causality running from: (a) oil consumption to GDP, (b) gas consumption to GDP, and (c) electricity consumption to GDP.

Chang *et al*. (2001) examine the causal relationship among energy consumption, employment, and output for Taiwan over the period January 1982 to November 1997. They used the Johansen (1988) and Johansen and Juselius (1990) cointegration test and found that these three variables were cointegrated. They then applied the vector error-correction model (VECM), which showed bidirectional Granger causality for employment-output and employment-energy consumption but only unidirectional causality running from energy consumption to output. Furthermore, the impulse responses and variance decompositions analyses were also undertaken. The results from these reveal a similar relationship, in that energy consumption appeared to have led to output growth in Taiwan over this sample period.

Cheng and Lai (1997) examine the causality relationship between gross national product (GNP), energy, and employment for Taiwan using time series annual data over the period 1955-1933. Using Hsiao's (1981) version of the Granger causality test, they show that causality runs from GDP to Energy.

Ho and Siu (2007) examine the relationship between real GDP and electricity consumption for Hong Kong using time series data for the period 1966 to 2002. Their empirical analysis is based on the cointegration and VECM modeling frameworks. The Johansen (1988) and Johansen and Juselious (1990) tests were used to search for cointegration relationships, and the authors find a long-run relationship between GDP and electricity consumption. Moreover, they find a one-way causality running from electricity consumption to real GDP

Mozumder and Marathe (2007) examine the causal relationship between electricity consumption and GDP for Bangladesh over the period 1971-1999. They use the Johansen (1988) and Johansen and Juselius (1990) test for cointegration and find evidence-supporting cointegration among the variables. They use the vector error correction model to capture the dynamic Granger causality relationship between the electricity consumption and GDP and find unidirectional causality running from GDP to electricity consumption.

Narayan and Singh (2007) investigate the nexus between electricity consumption and economic growth for Fiji within a multivariate framework through including the labor force variable. Their empirical analysis is for the period of 1971-2004 and is based on annual data. They use the bounds testing approach to cointergration and find that electricity consumption; GDP and labour force are only cointegrated when GDP is the endogenous variable. They then applied Granger causality F-test and found that in the long-run causality runs from electricity consumption and labor force to GDP for Fiji.

Narayan and Smyth (2005) examine the relationship between electricity consumption, employment and real income for Australia. They used annual time series data, namely total electricity consumption, real GDP and an index of manufacturing sector employment, for the period 1966 to 1999. They test for a long-run relationship among the variables by applying the Bounds testing approaching developed by Pesaran *et al*. (2001) and find the existence of a long-run relationship. Moreover, they find that in the long-run employment and real income Granger cause electricity consumption, while in the short run there is weak unidirectional Granger causality running from income to electricity consumption and from income to employment.

Oh and Lee (2004) investigate the causal relationship between energy consumption and economic growth applying a multivariate model of capital, labor, energy and GDP over the period 1970-1999.To test for Granger causality in the presence of cointegration (which they establish using the Johansen and Juselius (1990)), they employ a vector error correction model. Empirical results for Korea suggest a long-run bidirectional causal relationship between energy and GDP, and short-run unidirectional causality running from energy to GDP

Wolde-Rufael (2004) investigates the causal relationship between various kinds of industrial energy consumption (consisting of coal, coke, oil, electricity and total energy consumption) and GDP for Shanghai for the period 1952–1999. He uses a modified version of the Granger (1969) causality test proposed by Toda and Yamamoto (1995). The empirical evidence from disaggregated energy series seems to suggest that there is a uni-directional Granger causality running from coal, coke, electricity and total energy consumption to real GDP but no Granger causality running in any direction between oil consumption and real GDP

Morimoto and Hope (2004) examine the impact of energy electricity supply on economic growth in Sri Lanka. Annual time series data for the period 1960-1998 was used for GDP and electricity production. Using Yang's Granger causality model (2000) it was found that changes in electricity supply have a significant impact on a change in real GDP and was found that energy supply causes economic growth in the case of Sri Lanka.

Masih and Masih (1998) re-examine the relationship between energy consumption, real income and price level for two Asian countries (Thailand and Sri Lanka) over the period 1955-1991. They found these variables to be cointegrated upon using the Johansen and Juselius (1988) test. Furthermore, they used a dynamic vector error-correction model. They find that energy consumption is relatively exogenous as neither income nor prices seem to Granger cause this energy consumption. However, energy consumption itself plays an important role in influencing income and prices; in other words, Granger causality runs from energy consumption to income and prices.

Asafu-Adjaye (2000) estimates the causal relationship between energy consumption and income for India, Indonesia, the Phillipines, and Thailand. He uses annual time series data. The series data for India and Indonesia cover the period 1973-1995, while those for Thailand and the Philippines cover the period 1971-1995. Upon using the Johansen (1988) and Johansen and Juselius (1990) test and error-correction modeling techniques it was found that all variables are cointegrated and that there exists short-run unidirectional Granger causality running from energy to income for India and Indonesia. Meanwhile, it was found that bidirectional Granger causality runs from energy to income for Thailand and the Philippines. In the long-run, evidence suggests unidirectional Granger causality running from energy and prices to income for India and Indonesia, respectively. Finally, it was found that in the case of Thailand and the Philippines, energy, income and prices are mutually causal.

Glasure and Lee (1997) examine the causality relationship between energy consumption and GDP for South Korea and Singapore over the period 1961-1990. Using the Engel and Granger (1987) test and error-correction models it was found that there exists bidirectional causality between GDP and energy consumption for both South Africa and Singapore. However, results from the standard Granger causality tests show no causal relationship between GDP and energy consumption for South Africa and unidirectional causal relationship running from energy consumption to GDP for Singapore.

Joyeux and Ripple (2007) examine the relationship between income and energy consumption for seven East Indian Ocean countries (India, Indonesia, Burma, Bangladesh, Malaysia, Thailand, and Singapore). The variables used are residential electricity consumption, PPP-adjusted GDP and population over the period 1971-2001. Using the Pedroni (2004) test it was found that income and household electricity consumption were not cointegrated.

Masih and Masih (1996) study the causal relationship between energy consumption and economic growth for six Asian countries (India, Pakistan, Malaysia, Singapore, Indonesia and the Philippines) over the period 1955-1990 except for Indonesia and Singapore which cover 1960 to 1990. By applying Johansen and Juselius (1990) and Vector error-correction modelling (VECM) and exogeneity it was found that only three countries (India, Pakistan and Indonesia) were cointegrated. It was also shown that causality runs from energy to income for India; from income to energy for Indonesian and bidirectional causality for Pakistan.

Yoo (2006) investigates the causal relationship between electricity consumption and economic growth for four ASEAN member countries, namely Indonesia, Malaysia, Singapore, and Thailand. He uses annual times series data for the period 1971-2002. The results indicate, based on the standard Granger causality test and error correction model, that there is a bi-directional causality between electricity consumption and economic growth in the case of Malaysia and Singapore, and uni-directional causality runs from economic growth to electricity consumption in the case of Indonesia and Thailand

Yoo (2005) examines the short-run and long-run Granger causality between electricity consumption and economic growth for Korea. He employs annual time series annual data for the period 1970-2002 and applies the Johansen and Juselius (1990) cointegration test and error correcting modeling framework. He finds that there exists bi-directional causality between electricity consumption and economic growth for Korea.

Yang (2000) examines the causal relationship between electricity consumption and economic growth (using real GDP) for Taiwan, using annual time series data for the period 1954-1997. By using the Engel and Granger (1987) test, it is shown that real GDP and electricity consumption are cointegrated. Furthermore, using Granger causality tests, it is shown that there exists bi-directional causal relation between electricity consumption and economic growth for Taiwan.

Aqeel and Butt (2001) test the existence and direction of causality between electricity consumption and real GDP per capita for Pakistan. They use annual data for the period 1955-1996. By using the Engle and Granger (1987) for cointegration, they find that electricity consumption and GDP per capita for Pakistan are cointegrated. They also unravel the existence of causality running from electricity consumption to GDP.

Fatai *et al*. (2004) study the stability relationship between electricity consumption per capita and real GDP per capita for Australia over the period of 1960-1999. They use three approaches (namely, Toda-Yamamoto, 1995; ARDL bounds test; and Johansen and Juselius, 1990) and find that causality runs from GDP to electricity consumption.

Yoo and Kim (2006) examine the relationship between electricity and GDP for Indonesia for the period of 1971 to 2002. They use both electricity production and electricity consumption and examine how each affects economic growth of Indonesia. They find that causality runs from GDP to electricity consumption and electricity production.

Hu and Lin (2008) test for Granger causality between electricity consumption and GDP for Taiwan. They used quarterly data for the period of 1982:1-2005:4 and applied Hansen-Seo (2002) threshold cointegration test. Their results show that causality runs from GDP to electricity consumption for Taiwan.

2.1.2 Studies on the European and Central Asian Region

Altinay and Karagol (2005) investigate the causal relationship between electricity consumption and real GDP in Turkey using time series data for the period 1950-2000. Both data series were found to be stationary processes when a test for unit root with a structural break suggested by Zivot and Andrews (1992) was used. The Dolado-Lutkepohl (1996) test based on the VAR model in levels and the standard Granger causality test using the detrended data methods was employed to test the Granger non-causality. They find evidence for a unidirectional causality running from electricity consumption to the GDP.

Lise and Montfort (2007) study the relationship between energy consumption and GDP for Turkey using annual time series data for the period 1970 to 2003. Using the traditional Engle and Granger (1987) test for cointegration, evidence is uncovered that energy consumption and GDP share a long-run relationship. On the basis of this finding, the authors estimate an error correction model and unravel causality running unidirectionally from GDP to energy consumption.

Hondroyiannis *et al*. (2002) examine the empirical relationship between energy consumption and economic growth, for Greece over the period 1960-1996. The variables used are energy consumption (total energy, residential energy, and industrial energy), real GDP and price developments. Using the Johansen (1988) and Johansen and Juselius (1990) test, and the Engle and Granger (1987) test, for cointegration it was found that variables are cointegrated. Their test for causality reveals bidirectional Granger causality between economic growth and energy variables.

2.1.3 Studies on the Latin America and Caribbean Region

Cheng (1997) examines the causal relationship between energy consumption and economic growth for three developing countries. He uses annual data on GDP, energy consumption, and capital for Mexico (1949-1993); Venezuela (1952-1993) and Brazil (1963-1993). Applying cointegration tests and Hsiao's version of Granger causality test to these Latin countries, he finds that there are no causal linkages between energy consumption and economic growth for Mexico and Venezuela. However, capital is found to negatively, though weakly, Granger causes economic growth for both Mexico and Venezuela. Additionally, energy is found to Granger cause economic growth for Brazil. In sum, he finds no consistent causal patterns between energy and economic growth based on the causality tests

2.1.4 Studies on the Middle East and North African Region

Zamani (2007) examines the causal relationship between consumption of different kinds of energy (total energy consumption, total gas consumption, total petroleum consumption, industrial energy consumption, electricity consumption, gas consumption, petroleum products consumption, and total agricultural energy consumption, petroleum consumption and electricity consumption) and GDP for Iran. He uses time series data for the period of 1967-2003. Stationary test, cointegration test and vector error correction model (VECM) are used to model this relationship between energy and GDP. The Johansen (1988) and Johansen and Juselius (1990) tests showed evidence of cointegration relationship between variables. The industrial and agricultural sectors energy was also found to be cointegrated with GDP. The VECM is used to determine the direction of long-run causality and a bidirectional relationship between GDP and gas and GDP and petroleum consumption were discovered. Unidirectional relationship runs from GDP to total energy for Iran. Causality also runs from industrial value added to industrial total energy, gas, petroleum products and electricity consumption and from gas consumption to value added in industrial sector. The long-run bidirectional relation holds between agricultural value added and total energy, petroleum products and gas consumption. Short-run causalities exist for some relationships; runs from GDP to total energy and total petroleum consumption, and from industrial value added to industrial energy and petroleum products consumption.

Abosedra *et al*. (2009) examine the relationship between electricity consumption and economic growth for Lebanon using monthly data for the period 1995:01 to 2005:12. They use a bivariate model of electricity consumption and real imports (which they use to proxy economic activity), temperature and relative humidity. They do not find any long-run relationship between electricity consumption and real imports using the Johansen (1991) test for cointegration. They then model the relationship using a vector autoregressive model and find unidirectional causality running from electricity consumption to real imports.

Mehrara (2007) examines the causal relationship between energy consumption and economic growth for three oil-exporting countries (Iran, Kuwait, and Saudi Arabia). He uses annual time series data on real GDP and energy use for the period 1971-2002. The error correction model and the Toda-Yamamoto (1995) procedure were used to test for long-run and short-run causality, respectively. The results show a unidirectional long-run causality running from economic growth to energy consumption for Iran and Kuwait, and a unidirectional short-run causality running from energy consumption to economic growth for Saudi Arabia.

2.1.5 Studies on the Sub-Saharan African Region

Wolde-Rufael (2008) re-examines the causal relationship between energy consumption and economic growth for 17 African countries in a multivariate framework by including labor and capital as additional variables for the period 1971-2004. To evaluate the importance of the causal impact of energy consumption on economic growth relative to labor and capital the variance decomposition analysis proposed by Pesaran and Shin (1998). The results of the multivariate modified Granger causality test of Toda and Yamamoto (1995) tends to reject the neutrality hypothesis for the energy–income relationship in 15 out of the 17 countries. The results of the variance decomposition analysis show that in 11 out of the 17 countries, energy is no more than a contributing factor to output growth and not an important one when compared to capital and labor. Labor and capital are the most important factors in output growth in 15 of the 17 countries.

Wolde-Rufael (2006) examines the long-run and causal relationship between per capita electricity consumption and per capita real gross domestic product (GDP) for 17 African countries using data for the period 1971–2001. His empirical tests are based on the procedure for cointegration test proposed by Pesaran et al. (2001). To test for causality, he used the modified version of the Granger causality test recommended by Toda and Yamamoto (1995). Their main findings are as follows.

First, he find that there is a long-run relationship between electricity consumption and real GDP for only nine countries. Second, he finds evidence for Granger causality for only 12 countries. For six countries, there was a positive uni-directional causality running from real GDP to electricity consumption; opposite causality (from electricity consumption to GDP) for three countries, and bi-directional causality for the remaining three countries.

Jumbe (2004) examines the cointegration and causality relationships between electricity consumption and overall GDP (GDP), agricultural GDP (AGDP) and nonagricultural GDP (NGDP) for Malawi using time series data for the period 1970–1999. By applying the Engle and Granger (1987) test he found that cointegration only exists between electricity consumption and GDP; electricity consumption and NGDP and not between electricity consumption and AGDP. Then vector autoregressive models (VAR) and Error correction (ECM) techniques were used to determine the short-run and long-run causality, respectively, between the variables. It was found based on the VAR model that there exists bi-directional causality between electricity consumption and GDP and one-way causality running from NGDP to electricity consumption but when the ECM model was used evidence was only found in favour of one-way causality running from GDP (and also NGDP) to electricity consumption.

2.1.6 Studies on the North American Region

Sari *et al*. (2008) re-examines the relationship between disaggregate energy consumption (namely, coal, fossil fuels, conventional hydroelectric power, solar energy, wind energy, natural gas, wood, and waste) and industrial output as well as employment for the United States. They use the autoregressive-distributed lag (ARDL) modeling approach. The sample period includes monthly data and covers the period 2001:1 – 2005:6. The result of the bounds testing procedure confirms the presence of a long-run relationship between the various energy measures, employment and industrial output. Over the long-run, output and labor are the key determinants of fossil fuel, conventional hydroelectric power, solar, waste and wind energy consumption. Employment and output are not found to have a statistically significant long-run impact on natural gas, and wood energy.

Stern (2000) considers the causal relationship between GDP and energy use for the United States in the post-war period. His empirical analysis is based on annual time series data for the period 1948 to 1994 and includes three variables (GDP, energy input, capital input and labour input). Using the familiar cointegration tests (namely those of Johansen (1988) and Johansen and Juselius (1990)). Stern finds evidence of cointegration among the variables. They find that energy is a significant determinant of GDP. Finally, he concludes that energy Granger causes GDP in the long-run. The short-run causality relationships are not tested.

Yu and Hwang (1984) re-examine the causality relationship between GNP and energy consumption by using the US data for the period 1947-1979. They also include the employment variable and setup a multivariate model in order to avoid the omitted variable bias that often exists when bivariate models are used. Using Sims (1972) technique for Granger causality it was found that there is no causal relationship between GNP and energy consumption but some evidence of a unidirectional causality running from employment to energy consumption was found.

Bowden and Payne (2009) examine the causal relationship between energy consumption and real GDP using aggregate and sectoral primary energy. They empirical model is based on the US and uses annual time series data for the period 1949 to 2006.The variables used are sectoral primary energy (which consists of total, commercial, industrial, residential, and transportation), GDP, gross fixed capital formation, and total civilian employment. The Toda–Yamamoto (1995) test for causality is applied. The long-run causality tests reveal that the relationship between energy consumption and real GDP is not uniform across sectors. Granger-causality is absent between total and transportation primary energy consumption and real GDP, respectively. Bidirectional Granger-causality is present between commercial and residential primary energy consumption and real GDP, respectively. Finally, the results indicate that industrial primary energy consumption Granger-causes real GDP.

2.1.7 Studies based on a mixture of regions

Narayan and Prasad (2008) examine the causal effects between electricity consumption and real GDP for 30 OECD countries. They used bootstrapped causality testing approach and unravel evidence in favor of electricity consumption Granger causing real GDP in six countries (Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK) and for the rest of thee 22 countries their findings suggest that electricity consumption does not Granger cause real GDP.

Soytas and Sari (2003) re-examine the causal relationship between energy consumption and GDP for 16 countries. For all countries, the time period used is 1950-1992, except for: Argentina (1950-1990); Indonesia (1960-1992); Korea (1953-1991); and Poland (1965-1994). They used the Johansen (1988) and Johansen and Juselius (1990) test to examine possible cointegration relationship among the variables. They found that for seven countries, there exists a stationary linear cointegrating relationship between the variables. Using a vector-error correction model it was found that there exist a long-run uni-directional causality running from energy consumption to GDP for Turkey, France, West Germany, and Japan. The long-run causality is reversed for Italy and Korea, and there is bi-directional long-run causality in Argentina. In addition, there is evidence of short-run bi-directional causality in the case of Argentina and Turkey; while for the rest of the countries there is evidence of neutrality in the short-run.

Soytas and Sari (2006) assessed the impact of a change in energy consumption on income and vice versa for the G-7 countries. The variables used included total labour force, total energy use, real GDP, and gross fixed capital formation as a proxy for growth of capital stock. They used Johansen (1991, 1995) and Johansen–Juselius (1990) cointegration test, the vector error correction model (VECM), and the generalized variance decomposition analysis proposed by of Koop *et al*. (1996) and Pesaran and Shin (1998). They uncovered long-run causality between energy use and income for all the G-7 countries. In four countries (Canada, Italy, Japan, and UK) causality seems to run both ways: for two countries (US and France) from energy use to income, and for Germany, from income to energy consumption

Lee (2006) re-investigates the relationship between energy consumption and income in 11 major industrialized countries. The time period used is 1960–2001, except for Germany (1971–2001) and Canada (1965–2001). Using the Toda and Yamamoto (1995) test for Granger causality, evidence of bi-directional causality is found in the United States and unidirectional causality running from energy consumption to GDP is found in Canada, Belgium, the Netherlands, and Switzerland. Furthermore, the causality relationship appears to be uni-directional but reversed for France, Italy and Japan, which implies that, in these three countries, energy conservation may be viable without being disadvantageous to economic growth.

Squalli (2007) investigates the relationship between electricity consumption and economic growth for OPEC members over the period 1980-2003. Based on the Toda and Yamamoto (1995) test for Granger non-causality, Squalli (2007) finds: (a) bi-directional causality between electricity consumption and GDP for Iran, Qatar, and Saudi Arabia; (b) uni-directional causality running from GDP to electricity consumption for Algeria, Iraq, and Kuwait; and (c) unidirectional causality running from electricity consumption to GDP for Indonesia, Nigeria, UAE, and Venezuela.

Yoo and Ku (2009) investigate the causal relationship between nuclear energy consumption and economic growth using the time series data for six countries: Argentina (1974-2005), France (1965-2005), Germany (1971-2005), Korea (1977-2005), Pakistan (1972-2005), and Switzerland (1969-2005). By using the standard Granger causality test and the error correction model they find that: (a) there exists bi-directional causality between nuclear energy consumption and economic growth for Switzerland, (b) uni-directional causality runs from economic growth to nuclear energy consumption without any feedback effects in France and Pakistan, and (c) uni-directional causality runs from nuclear energy to economic growth in the case of Korea. However, no evidence of any causality between nuclear energy consumption and economic growth was found for Argentina and Germany and in the long-run causaity runs from GDP to energy consumption in Pakistan and from energy consumption to GDP in Korea.

2.2 STUDIES ON PANEL DATA MODELS

In this section, I review the findings of all those studies on energy and economic growth nexus that have used panel data modelling techniques. At the outset, it should be noted that panel data modelling techniques are relatively recent compared with modelling techniques based on time series data. One nice example is the developments in unit root testing. For time series data (relating to individual country analysis), unit root tests were first developed in 1979 by Dickey and Fuller (1979). By comparison, the first set of panel unit root tests (obviously for panel data models) was developed in 1997 by Pesaran *et al*. (1997). The same gap exists for other branches of econometric methodologies, such as cointegration testing. It follows, there compared with individual (or time series) studies, panel data studies are substantial less in number.

Narayan and Smyth (2008) examine the relationship between capital formation, energy consumption and real GDP for a panel of G7 countries using panel unit root, panel cointegration, panel Granger causality, and panel long-run estimators over the period of 1972-2002. The Pedroni (1999) and Westerlund (2006) tests were performed to examine a long-run relationship between the variables. The Pedroni (1999) test failed to reveal evidence of cointegration but cointegration was found once structural breaks were allowed based on the Westerlund (2006) test. In the long-run, capital formation and energy consumption were found to Granger cause real

GDP at the 1 per cent level, and capital formation and energy consumption have had a positive effect on real GDP in the G7 countries.

Narayan and Smyth (2009) examine the casual relationship between electricity consumption, exports, and GDP for six Middle Eastern countries using annual panel data for the period 1974-2002. They use the panel cointergration test suggested by Westerlund (2006) and find that there exists cointegration between all variables. They then apply the panel Granger causality test and find that Granger causality between electricity consumption and real income runs in both directions. Moreover, they find that Granger causality runs from exports to real income and from exports to electricity consumption. The results from the fully modified ordinary least squares estimator suggests that the long-run elasticity for the panel as a whole an increase in electricity consumption and exports have a positive and statistically significant effect on real income, while an increase in real income has a positive and statistically significant effect on electricity consumption.

Apergis and Payne (2008) examine the relationship between energy consumption and economic growth for six Central American countries (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) over the period 1980–2004 within a multivariate framework. The empirical model includes real GDP, real gross fixed capital formation, labor force, and energy usage. Based on the heterogeneous panel cointegration test proposed by Pedroni (1999), cointegration is found between real GDP, energy consumption, the labor force, and real gross fixed capital formation. Long-run elasticities, estimated using the heterogeneous panel cointegration test by Pedroni (1999, 2004) and it turn out to be positive and statistically significant. The Granger causality results indicate the presence of both short-run and long-run causality running from energy consumption to economic growth which supports the energy-led growth hypothesis.

Lee (2005) examined the relationship between energy consumption and GDP for a panel of 18 developing countries, using data for the period 1975 to 2001. His model includes real capital stock as a third variable. They use panel data techniques, namely recent developments in panel unit root testing (such as those of Levin and Lin, 1993; Im *et al*., 1997; and Hadri, 2000) and panel cointegration test approach developed by Pedroni (1999). To estimate the long-run impact of energy consumption on GDP, he uses the fully modified ordinary least squares technique proposed by Pedroni (2000). Finally, he tests for Granger causality within a panel data framework. His main findings are that the three variables are panel nonstationary and panel cointegrated. His long-run elasticities reveal that both energy consumption and capital stock have statistically significant positive effects on GDP, with energy consumption having a relatively larger effect on GDP than real capital stock. Finally, his causality tests reveal that in both the short-run and long-run energy consumption Granger causes GDP. There is no statistical evidence supporting a causal relationship running from GDP to energy consumption for the panel of 18 developing countries.

Chen *et al*. (2007) study the relationship between GDP and electricity consumption in 10 newly industrializing and developing Asian countries using both individual country data models and panel data models over the period of 1971-2001. The Pedroni (1999, 2004) tests were applied to examine the long-run relationship among the variables and causality between the variables was tested based on an error correction model. The empirical results from country specific data indicate evidence of mixed causality in terms of direction, while there is a uni-directional short-run causality running from economic growth to electricity consumption. Finally, a bi-directional long-run causality between electricity consumption and economic growth is found when panel data model is used.

Al-Iriani (2006) investigates the causality relationship between GDP and energy consumption for the six countries of making up the Gulf Cooperation of Council (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)). Panel data was used over the period 1972-2002. Individual country test for cointegration is based on the Johansen (1988) approach while the panel test for cointegration is based on Pedroni (2004). The main finding was that the variables share a long-run relationship. Finally, Arellano and Bond (AB, 1991) test is performed to test the causality relationship, and it is found that there exists unidirectional causality running from GDP to energy consumption for the panel of six countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)).

Lee and Chang (2008) re-investigate the causal relationship between energy consumption and real GDP within multivariate framework that includes capital stock and labor force for 16 Asian countries. They use annual time series data for the period 1971-2002. In terms of their econometric approach, they use panel unit root, panel cointegration, and panel based error correction models. They find that a long-run relationship exists among the variables. And, in the long-run unidirectional causality runs from energy consumption to economic growth for the panel of Asian countries.

2.3 SOME OBSERVATIONS ON THE FEATURES OF THE LITERATURE

A summary of the literature review is provided in Tables 2.1 and 2.2 on individual country models and panel data models, respectively. There are three main features of the literature on energy-economic growth nexus. First, there is a large volume of studies that have examined the energy-growth relationship for individual countries. A feature of these studies is that they all use more or less similar approach to model the relationship. The modeling approach generally as follows: (a) test for integrational properties of the data series, (b) if variables are found to be non-stationary in step (a), then test for possible cointegration; and (c) depending on the outcomes in (a) and (b), test for Granger causality either by using a vector autoregressive model or a vector error correction model, the former is only possible when cointegration is found amongst the variables.

Second, there is a set of studies that take a panel data modeling approach to understanding the relationship between energy and economic growth. The steps involved in these studies are similar to the individual country analysis except that the framework is panel based, such as panel unit roots, panel cointegration, and panel Granger causality. It is noticed from the review that there are very few studies based on panel data models compared with the single country studies. It seems that the main reason for this is because panel data models are relatively new developments in the applied econometrics literature; hence, there remains scope for additional work based on panel data models.

The third feature of the literature relates to empirical findings. It is noticeable that there is no consensus on the direction of causation between energy and economic growth. Different studies have found different results; in other words, some find energy causing GDP while others find GDP causing energy. The mixture of results is likely to be results of several factors, including, different energy related policies in different countries, different estimation techniques used in testing the hypothesis, different time periods used for analysis, and the different economic models used in the analysis.

2.4 HOW IS MY WORK DIFFERENT FROM THE EXTANT LITERATURE?

The literature reviewed here clearly reveals that existing work has covered the following branches of the energy literature:

1. Cointegrattion and causality relationships between energy and economic growth for individual countries; and
2. Panel data models of cointegration and causality.

What the literature has not considered is the relationship between energy and economic growth within a growth framework. The work in this study is different for four reasons:

1. It estimates the relationship between energy and economic growth using a growth framework, which is theoretically augmented with traditional growth determinants, such as trade, inflation and capital stock;
2. It uses six different proxies for energy in order to gauge the robustness of the results;
3. It uses a completely different estimation procedure – namely a dynamic panel data estimator; and
4. It estimates growth models of energy for six different regions, including one for the globe as a whole; allowing results to be compared and contrasted by regions.

2.5 CONCLUSION

The aim of this chapter was to provide a comprehensive review of the literature that has considered the energy-GDP nexus. This literature is broad and a total of 54 studies were reviewed in this chapter. Essentially, this literature can be classified into two categories: individual country analysis and panel data analysis of the energy-GDP relationship. The studies are, in the main, based on cointegration and Granger causality analysis, and the findings are mixed. In other words, some studies find that energy Granger causes economic growth while others find the opposite.

A key research gap in the literature relates to modeling energy and economic growth within a growth framework. A second research gap exists in terms of estimation techniques. Existing studies focus on using time series and panel econometric techniques, relating to cointegration and causality. A dynamic estimation technique has not been used thus far, which is identified as one of the main motivations for this study.

In the next chapter, the theoretical framework and the empirical model for this study are provided.

Table 2.1: Summary of studies on individual countries

Studies on East/South Asia & Pacific Region			
Authors	**Countries**	**Methods and Tests Used [Time Period]**	**Causal Relationship**
Aqeel and Butt (2001)	Pakistan	Engle and Granger (1987) [1954-1997]	Electricity→GDP
Asafy-Adjaye (2000)	India Indonesia Thailand and Philippines	Johansen (1988) and Johansen and Juseliusn (1990) test and ECM techniques [1973-1995 & 1971-1995]	SR: Energy →income LR: Energy→Income SR: Energy→Income LR: Prices → Income SR: Energy ↔income
Chang et al.,(2001)	Taiwan	Johansen (1988) and Johansen and Juselius (1990) and VECM [1982:01-1997:11]	Employment ↔ output Employment ↔ energy Energy → output
Cheng and Lai (1997)	Taiwan	Hasiao (1981) [1955-1933]	GDP → Energy
Fatai, Oxley and Scrimgeour (2004)	Australia	Toda-Yamamoto (1995); ARDL Bounds Test and Johansen and Juselius (1990) [1960-1999]	GDP → Electricity
Ghosh (2002)	India	VAR approach [1950-51 to 1996-97]	GDP → Electricity
Glasure and Lee (1997)	South Korea and Singapore	Engel and Granger (1987) test and ECM [1961-1990]	Energy ↔ Income
Ho and Shiu (2007)	Hong Kong	Johansen (1988) and johansen and Juselious (1990) and VECM modeling [1966-2002]	Electricity → GDP
Hu and Lin (2008)	Taiwan	Hansen-Seo threshold Cointegration (2002) [1982:1-2005:4]	GDP → Electricity
Joyeux and Ripple (2007)	East Indian Ocean Countries	Pedroni (2004) [1971-2001]	Income and household electricity consumption not

			cointegrated and further tests for causality haven't done.
Lee and Chang (2005)	Taiwan	Johansen and Juselius, (1992) and Hansen parameter stability test [1954-2003]	GDP ↔ Total energy GDP ↔ Coal Oil → GDP Gas → GDP Electricity → GDP
Masih et al., (1996)	Six Asian Countries (India, Pakistan, Malaysia, Singapore, Indonesia and the Philippines) India Indonesia Pakistan	Johansen and Juselius (1990) and VECM	Energy →GDP GDP → Energy GDP ↔ Energy
Masih et al., (1998)	Asian LDCs (Thailand and Sri Lanka)	Johansen and Juselius (1988) and a dynamic VECM [1955-1991]	Energy → income and price
Morimoto and Hope (2004)	Sri Lanka	Yang's Granger causality model (2000) [1960-1998]	Energy → GDP
Mozumder and Marathe (2007)	Bangladesh	Johansen (1988) and Johansen and Juselius (1990) and VECM [1971-1999]	GDP →Electricity
Narayan and Singh (2007)	Fiji	Bounds testing approach and Granger causality F-test [1971-2004]	Electricity and labor force → GDP
Narayan and Smyth (2005)	Australia	Bounds testing approach [1966-1999]	LR: Employment and GDP → Electricity SR: GDP → Electricity and Employment
Oh and Lee (2004)	Korea	Johansen and Juselius (1990) and VECM [1970-1999]	LR: Energy ↔ GDP SR: energy → GDP
Paul and	India	Standard Granger	Energy ↔ income

Bhattacharya (2004)		causality test and the Engle–Granger error correction approach [1950-1996]	
Shiu and Lam (2004)	China	Johansen (1988) and Johansen and Juselius (1990) and Engle and Granger (1987) tests [1971-2000]	Electricity → GDP
Wolde-Rufael (2004)	Shanghai	Toda and Yamamoto (1995) [1952-1999]	Coal, coke, electricity and total energy → GDP
Yang (2000)	Taiwan	Engle and Granger (1987) tests [1954-1997]	Electricity → GDP
Yoo (2005)	Korea	Johansen and Juselius (1990) and ECM [1970-2002]	GDP↔ Electricity
Yoo (2006)	Indonesia and Thailand Malaysia and Singapore	[1971-2002]	GDP→ Electricity GDP↔ Electricity
Yoo and Kim (2006)	Indonesia	Engle and Granger (1987) tests [1971-2002]	GDP → Electricity
Yuan, Kang, Zhao and Hu (2008)	China	Johansen cointegration technique and a VECM [1963-2005]	LR: Electricity → GDP Oil → GDP SR: GDP →Total Energy GDP → coal and oil consumption
Yuan, Zhao, Yu, and Hu (2007)	China	Johansen and Juselius (1990) and The Hodrick–Prescott filter [1978-2004]	Electricity → GDP

Studies on Europe and Central Asia Region

Authors	**Countries**	**Methods Used**	**Causal Relationship**
Altinay and Karagol (2005)	Turkey	Dolado-Lutkepohl (1996) test and Standard Granger causality test [1950-2000]	Electricity → GDP
Hondroyiannia et al., (2002)	Greece	Johansen (1988) and Johansen and Juselius (1990) test, and the	GDP ↔Energy

		Engle and Granger (1987) test [1960-1996]	
Lise and Montfort (2007)	Turkey	Engle and Granger (1987) and ECM [1970-2003]	GDP → Energy
Studies on Latin America and Caribbean Region			
Authors	**Countries**	**Methods Used**	**Causal Relationship**
Cheng (1997)	Mexico Venezuela Brazil	Hsiao's version of Granger causality test [Mexico:1949-1993; Venezuela: 1952-1993; Brazil: 1963-1993]	Capital → GDP Capital → GDP Energy → GDP
Studies on Middle East and North Africa Region			
Authors	**Countries**	**Methods Used**	**Causal Relationship**
Abosedra et al., (2009)	Lebanon	Johansen (1991) and VAR approach [1995:01-2005:12]	Electricity → real imports
Mehrara (2007)	Iran and Kuwait Saudi Arabia	ECM and Toda-Yamamoto (1995) [1971-2002	LR: GDP → Energy SR: Energy → GDP
Zamani (2007)	Iran	VECM [1967-2003]	GDP ↔ Gas GDP ↔ Petroleum GDP → Energy
Studies on Sub-Saharan Africa Region			
Authors	**Countries**	**Methods Used**	**Causal Relationship**
Jumbe (2004)	Malawi	VAR model and ECM techniques [1970-1999]	GDP → Electricity
Wolde-Rufael (2006)	(African Countries) Cameroon,Ghana, Nigeria, Senegal, Zambia and Zimbabwe Benin, the Democratic Republic of the Congo and	Toda and Yamamoto (1995) [1971-2001]	GDP → Electricity Electricity → GDP

	Tunisia Egypt, Gabon and Morocco		GDP ↔ Electricity
Wolde-Rufael (2008)	(African Countries) Benin South Africa, Algeria Ghana, Senegal, Sudan, Morocco, Nigeria, Ivory Coast, Egypt Tunisia, Zambia Togo and Zimbabwe	Toda and Yamamoto (1995) [1971-2004]	Energy → GDP GDP → Energy GDP ↔ Energy
Studies on North America Region			
Authors	**Countries**	**Methods Used**	**Causal Relationship**
Bowden and Payne (2009)	USA	Toda–Yamamoto (1995) [1949-2006]	Commercial primary energy ↔ GDP Residential primary energy ↔ GDP Industrial primary energy → GDP
Sari *et al*., (2008)	United States	Autoregressive distributed lag (ARDL) modeling approach [2001:01-2005:06]	Output and labor → fossil fuel, conventional hydroelectric power, solar, waste and wind energy consumption
Stern (2000)	USA	Johansen (1988) and Johansen and Juselius (1990) [1948-1994]	Energy → GDP
Yu and Hwang (1984)	USA	Sims (1972) technique [1947-1979]	Employment → energy

Studies on Mixed Countries from Different Regions

Authors	**Countries**	**Methods Used**	**Causal Relationship**
Lee (2006)	G-11 countries	Toda and Yamamoto (1995) [1960–2001, except for Germany (1971–2001) and Canada (1965–2001)]	
	United States		GDP ↔ Energy
	Canada, Belgium, the Netherlands and Switzerland		Energy → GDP
	France, Italy and Japan		GDP → Energy
Narayan and Prasad (2008)	OECD countries	Bootstrapped causality testing approach [1960-2002]	
	Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK		Electricity → GDP
Soytas and Sari (2003)	G-7 countries	Johansen (1988) and Johansen and Juselius (1990) and VECM [1950-1992 except for Argentina (1950-1990) and Korea (1953-1991)]	
	Turkey, France, West Germany, and Japan		Energy → GDP
	Italy and Korea		GDP → Energy
	Argentina		GDP ↔ Energy
Soytas and Sari (2006)	G-7 Countries	Johansen (1991, 1995) and Johansen–Juselius (1990) and VECM. [1960-2004]	
	Canada, Italy, Japan and UK		GDP ↔ Energy
	US and France		Energy → GDP
	Germany		Income → Energy
Squalli (2007)	OPEC members	Toda and Yamamoto (1995) [1980-2003]	
	Iran Qatar and Saudi Arabia		Electricity ↔ GDP
	Algeria Irag and Kuwait Indonesia, Nigeria		GDP → Electricity

	UAE and Venezuela		Electricity → GDP
Yoo and Ku (2009)	Argentina France Germany Korea Pakistan Switzerland	Standard Granger causality test and the ECM [Argentina:1974-2005; France:1965-2005;Germany:1971-2005;Korea:1977-2005;Pakistan:1972-2005;Switzerland:1969-2005]	GDP → Energy Energy → GDP GDP → Energy Energy ↔ GDP

Notes: LR- long-run; SR – short run; → indicates unidirectional causal relationship; ↔ bi-directional causal relationship; ARDL stands for autoregressive distributed lag; VAR stands for vector autoregressive; ECM stands for error correction model and VECM means vector error correction model

Table 2.2: Summary of studies on panel data models

Studies Using Panel Data			
Authors	**Countries**	**Methods Used**	**Causal Relationship**
Narayan and Smyth (2008)	G-7 countries (Canada, France, Germany, Italy, Japan, United Kingdom, United States)	Panel unit root, panel cointegration, panel Granger causality, and panel long-run estimators [1972-2002]	Energy → GDP Capital Formation → GDP
Apergis and Payne (2008)	6 central American Countries (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama.	Heterogeneous panel cointegration test by Pedroni (1999, 2004) [1980-2004]	Energy → GDP
Lee (2005)	18 developing countries (South Korea, Singapore, hungary, Argentina, Chile, Colombia, Mexico, Peru, Venezuela, Indonesia, Malaysia, Philippines, Thailand, India, Pakistan, Sri Lanka, Ghana and kenya)	Panel unit root and panel cointegration test approach [1975-2001]	Energy → GDP
Chen *et al*., (2007)	10 developing Asian Countries(China, Hong Kong, Indonesia, India, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand)	Pedroni (1999, 2004) test and ECM [1971-2001]	SR: GDP → Electricity LR: GDP ↔ Electricity
Narayan and Smyth (2009)	6 Middle Eastern Countries (Iran, Israel, Kuwait, Oman, Saudi Arabia, and Syria)	Panel cointergration test suggested by Westerlund (2006) and panel Granger causality test [1974-2002]	Electricity ↔ GDP Exports → GDP Exports → Electricity

Al-Iriani (2006)	Six countries of making up the GCC (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)).	Johansen (1988) approach, Pedroni (2004) test and Arellano and Bond (1991) test [1972-2002]	GDP → Energy
Lee and Cheng (2008)	16 Asian Countries	Panel unit root, heterogeneous panel cointegration and panel ECM [1971-2002]	LR: Energy → GDP

Notes: LR- long-run; SR – short run; → indicates unidirectional causal relationship; ↔ indicates bi-directional causal relationship; ECM stands for Error correction model

CHAPTER 3
A PRELIMINARY ANALYSIS OF THE DATA

3.0 INTRODUCTION

The aim of this chapter is to provide a detailed description of the dataset used to model the relationship between economic growth and energy. The need for this analysis is motivated by the use of a large dataset – a dataset that includes 66 countries and time series data for 20 years.

The rest of this chapter is organized as follows. In the next section, data source and structure is explained. In section 3.2, some commonly used descriptive statistics on the dataset are provided. In section 3.3, some concluding comments on the data are provided.

3.1 DATA SOURCE AND STRUCTURE

To study the relationship between energy consumption and economic growth, annual data is extracted from World Bank's *World Development Indicators* (World Bank, 2008) for the period 1986 to 2005. The specific countries selected for the study and the timeframe was dictated by data availability and the need for a balanced panel.

In this chapter, four regions are identified. These include: (1) East/South Asia and the Pacific region, consisting of 11 countries (Australia, Hong Kong, India, Indonesia, Japan, the Republic of Korea, Malaysia, New Zealand, Pakistan, the Philippines, and Thailand); (2) Europe and Central Asian region, consisting of 19 countries (Austria, Belgium, Bulgaria, Denmark, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the and United Kingdom); (3) Latin America and the Caribbean region, consisting of 16 countries (Argentina, Bolivia, Brazil, Chile, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay, and Venezuela); and (4) Sub-Saharan/North Africa and Middle East region, which consists of 20 Countries (Algeria, Botswana, Cameroon, Cote D'lvoire, Egypt, Arab Republic; Ethiopia, Gabon, Ghana, Iran, the Islamic Republic; Jordan Kenya, Morocco, South Africa, Senegal, Sudan Syrian Arab Republic, Togo, Tunisia, Zambia, and Zimbabwe).

The idea behind a regional allocation of countries is twofold: (a) it allows me to form regional panels for econometric analysis, and (b) it allows me to undertake a regional-based comparison of the results—mainly to gauge whether or not the role of energy in economic growth differs by region.

Altogether six variables are taken to proxy the energy: energy use (kg of oil equivalent per capita), energy use (kt of oil equivalent), electric power consumption (kWh), electricity production (kWh), energy production (kt of oil equivalent), and fossil fuel energy consumption (as a percentage of total consumption).

Apart from these energy variables, other conventional variables that affect economic growth, such as inflation, trade openness, and capital stock, are used to model their impact on economic growth.[1] More specifically, economic growth rate is measured by the growth rate of gross domestic product; prices are measured by the inflation rate, based on the consumer prices; capital stock is proxied by the gross fixed capital formation (annual percentage growth rate); and trade openness is measured as total trade as a percentage of GDP. The plots of all the variables by region are provided in Appendix 1.

3.2 DESCRIPTIVE STATISTICS

In this section, all variables used in modeling the relationship between economic growth and energy are tabulated in statistical form and discussions are done

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[1] Labour variable not available for all countries for the sample period.

accordingly. The comparisons are made by region where the regional statistics is found by taking the average of the countries making up the region.

This section is further divided into five sub-sections. Section 3.21 discusses the statistical analysis of variables used to proxy energy; section 3.22 discusses the income in the form of GDP in each region; section 3.23 discusses inflation; section 3.24 discusses the gross fixed capital formation used as a proxy for capital stock; and section 3.25 discusses the statistical analysis on trade openness.

3.2.1 Energy by region

In this section, it is generally shown how the six proxies of energy contrast in each country and in each region. This section is further divided into six sub-sections in which each energy variable used as the proxy for energy is discussed in further details and compared by region.

3.2.1.1 Energy use (kg of oil equivalent per capita)

Tables 3.1.0, 3.1.1, 3.1.2 and 3.1.3 show the statistical analysis of growth rate of energy use per capita in each region. Energy use is measured equivalent to kg of oil per capita. The mean growth rate of energy use per capita is highest for the East/South Asian and Pacific region, followed by the Latin American and the Caribbean, European and Central Asian, and Sub-Saharan/North African and the Middle Eastern regions, respectively. It could be also seen that growth rate of energy used (in terms of kg of oil per capita) is the maximum in Latin America and Caribbean region, around 10.08kg of oil per capita, followed by East/south Asia and Pacific region which used close to 9.9 kg of oil. The minimum energy use per capita growth rate is recorded at -9.386 kg by the Latin America and the Caribbean region.

Table 3.1.0: Statistical analysis on energy use (kg of oil equivalent per capita) in East/South Asia and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	1.287	5.834	-3.306	2.477	0.220	2.511	1.925
HONG KONG, CHINA	2.929	15.331	-14.449	7.392	-0.419	3.124	2.523
INDIA	1.905	4.470	-0.180	1.295	0.364	2.491	0.680
INDONESIA	3.172	16.800	-8.943	4.755	0.519	6.647	1.499
JAPAN	1.640	6.368	-1.769	2.375	0.612	2.644	1.448
KOREA, REP.	5.686	14.172	-9.567	5.196	-1.216	5.090	0.914
MALAYSIA	3.915	13.714	-7.017	6.666	-0.063	1.875	1.702
NEW ZEALAND	0.794	5.352	-4.697	2.946	-0.573	2.467	3.708
PAKISTAN	1.736	6.565	-0.968	1.929	0.703	3.218	1.111
PHILIPPINES	1.749	8.667	-5.338	3.700	-0.211	2.527	2.115
THAILAND	5.695	12.145	-7.636	4.423	-1.245	5.471	0.777
Average	2.774	9.947	-5.806	3.923	-0.119	3.460	1.673

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Table 3.1.1: Statistical analysis on energy use (kg of oil equivalent per capita) in Europe and Central Asian Region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	1.576	5.947	-3.661	2.742	0.058	2.062	1.740
BELGIUM	0.746	7.183	-3.994	2.725	0.260	3.220	3.651
BULGARIA	-1.563	8.534	-24.626	7.681	-1.278	5.337	-4.914
DENMARK	-0.443	11.461	-7.672	5.121	0.910	3.156	-11.547
FINLAND	0.902	8.462	-8.293	4.844	-0.418	2.229	5.371
FRANCE	0.953	5.103	-4.100	2.543	-0.211	2.475	2.669
GREECE	2.500	8.964	-1.810	2.635	0.781	3.325	1.054
HUNGARY	-0.140	5.388	-9.229	3.605	-0.790	3.400	-25.797
ICELAND	2.350	12.190	-3.530	3.455	0.982	4.720	1.470
IRELAND	1.827	7.465	-5.233	3.396	-0.224	2.353	1.859
ITALY	1.588	8.254	-1.258	2.280	1.297	4.800	1.436
LUXEMBOURG	1.143	8.614	-13.154	4.852	-1.250	5.022	4.246
NETHERLANDS	0.715	4.752	-2.424	1.909	0.273	2.548	2.670
NORWAY	1.607	12.110	-5.890	4.531	0.222	2.898	2.820
PORTUGAL	3.777	19.181	-3.299	4.958	1.421	5.963	1.313
SPAIN	2.982	9.297	-4.262	3.088	-0.220	3.474	1.035
SWEDEN	-0.110	5.962	-5.375	3.378	0.164	2.125	-30.849
SWITZERLAND	-0.066	5.848	-4.070	2.559	0.696	3.296	-38.498
UNITED KINGDOM	0.316	3.966	-2.945	1.559	-0.050	4.246	4.936
Average	1.087	8.352	-6.043	3.572	0.138	3.508	-3.965

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Furthermore, it is clear that except for Sub-Saharan/North Africa and Middle East region, none of the other regions shows a normal distribution for the energy data series. The Sub-Saharan/North African and Middle Eastern region has skewness statistic very close to zero, whereas East/South Asia and Pacific and Latin America and Caribbean regions have negative skewness statistics, implying a long left-hand tailed distribution. Meanwhile, Europe and Central Asian region recorded positive skewness, indicating a long right-hand tail distribution. Together with skewness, the peakedness, measured by the Kurtosis statistic, of the distribution is also recorded.

Table 3.1.2: Statistical analysis on energy use (kg of oil equivalent per capita) in Latin America and Caribbean Region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	0.746	5.937	-6.457	3.595	-0.471	2.351	4.820
BOLIVIA	1.724	10.441	-13.907	6.118	-0.963	3.702	3.548
BRAZIL	0.958	4.231	-5.061	2.125	-0.823	4.590	2.219
CHILE	4.112	10.493	-3.694	4.419	-0.147	2.032	1.075
COSTA RICA	1.912	16.778	-18.487	7.143	-0.549	5.485	3.736
DOMINICAN REPUBLIC	1.573	14.983	-7.112	6.226	0.521	2.510	3.958
ECUADOR	1.218	11.394	-10.654	5.490	-0.340	2.935	4.506
EL SALVADOR	1.917	9.222	-6.663	4.239	-0.378	3.049	2.212
GUATEMALA	1.713	7.286	-3.734	2.592	-0.258	3.294	1.513
HONDURAS	0.896	7.425	-14.944	5.409	-1.324	4.879	6.037
MEXICO	1.035	5.610	-4.823	2.215	-0.611	4.241	2.140
PANAMA	0.641	11.522	-12.282	6.497	-0.108	2.525	10.128
PARAGUAY	0.229	10.926	-8.780	5.142	0.220	2.464	22.431
PERU	-0.463	10.694	-10.336	5.106	0.262	2.593	-11.032
URGUAY	1.322	12.935	-13.145	7.257	-0.343	2.067	5.488
VENEZUELA, RB	-0.050	11.431	-10.094	5.957	0.007	2.164	-118.706
Average	1.218	10.082	-9.386	4.971	-0.332	3.180	-3.495

Source: Author's calculation based on data extracted from World Development Indicators (2008).

In all the regions it was noted that the kurtosis statistic is greater than the value of three, which is an indication of a leptokurtic distribution. In other words, this means that all regions have a larger probability of values close to or far away from the mean and it does not show a normal distribution. It is also found that the East/South Asian and the Pacific region is the most volatile; its coefficient of variation is recorded as 1.673, which is the highest when compared with other regions.

Table 3.1.3: Statistical analysis on energy use (kg of oil equivalent per capita) in Middle East and North/Sub-Saharan African Region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	0.560	5.172	-5.754	3.351	-0.408	2.063	5.983
BOTSWANA	1.319	13.570	-5.284	5.016	0.947	3.343	3.802
CAMEROON	-0.387	1.625	-2.019	1.166	-0.060	1.757	-3.011
COTE D'LVOIRE	0.532	14.917	-7.144	5.942	0.947	3.187	11.163
EGYPT, ARAB REP.	2.476	8.391	-7.706	3.847	-0.869	3.912	1.554
ETHIOPIA	-0.412	3.950	-6.756	2.215	-1.416	6.031	-5.373
GABON	-1.476	4.608	-14.003	5.430	-0.903	2.800	-3.678
GHANA	1.012	5.063	-4.874	2.558	-0.518	3.312	2.528
IRAN, ISLAMIC REP.	3.876	9.664	-2.554	3.813	-0.237	1.891	0.984
JORDAN	1.009	13.861	-10.044	5.311	0.277	3.529	5.262
KENYA	-0.833	4.423	-7.057	2.541	-0.124	3.703	-3.051
MOROCCO	3.152	15.358	-2.272	3.901	1.439	6.152	1.238
SOUTH AFRICA	-0.185	10.282	-8.511	4.657	0.419	3.007	-25.148
SENEGAL	-0.697	5.703	-24.720	6.570	-2.668	10.613	-9.425
SUDAN	1.060	12.055	-11.946	5.701	-0.005	3.356	5.381
SYRIAN ARAB REPUBLIC	0.783	9.689	-6.185	4.755	0.540	1.987	6.073
TOGO	0.174	15.875	-8.392	6.219	0.888	3.238	35.690
TUNISIA	1.701	8.800	-3.906	3.814	0.352	2.408	2.242
ZAMBIA	-0.837	1.581	-4.149	1.760	-0.368	1.964	-2.104
ZIMBABWE	-0.821	4.970	-7.593	3.515	-0.003	2.485	-4.281
Average	0.600	8.478	-7.543	4.104	-0.089	3.537	1.291

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.1.2 Energy use (kt of oil equivalent)

After discussing the energy usage per capita in the terms of kg of oil, the same variable is discussed again but here data is not recorded as per capita, it is for total energy use (kt of oil equivalent) for the region as a whole. In Table 3.1.4, it is shown that average growth rate for energy use is highest for East/South Asia and Pacific region, followed by Latin America and Caribbean, Sub-Saharan/North Africa and Middle East, and Europe and Central Asian region, respectively. The mean growth rate of energy use per capita is also recorded highest by Asia region in table 3.1.0 as discussed earlier.

Table 3.1.4: Statistical analysis on energy use (kg of oil equivalent) in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	2.559	7.152	-1.958	2.516	0.281	2.483	0.983
HONG KONG, CHINA	4.025	16.166	-13.568	7.021	-0.476	3.531	1.744
INDIA	3.676	5.899	1.436	1.336	0.126	2.060	0.363
INDONESIA	4.667	18.594	-7.588	4.828	0.539	6.686	1.034
JAPAN	1.905	6.795	-1.549	2.425	0.623	2.668	1.273
KOREA, REP.	6.524	15.319	-8.845	5.336	-1.149	4.804	0.818
MALAYSIA	6.357	16.407	-4.527	6.728	-0.075	1.903	1.058
NEW ZEALAND	2.017	6.774	-3.023	2.886	-0.422	2.259	1.431
PAKISTAN	4.210	9.200	1.444	1.972	0.700	3.287	0.468
PHILIPPINES	3.952	10.782	-3.246	3.734	-0.242	2.476	0.945
THAILAND	6.751	13.380	-6.546	4.489	-1.151	5.182	0.665
Average	4.240	11.497	-4.361	3.934	-0.113	3.394	0.980

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Over the time period 1986-2005, the growth rate is highest for Latin America and Caribbean region (at 11.845kt). The other regions more or less behaved in a similar manner and there is not much difference in their peak growth rates. For instance, East/South Asia and Pacific region recorded maximum growth rate in total energy use of 11.497kt, Sub-Saharan/North Africa and Middle East recorded a growth rate of 10.959kt, and Europe and Central Asian region recorded a growth rate of 8.768kt. By comparison, the minimum growth rate over this same period is recorded by Latin America and Caribbean region.

Table 3.1.5: Statistical analysis on energy use (kg of oil equivalent) in Europe and Central Asian Region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	2.021	6.295	-3.872	2.843	-0.085	2.251	1.406
BELGIUM	1.066	7.382	-3.548	2.668	0.319	3.233	2.504
BULGARIA	-2.332	8.118	-25.617	7.709	-1.312	5.437	-3.306
DENMARK	-0.149	12.109	-7.250	5.177	0.933	3.222	-34.814
FINLAND	1.242	8.767	-7.950	4.817	-0.407	2.227	3.879
FRANCE	1.449	5.505	-3.767	2.562	-0.318	2.529	1.768
GREECE	3.070	9.490	-0.888	2.533	0.891	3.506	0.825
HUNGARY	-0.368	5.190	-9.268	3.560	-0.749	3.344	-9.673
ICELAND	3.401	13.460	-2.282	3.472	1.040	4.903	1.021
IRELAND	2.674	8.257	-3.621	3.225	-0.087	2.244	1.206
ITALY	1.771	8.257	-1.237	2.258	1.188	4.576	1.275
LUXEMBOURG	2.258	9.356	-11.752	4.747	-1.256	5.031	2.103
NETHERLANDS	1.311	5.538	-1.846	1.918	0.317	2.608	1.462
NORWAY	2.151	12.790	-5.337	4.554	0.257	2.921	2.117
PORTUGAL	4.053	18.870	-2.600	4.778	1.405	5.931	1.179
SPAIN	3.610	9.496	-3.951	2.984	-0.564	4.035	0.826
SWEDEN	0.286	6.672	-5.244	3.406	0.188	2.164	11.889
SWITZERLAND	0.639	6.822	-3.313	2.516	0.840	3.705	3.937
UNITED KINGDOM	0.635	4.221	-2.598	1.545	-0.096	4.286	2.433
Average	1.515	8.768	-5.576	3.541	0.132	3.587	-0.419

Source: Author’s calculation based on data extracted from World Development Indicators (2008).

In addition, it should be noted that only Sub-Saharan/North Africa and Middle East recorded skewness statistics very close to zero, indicating a normal distribution of the total energy use. For the other regions, the distribution was same as in the case of per capita energy use discussed above: East/South Asia and Pacific and Latin America and Caribbean region showed a long left-tailed distribution and Europe and Central Asian region have a long right-hand distribution.

Table 3.1.6: Statistical analysis on energy use (kg of oil equivalent) in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	1.961	7.246	-5.436	3.618	-0.516	2.417	1.845
BOLIVIA	3.880	12.688	-11.864	6.142	-0.973	3.714	1.583
BRAZIL	2.517	5.613	-3.338	2.068	-0.839	4.572	0.822
CHILE	5.590	12.162	-2.458	4.514	-0.180	2.073	0.808
COSTA RICA	4.258	19.245	-16.082	7.161	-0.513	5.433	1.682
DOMINICAN REPUBLIC	3.360	16.886	-5.140	6.274	0.533	2.513	1.867
ECUADOR	2.987	13.133	-9.221	5.361	-0.388	3.185	1.795
EL SALVADOR	3.627	10.450	-5.252	4.272	-0.412	2.946	1.178
GUATEMALA	4.068	9.610	-1.240	2.556	-0.239	3.317	0.628
HONDURAS	3.263	9.829	-12.895	5.412	-1.409	5.207	1.659
MEXICO	2.569	6.624	-3.053	2.142	-0.628	3.906	0.833
PANAMA	2.614	13.570	-10.424	6.522	-0.107	2.522	2.495
PARAGUAY	2.651	14.116	-6.706	5.341	0.269	2.515	2.015
PERU	1.177	11.877	-8.215	4.974	0.268	2.468	4.225
URGUAY	1.785	12.880	-12.918	7.291	-0.370	2.049	4.085
VENEZUELA, RB	2.023	13.595	-8.310	5.959	0.005	2.236	2.945
Average	3.021	11.845	-7.660	4.975	-0.344	3.192	1.904

Source: Author’s calculation based on data extracted from World Development Indicators (2008).

The kurtosis shows that all regions experienced a leptokurtic distribution, where it can be said that the distribution is not normal for any region. Regardless of the nature of the distribution, it can be noted that Latin America and Caribbean region is found to be more volatile over this period.

Table 3.1.7: Statistical analysis on energy use (kg of oil equivalent) in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	2.494	6.596	-3.641	3.237	-0.373	2.024	1.298
BOTSWANA	3.508	16.618	-2.977	5.228	1.006	3.452	1.490
CAMEROON	2.222	3.983	0.172	1.137	-0.175	1.789	0.512
COTE D'LVOIRE	3.312	17.346	-5.514	5.848	0.752	3.185	1.766
EGYPT, ARAB REP.	4.418	10.214	-5.860	3.839	-0.936	4.028	0.869
ETHIOPIA	2.637	7.282	-3.407	2.172	-1.106	5.758	0.824
GABON	0.964	7.704	-10.930	5.304	-0.740	2.624	5.503
GHANA	3.553	8.001	-2.050	2.598	-0.439	3.212	0.731
IRAN, ISLAMIC REP.	5.703	11.698	-0.651	3.704	-0.080	1.919	0.649
JORDAN	4.584	16.272	-1.495	4.701	0.832	3.214	1.026
KENYA	2.096	7.038	-4.051	2.418	-0.319	3.968	1.153
MOROCCO	4.747	16.372	-0.791	3.817	1.263	5.703	0.804
SOUTH AFRICA	1.806	11.502	-6.425	4.573	0.207	2.640	2.532
SENEGAL	2.035	8.335	-22.029	6.555	-2.704	10.770	3.222
SUDAN	3.399	14.674	-9.551	5.673	0.067	3.521	1.669
SYRIAN ARAB REPUBLIC	3.536	12.638	-3.564	4.802	0.538	2.015	1.358
TOGO	3.249	18.800	-4.719	6.151	0.916	3.255	1.893
TUNISIA	3.236	11.229	-2.938	3.908	0.520	2.709	1.208
ZAMBIA	1.613	4.499	-1.290	1.596	-0.174	2.357	0.990
ZIMBABWE	1.055	8.374	-6.537	3.894	0.025	2.408	3.691
Average	3.008	10.959	-4.912	4.058	-0.046	3.528	1.659

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.1.3 Electric power consumption (kWh)

Tables 3.1.8, 3.1.9, 3.2.0 and 3.2.1 report the statistical description of electric power consumption in all four regions. According to the statistical analysis, it can be said that for East/South Asian and Pacific region the average growth rate of electric power consumption is highest followed by Latin America and Caribbean region, Middle East and North/Sub-Saharan African region, and Europe and Central Asian Region. The growth rate over this period (1986-2005) is highest for North/Sub Sharan African region reported as 18.67kWh and the lowest growth rate of -9.43 is also reported for this same region.

Table 3.1.8: Statistical analysis on Electric power consumption (kWh) in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUS	3.649	6.273	0.622	1.622	-0.064	1.920	0.444
HK	4.309	19.479	-5.561	5.370	1.085	5.083	1.246
INDIA	6.107	10.690	1.867	2.452	-0.271	2.360	0.401
INDONESIA	10.560	17.784	1.154	4.660	-0.513	2.345	0.441
JAPAN	2.556	6.239	-1.645	2.242	0.084	2.419	0.877
KOREA	9.568	18.135	-4.021	4.657	-1.014	5.200	0.487
MALAYSIA	9.160	16.474	1.666	4.121	0.026	2.232	0.450
NZ	2.345	7.979	-2.481	2.500	0.147	3.090	1.066
PAKISTAN	6.569	14.351	-2.873	4.049	0.009	3.491	0.616
PHILLIPINE	5.534	11.799	-3.043	4.140	-0.583	2.463	0.748
THAILAND	8.988	15.709	-2.744	4.909	-0.748	2.992	0.546
Average	6.304	13.174	-1.551	3.702	-0.168	3.054	0.666

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Table 3.1.9: Statistical analysis on Electric power consumption (kWh) in Europe and Central Asian Region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	2.777	12.707	-0.812	2.860	2.155	8.835	1.030
BELGIUM	2.472	7.211	-0.892	2.070	0.200	2.760	0.837
BULGARIA	-1.413	9.162	-16.558	6.409	-0.833	3.105	-4.535
DENMARK	0.838	13.269	-17.661	5.700	-1.351	7.917	6.804
FINLAND	2.546	10.163	-3.705	2.866	0.403	4.502	1.126
FRANCE	2.254	6.895	-0.759	1.715	0.760	4.350	0.761
GREECE	4.132	10.395	1.565	2.095	1.387	5.189	0.507
HUNGARY	0.365	6.861	-6.101	3.858	-0.164	1.992	10.565
ICELAND	4.209	15.197	-0.919	4.586	1.048	3.116	1.090
IRELAND	4.242	7.786	-0.058	1.700	-0.337	3.933	0.401
ITALY	2.713	7.773	-0.099	1.583	1.513	6.871	0.584
LUXEM	2.464	9.999	-7.264	4.482	-0.052	2.833	1.819
NETHERLANDS	2.721	14.429	-7.682	3.943	0.456	7.443	1.449
NORWAY	1.276	5.686	-6.070	3.196	-1.002	3.411	2.505
PORTUGAL	4.572	12.994	-2.837	3.759	0.080	3.175	0.822
SPAIN	4.374	11.839	-0.902	2.718	0.812	4.510	0.621
SWEDEN	0.584	8.027	-5.775	3.262	0.270	3.239	5.585
SWITZERLAND	1.779	10.340	-7.095	4.758	-0.045	2.720	2.675
UK	1.412	4.417	-1.801	1.515	0.097	2.887	1.073
Average	2.332	9.745	-4.496	3.320	0.284	4.357	1.880

Source: Author's calculation based on data extracted from World Development Indicators (2008).

The skewness and kurtosis of the above distributions show that none of the regions have a normal distribution, where three regions except for East/South Asian and the Pacific region experienced a leptokurtic distribution. Meanwhile, it is noticeable that Latin America and Caribbean and Middle East and North/Sub-Saharan African region have a long left-hand tailed distribution.

Table 3.2.0: Statistical analysis on Electric power consumption (kWh) in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	4.347	9.000	-6.697	4.431	-1.029	3.410	1.019
BOLIVIA	5.719	11.460	-0.086	2.947	-0.266	2.650	0.515
BRAZIL	3.483	7.774	-6.461	2.987	-1.941	7.637	0.858
CHILE	7.183	11.986	0.749	2.894	-0.155	2.636	0.403
COSTA	4.557	13.167	-3.117	4.566	0.149	2.603	1.002
DOMINICAN	5.713	32.411	-20.797	12.371	0.158	3.262	2.165
ECUATOR	4.614	12.456	-6.150	4.414	-0.311	3.151	0.957
EL	5.823	16.099	-8.674	6.184	-0.611	3.440	1.062
GUAT	7.787	28.729	-7.214	6.627	1.131	7.433	0.851
HONDU	6.554	21.594	-8.993	9.229	-0.022	2.029	1.408
MEXICO	4.388	8.045	-1.250	2.671	-0.441	2.298	0.609
PANAMA	4.132	9.038	-6.189	3.925	-1.124	3.672	0.950
PARAGUAY	7.852	30.725	-3.465	7.750	1.290	4.992	0.987
PERU	3.726	11.263	-17.582	6.115	-2.364	9.017	1.641
URUGUAY	3.570	18.473	-3.919	5.466	0.727	4.114	1.531
VENEZ	3.163	8.990	-2.101	3.048	0.039	2.489	0.964
Average	5.163	15.701	-6.372	5.352	-0.298	4.052	1.058

Source: Author's calculation based on data extracted from World Development Indicators (2008).

The East/South Asian and Pacific region recorded kurtosis statistics very close to three, indicating a normal distribution and on the other hand the negative skewness of this region implies a long left-hand tailed distribution. On the other hand, Europe and Central Asian region recorded positive skewness statistics, meaning it has a long right-hand tail distribution.

Table 3.2.1: Statistical analysis on Electric power consumption (kWh) in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	5.119	11.609	-2.955	3.636	-0.177	2.750	0.710
BOTS	7.106	36.219	-10.178	10.790	0.871	4.200	1.518
CAMEROON	2.508	16.785	-10.459	5.895	0.226	3.796	2.350
COTE	3.713	21.876	-5.500	7.224	0.860	3.310	1.945
EGYPT	5.848	9.519	2.707	1.853	0.041	2.350	0.317
ETHIOPIA	5.948	22.268	-1.948	6.632	1.057	3.262	1.115
GABAN	2.025	12.425	-15.137	6.401	-0.887	4.590	3.161
GHANA	2.975	26.067	-30.663	13.881	-0.839	3.252	4.666
IRAN	7.180	11.730	2.929	2.256	0.062	2.561	0.314
JORDAN	7.122	15.857	1.697	3.689	0.838	3.085	0.518
KENYA	4.371	11.123	-8.027	4.905	-0.983	3.924	1.122
MOROCCO	5.320	11.043	-14.250	5.715	-2.151	8.296	1.074
SAFRICA	2.518	5.591	-2.063	2.181	-0.529	2.316	0.866
SENEGAL	5.071	21.816	-11.977	8.837	-0.111	2.954	1.743
SUDAN	5.609	41.624	-10.429	11.268	1.719	6.579	2.009
SYRIAN	7.290	13.022	0.523	3.429	-0.516	2.602	0.470
TOGO	3.915	43.198	-52.623	20.726	-0.821	4.595	5.294
TUNISIA	5.820	10.018	2.771	2.035	0.387	2.330	0.350
ZAMBIA	1.326	8.498	-15.127	5.509	-1.448	5.281	4.156
ZIMBABWE	2.871	23.112	-7.967	8.621	0.956	3.198	3.003
Average	4.683	18.670	-9.434	6.774	-0.072	3.762	1.835

Source: Author’s calculation based on data extracted from World Development Indicators (2008).

The coefficient of variation recorded in Table 3.1.9 reveals that Europe and Central Asian region seems to be the most volatile compared to other regions in consuming electric power.

3.2.1.4 Electricity production (kWh)

Tables 3.2.2, 3.2.3, 3.2.4, and 3.2.5 show the statistical description of growth rate of electricity production in each of the four regions. As reported in Table 3.1.8, East/South Asian and Pacific region recorded the highest average growth rate of electric power consumption and the same is true for the electricity production in Table 3.2.2. The consumption and production growth rate is highest for Middle East and North/Sub-Saharan African region and the lowest for the same region. So basically, it is apparent that the higher consumption of electric power leads to higher production of electricity.

Table 3.2.2: Statistical analysis on Electricity production (kWh) in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	3.652	6.759	0.765	1.638	0.048	2.155	0.449
HONG KONG, CHINA	3.083	10.374	-29.586	8.739	-2.950	11.605	2.835
INDIA	6.553	10.739	2.959	2.138	0.096	2.220	0.326
INDONESIA	10.176	18.003	1.007	4.365	-0.196	2.412	0.429
JAPAN	2.573	6.367	-1.754	2.285	0.094	2.379	0.888
KOREA, REP.	9.492	15.943	-2.759	4.363	-1.052	4.371	0.460
MALAYSIA	8.888	16.963	3.091	4.121	0.373	1.946	0.464
NEW ZEALAND	2.145	5.075	-1.284	1.910	-0.129	2.156	0.891
PAKISTAN	6.839	17.251	0.537	3.996	1.130	3.963	0.584
PHILIPPINES	5.220	12.884	-3.680	4.285	-0.318	2.364	0.821
THAILAND	8.825	16.635	-3.464	5.069	-0.702	3.188	0.574
Average	6.131	12.454	-3.106	3.901	-0.328	3.524	0.793

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Moreover, except for Middle East and North/Sub-Saharan African, none other region shows a normal distribution, but again the Middle East and North/Sub-Saharan African region does not reveal a normal distribution when the kurtosis statistic is taken into account. All the four regions formed a leptokurtic distribution, as all the regions recorded kurtosis greater than three on average. The East/South Asian and Pacific region, and Latin America and Caribbean region, have a long left-hand tail distribution. Meanwhile, the European and Central Asian region recorded a positive skewness, implying a right-hand tail distribution.

Table 3.2.3: Statistical analysis on Electricity production (kWh) in Europe and Central Asian Region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	1.890	12.210	-4.629	3.889	0.751	3.940	2.057
BELGIUM	2.090	7.851	-5.150	2.815	-0.547	4.078	1.347
BULGARIA	0.264	9.155	-13.757	5.817	-0.576	3.023	22.058
DENMARK	0.864	37.961	-20.212	16.774	0.816	2.821	19.413
FINLAND	1.890	11.738	-19.625	6.511	-1.718	7.465	3.445
FRANCE	2.416	7.940	-1.623	1.942	0.768	5.134	0.804
GREECE	3.938	9.734	-0.655	2.811	0.443	2.131	0.714
HUNGARY	1.275	5.898	-7.236	3.896	-0.711	2.613	3.056
ICELAND	3.933	13.488	-0.597	3.931	1.099	3.378	0.999
IRELAND	3.860	8.403	0.072	2.161	0.163	2.546	0.560
ITALY	2.335	4.855	-1.321	1.489	-0.593	3.181	0.638
LUXEMBOURG	9.159	172.463	-24.146	40.979	3.555	14.827	4.474
NETHERLANDS	2.107	5.226	-4.887	2.578	-1.069	3.902	1.223
NORWAY	1.848	22.020	-19.874	10.678	-0.570	2.819	5.778
PORTUGAL	4.320	13.092	-3.709	5.116	0.373	1.996	1.184
SPAIN	4.306	8.717	-0.838	2.381	-0.085	2.657	0.553
SWEDEN	0.721	11.365	-9.670	5.857	0.070	2.330	8.121
SWITZERLAND	0.112	9.733	-10.464	6.570	-0.285	1.975	58.902
UNITED KINGDOM	1.494	4.936	-0.715	1.361	0.575	3.546	0.911
Average	2.570	19.831	-7.844	6.713	0.129	3.914	7.170

Source: Author's calculation based on data extracted from World Development Indicators (2008).

In Table 3.2.4, the coefficient of variation of 7.7 for the Latin America and Caribbean region, turns out to be the highest. Hence, this region is the most volatile in producing electricity

Table 3.2.4: Statistical analysis on Electricity production (kWh) in Latin America and Caribbean Region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	4.047	9.774	-6.467	4.350	-0.692	3.064	1.075
BOLIVIA	5.853	16.511	0.058	3.658	0.903	5.148	0.625
BRAZIL	3.632	5.985	-6.300	2.881	-2.339	8.536	0.793
CHILE	6.421	11.358	-4.007	3.259	-1.611	6.735	0.508
COSTA RICA	5.416	15.726	-4.501	5.306	0.138	2.332	0.980
DOMINICAN, REP.	5.749	35.967	-24.768	13.065	-0.082	3.818	2.273
ECUADOR	5.177	10.384	-5.492	4.325	-0.875	3.354	0.835
EL SALVADOR	5.417	15.273	-1.180	4.190	0.778	3.052	0.774
GUATEMALA	7.431	15.377	-3.226	4.497	-0.291	3.520	0.605
HONDURAS	7.009	19.882	-9.278	7.327	-0.592	3.068	1.045
MEXICO	4.648	7.747	0.190	2.201	-0.320	1.999	0.474
PANAMA	4.274	8.876	-4.284	3.039	-0.933	4.529	0.711
PARAGUAY	7.671	44.551	-16.585	12.416	0.991	5.670	1.618
PERU	3.567	12.088	-9.862	4.547	-1.214	5.587	1.275
URGUAY	0.177	29.191	-37.448	19.185	-0.120	2.202	108.440
VENEZUELA, RB	3.717	7.717	-1.237	2.692	-0.314	2.334	0.724
Average	5.013	16.650	-8.399	6.059	-0.411	4.059	7.672

Table 3.2.5: Statistical analysis on Electricity production (kWh) in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	5.055	9.329	-2.015	3.036	-0.752	3.217	0.601
BOTSWANA	2.560	41.712	-31.857	17.046	0.643	3.989	6.659
COTE D'LVOIRE	5.770	22.170	-10.430	9.711	0.144	2.080	1.683
EGYPT, ARAB REP.	6.200	13.178	1.447	2.847	0.985	4.023	0.459
ETHIOPIA	6.020	31.296	-2.546	8.284	1.658	5.598	1.376
GABON	2.996	11.014	-3.808	3.553	0.276	2.802	1.186
GHANA	2.279	19.754	-31.746	12.261	-1.343	4.696	5.379
IRAN, ISLAMIC REP.	7.725	11.442	2.992	2.181	-0.356	3.016	0.282
JORDAN	6.229	17.179	-6.611	5.535	-0.054	3.647	0.889
KENYA	5.033	14.012	-9.790	5.475	-0.981	4.343	1.088
MOROCCO	5.634	15.787	-4.493	5.520	0.266	2.545	0.980
SOUTH AFRICA	2.663	7.415	-2.333	2.591	-0.256	2.527	0.973
SENEGAL	6.366	16.513	-1.501	4.228	0.696	3.469	0.664
SUDAN	5.924	20.901	-8.947	7.145	0.095	2.745	1.206
SYRIAN ARAB REP.	7.796	18.515	0.590	4.728	0.816	3.726	0.606
TOGO	2.938	73.730	-52.745	37.511	0.101	2.213	12.766
TUNISIA	5.850	9.566	2.074	1.999	-0.008	2.206	0.342
ZAMBIA	-0.479	22.031	-31.885	13.547	-0.637	3.329	-28.269
ZIMBABWE	3.577	24.679	-10.311	9.491	0.433	2.746	2.653
Average	4.642	20.562	-10.548	8.054	0.086	3.315	0.606

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.1.5 Energy production (kt of oil equivalent)

As discussed earlier about all the energy variables, it has been noted that average growth rate is highest for East/South Asian and Pacific region and this holds true for energy production, followed by Middle East and North/Sub-Saharan African region, Latin America and Caribbean region, and Europe and Central Asian region, respectively, as reported in above four tables. Middle East and North/Sub-Saharan African region recorded the highest growth rate over this period, whereas Latin America and Caribbean region recorded the minimum growth rates in energy production.

Table 3.2.6: Statistical analysis on Energy production (kt of oil equivalent) in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUS	3.659	8.954	-4.971	3.787	-0.537	2.494	1.035
HK	0.703	4.349	0.000	1.287	1.568	4.346	1.832
INDIA	2.705	5.176	-0.363	1.241	-0.387	3.602	0.459
INDONESIA	3.421	11.519	-2.895	3.829	0.368	2.643	1.119
JAPAN	1.973	12.324	-14.257	6.161	-0.899	3.947	3.123
KOREA	4.461	15.066	-8.467	6.274	-0.119	2.361	1.406
MALAYSIA	4.298	10.260	-2.144	3.126	-0.033	2.612	0.727
NZ	1.112	9.578	-10.243	5.112	-0.366	2.583	4.599
PAKISTAN	4.194	9.833	0.494	2.358	1.028	3.876	0.562
PHILLIPINE	3.251	9.935	-3.949	3.592	-0.214	2.784	1.105
THAILAND	5.569	10.926	-2.126	3.881	-0.729	2.589	0.697
Average	3.213	9.811	-4.447	3.695	-0.029	3.076	1.515

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Looking at the regions kurtosis and skewness statistics, it is found that East/South Asian and Pacific Region have a normal distribution, whereas Latin America and Caribbean region, based on skewness, do not have a normally distributed production series. However, when kurtosis statistic is taken into account, it is a leptokurtic distribution is noticed. The European and Central Asian region and the Middle Eastern and North/Sub-Saharan African region recorded positive skewness statistics, indicating a long right-hand tail distribution. Both regions kurtosis statistics reveals

Table 3.2.7: Statistical analysis on Energy production (kt of oil equivalent) in Europe and Central Asian Region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	1.299	13.145	-6.415	4.631	0.440	3.730	3.564
BELGIUM	-0.291	8.127	-7.511	3.788	0.338	2.968	-13.003
BULGARIA	0.397	8.880	-12.270	5.737	-0.698	2.767	14.446
DENMARK	8.266	22.584	-2.176	6.809	0.274	2.204	0.824
FINLAND	2.002	12.545	-10.160	6.139	-0.233	2.368	3.067
FRANCE	1.661	6.050	-2.308	2.393	-0.073	2.344	1.441
GREECE	1.868	10.812	-3.229	3.557	0.664	3.311	1.905
HUNGARY	-2.329	4.350	-11.370	3.785	-0.215	3.510	-1.625
ICELAND	3.819	18.882	-3.325	4.632	1.646	7.093	1.213
IRELAND	-2.428	26.906	-21.376	13.634	0.558	2.289	-5.616
ITALY	0.566	5.164	-4.788	2.969	-0.181	1.953	5.248
LUXEM	5.505	37.469	-18.659	14.712	0.396	2.504	2.672
NETHERLANDS	-0.035	14.649	-11.779	7.436	0.312	2.383	-211.454
NORWAY	5.950	17.351	-3.322	5.769	0.146	2.154	0.970
PORTUGAL	3.485	30.863	-14.287	11.934	0.333	2.570	3.425
SPAIN	0.353	13.256	-7.581	5.038	0.846	3.524	14.261
SWEDEN	0.944	10.525	-8.533	5.235	0.124	2.538	5.543
SWITZERLAND	0.689	5.290	-8.285	3.804	-0.815	2.841	5.522
UK	-1.008	9.069	-11.244	5.361	-0.245	2.505	-5.319
Average	1.616	14.522	-8.875	6.177	0.190	2.924	-9.101

Table 3.2.8: Statistical analysis on Energy production (kt of oil equivalent) in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	3.349	9.136	-3.796	3.625	-0.265	2.293	1.082
BOLIVIA	5.750	42.477	-14.134	12.013	1.458	5.918	2.089
BRAZIL	3.495	9.279	-2.974	3.148	-0.180	2.309	0.901
CHILE	1.381	7.785	-5.453	3.471	-0.215	2.728	2.514
COSTA	3.270	44.606	-36.460	15.520	0.220	5.687	4.747
DOMINICAN	0.539	25.185	-18.289	8.974	0.369	5.097	16.641
ECUADOR	2.917	48.293	-44.232	16.465	-0.091	7.409	5.645
EL SALVADOR	2.210	8.331	-7.674	3.663	-0.513	4.277	1.657
GUAT	3.025	10.146	-2.556	3.644	0.445	2.478	1.204
MEXICO	1.825	5.303	-2.472	2.339	0.024	1.949	1.282
PANAMA	1.046	14.893	-10.757	7.021	0.232	2.462	6.713
PARAGUAY	4.536	27.692	-10.491	8.214	0.756	4.774	1.811
PERU	-1.346	13.035	-10.991	5.154	0.712	4.745	-3.831
URUGUAY	-1.007	24.425	-31.094	15.889	-0.290	2.268	-15.784
VENEZ	2.679	12.446	-12.948	6.833	-0.707	2.975	2.550
HONDU	0.979	11.451	-25.041	6.985	-2.716	11.616	7.139
Average	2.166	19.655	-14.960	7.685	-0.048	4.312	2.272

Source: Author's calculation based on data extracted from World Development Indicators (2008).

different stories; Europe and Central Asia recorded kurtosis of less than 3, implying that the distribution has a larger probability of values intermediately distant from the mean and it is known to form a leptokurtic distribution, whereas Middle East and North/Sub-Saharan African region recorded kurtosis of 5.228, which is far more than the value of three implying a leptokurtic distribution. The Latin American and the Caribbean region are found to be most volatile, as they recorded the maximum coefficient of variation compared to other regions.

Table 3.2.9: Statistical analysis on Energy production (kt of oil equivalent) in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	3.657	8.029	-4.378	3.488	-0.997	3.495	0.954
BOTS	1.861	18.002	-8.482	6.238	0.691	3.949	3.352
CAMEROON	-0.208	6.910	-6.180	4.215	0.279	1.662	-20.242
COTE	4.021	19.410	-8.272	6.395	0.421	3.334	1.591
EGYPT	2.435	16.207	-4.965	5.007	1.137	4.287	2.056
ETHIOPIA	2.476	6.850	-2.972	1.875	-0.929	6.432	0.757
GABAN	1.492	27.074	-12.948	10.509	1.009	3.642	7.046
GHANA	2.717	5.493	-2.355	1.863	-1.207	4.223	0.686
IRAN	5.739	24.701	-2.834	7.696	1.328	4.079	1.341
JORDAN	14.232	109.861	-18.232	34.561	1.960	5.707	2.428
KENYA	1.995	5.264	-6.373	2.238	-2.737	11.775	1.122
MOROCCO	0.517	39.686	-21.825	12.102	1.503	7.231	23.399
SAFRICA	1.801	6.484	-1.970	2.698	0.476	1.912	1.498
SENEGAL	0.204	5.323	-38.064	9.373	-3.856	16.305	46.038
SUDAN	7.020	32.321	1.034	7.706	2.014	7.154	1.098
SYRIAN	5.672	26.947	-5.859	9.748	0.744	2.511	1.719
TOGO	2.987	17.487	-4.781	4.527	1.474	6.960	1.516
TUNISIA	-0.046	10.296	-13.134	6.379	-0.268	2.747	-137.845
ZAMBIA	1.518	3.909	-3.036	1.980	-1.100	3.322	1.304
ZIMBABWE	1.381	11.414	-4.579	3.765	0.978	3.836	2.726
Average	3.073	20.083	-8.510	7.118	0.146	5.228	-2.873

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.1.6 Fossil fuel energy consumption (% of total)

The sixth variable that is used to measure energy in this study is fossil fuel energy consumption. The four tables referred to below, give statistical description of the growth rate of this variable in regional form. It is noted that the mean growth rate of fossil fuel energy consumption is highest for the Latin American and the Caribbean region.

Table 3.3.0: Statistical analysis on Fossil Fuel Energy Consumption (% of total) in East/South Asian and Pacific Region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	0.055	0.685	-0.600	0.294	0.118	3.199	5.347
HONG KONG, CHINA	-0.211	1.028	-6.737	1.670	-3.339	13.723	-7.906
INDIA	1.568	2.987	-0.107	0.968	-0.166	1.910	0.618
INDONESIA	1.409	3.954	-1.985	1.354	-0.678	3.671	0.961
JAPAN	-0.177	2.845	-1.873	1.286	0.688	2.798	-7.281
KOREA, REP.	-0.412	1.999	-4.134	1.690	-0.798	3.008	-4.099
MALAYSIA	0.390	1.509	-0.859	0.766	-0.168	1.828	1.964
NEW ZEALAND	0.048	3.585	-4.588	2.301	-0.309	2.375	48.373
PAKISTAN	1.234	5.928	-0.930	1.780	0.843	3.422	1.443
PHILIPPINES	1.284	8.975	-7.225	3.680	-0.256	3.547	2.865
THAILAND	2.018	6.457	-0.462	2.126	0.621	2.327	1.054
Average	0.655	3.632	-2.682	1.629	-0.313	3.801	3.940

Source: Author's calculation based on data extracted from World Development Indicators (2008).

The statistical description also shows that the maximum and also minimum growth rate is recorded by Sub-Saharan/North Africa and Middle East regions, whereas the maximum growth rate stands at 14.7. For Latin America and Caribbean, Europe and Central region and East/South Asian and the Pacific region, the maximum growth rates of per capita total energy consumption are 9.225, 3.836, and 3.632, respectively.

Table 3.3.1: Statistical analysis on Fossil Fuel Energy Consumption (% of total) in Europe and Central Region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	-0.126	3.329	-6.244	1.974	-1.331	6.298	-15.684
BELGIUM	-0.225	1.630	-1.912	1.080	0.221	1.793	-4.804
BULGARIA	-0.904	5.020	-3.552	1.984	1.307	5.212	-2.195
DENMARK	-0.692	6.234	-4.475	3.024	0.808	2.781	-4.373
FINLAND	-0.696	5.461	-8.578	4.092	0.001	1.913	-5.877
FRANCE	-0.784	3.426	-3.490	1.533	0.826	4.320	-1.956
GREECE	-0.086	0.616	-2.055	0.608	-1.672	6.829	-7.028
HUNGARY	-0.499	2.833	-3.048	1.406	0.325	3.134	-2.818
ICELAND	-0.978	6.290	-12.114	5.117	-0.465	2.551	-5.234
IRELAND	-0.154	0.309	-1.015	0.361	-0.935	3.040	-2.352
ITALY	-0.020	2.057	-0.565	0.637	2.080	7.176	-31.136
LUXEMBOURG	0.176	6.249	-3.095	1.797	1.772	8.393	10.234
NETHERLANDS	-0.247	0.273	-1.210	0.426	-0.958	2.783	-1.722
NORWAY	0.552	10.352	-3.700	3.525	1.263	4.309	6.388
PORTUGAL	-0.008	3.492	-4.435	2.490	-0.249	1.914	-312.845
SPAIN	0.043	2.731	-3.103	1.684	-0.199	1.873	39.020
SWEDEN	-0.982	9.008	-4.398	3.202	1.665	6.124	-3.260
SWITZERLAND	-0.473	2.223	-2.713	1.642	0.197	1.802	-3.469
UNITED KINGDOM	-0.210	1.347	-1.544	0.793	0.042	2.283	-3.774
Average	-0.332	3.836	-3.750	1.967	0.247	3.923	-18.573

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Furthermore, the four regions recorded kurtosis greater than the value of three, implying that the distribution of per capita total energy consumption is leptokurtic. The skewness statistic of each region shows that Latin America and Caribbean region and the Sub-Saharan/North Africa and Middle East region were close to normal distribution, whereas East/South Asia and Pacific region revealed negative coefficient of skewness, implying a long left-hand tail distribution. Finally, Europe and Central region have a long right-hand distribution.

Table 3.3.2: Statistical analysis on Fossil Fuel Energy Consumption (% of total) in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	0.002	3.471	-3.012	1.517	0.106	3.596	740.968
BOLIVIA	1.697	14.117	-3.275	3.834	1.702	6.886	2.260
BRAZIL	0.435	3.208	-4.023	1.628	-0.952	4.475	3.738
CHILE	0.693	6.103	-5.568	2.833	-0.235	2.944	4.085
COSTA RICA	1.167	18.625	-14.706	7.715	0.268	3.132	6.609
DOMINICAN REPUBLIC	1.085	5.676	-2.938	2.604	0.260	1.966	2.399
ECUADOR	0.686	5.713	-3.035	2.269	0.348	2.913	3.309
EL SALVADOR	2.450	13.459	-7.627	5.446	0.052	2.350	2.223
GUATEMALA	3.075	11.263	-4.889	4.417	0.203	2.565	1.437
HONDURAS	3.137	17.191	-6.966	7.341	0.436	2.215	2.340
MEXICO	-0.013	1.447	-2.213	0.706	-1.142	6.757	-54.008
PANAMA	0.802	9.518	-6.866	4.787	0.187	1.960	5.969
PARAGUAY	1.571	16.686	-13.865	7.359	-0.162	2.779	4.684
PERU	0.652	5.412	-3.228	2.303	0.120	2.282	3.530
URGUAY	0.843	15.036	-12.959	7.477	-0.005	2.278	8.868
VENEZUELA, RB	-0.291	0.676	-1.357	0.668	-0.091	1.696	-2.297
Average	1.125	9.225	-6.033	3.931	0.068	3.175	46.007

Source: Author's calculation based on data extracted from World Development Indicators (2008).

It is also noted that the Latin American and the Caribbean region are very volatile compared to other regions. To compute for volatility, the coefficient of variation is reported and it is seen that Latin America and Caribbean region recorded a coefficient of variation of 46, which is far larger than what other regions reported.

Table 3.3.3: Statistical analysis on Fossil Fuel Energy Consumption (%of total) in Sub-Saharan/North Africa and Middle East region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	-0.009	0.138	-0.293	0.097	-1.109	4.993	-10.311
BOTSWANA	1.316	12.937	-4.881	3.820	1.235	5.736	2.902
CAMEROON	-1.037	9.170	-10.970	5.273	-0.081	2.202	-5.084
COTE D'LVOIRE	1.445	26.912	-14.865	12.178	0.707	2.638	8.429
EGYPT, ARAB REP.	0.146	1.025	-0.734	0.339	0.032	5.488	2.325
ETHIOPIA	2.239	26.239	-50.781	15.144	-2.087	9.339	6.764
GABON	-1.443	7.571	-18.748	7.730	-0.780	2.626	-5.357
GHANA	2.494	23.590	-28.196	12.107	-0.644	3.644	4.855
IRAN, ISLAMIC REP.	0.060	0.396	-0.281	0.184	0.014	2.271	3.057
JORDAN	-0.132	0.637	-1.605	0.520	-1.461	4.832	-3.950
KENYA	0.491	16.468	-15.790	8.297	0.132	2.557	16.905
MOROCCO	0.091	1.595	-1.388	0.675	-0.134	3.469	7.442
SOUTH AFRICA	-0.062	2.129	-1.649	1.004	0.393	2.839	-16.092
SENEGAL	1.888	22.691	-6.519	6.054	2.033	8.559	3.206
SUDAN	1.500	26.718	-27.913	15.666	-0.112	1.996	10.446
SYRIAN ARAB REPUBLIC	0.048	0.373	-0.693	0.237	-1.519	6.163	4.969
TOGO	1.081	73.474	-41.324	26.392	0.868	4.132	24.420
TUNISIA	0.481	7.597	-1.170	1.944	2.765	10.679	4.045
ZAMBIA	-2.581	20.426	-21.255	9.830	0.069	3.232	-3.808
ZIMBABWE	-1.448	13.142	-12.798	5.740	0.490	3.863	-3.964
Average	0.328	14.661	-13.093	6.662	0.041	4.563	2.560

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.2 Income by region

Gross domestic product (GDP) growth is taken to measure the regional income or it can be said the regional economy. The statistical description of GDP of each region is reported. Table 3.3.4 reports the statistical description of East/South Asian and Pacific region and in the similar way Table 3.3.5, table 3.3.6 and Table 3.3.7 describe the behavior (from a statistical point of view) of Europe and Central Asian region, Latin America and Caribbean region and Middle East and North/Sub-Saharan African region respectively.

Table 3.3.4: Statistical analysis on Income in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	3.431	5.172	-0.641	1.509	-1.486	4.583	0.440
HONG KONG, CHINA	4.992	13.411	-6.026	4.151	-0.437	4.146	0.832
INDIA	5.974	9.637	1.064	2.141	-0.191	2.703	0.358
INDONESIA	5.181	9.085	-13.127	4.781	-2.953	12.042	0.923
JAPAN	2.157	6.765	-2.049	2.101	0.307	2.925	0.974
KOREA, REP.	6.649	11.104	-6.854	4.002	-1.901	7.483	0.602
MALAYSIA	6.441	10.003	-7.359	4.334	-1.817	6.188	0.673
NEW ZEALAND	2.441	6.439	-1.310	2.131	0.111	2.021	0.873
PAKISTAN	4.682	7.706	1.014	2.003	-0.023	2.185	0.428
PHILIPPINES	3.843	6.753	-0.578	2.229	-0.748	2.539	0.580
THAILAND	6.176	13.288	-10.510	5.207	-1.658	6.473	0.843
Average	4.724	9.033	-4.216	3.144	-0.981	4.844	0.684

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Table 3.3.5: Statistical analysis on Income in Europe and Central region

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	2.408	4.605	0.333	1.129	-0.070	2.238	0.469
BELGIUM	2.217	4.723	-0.962	1.324	-0.302	2.996	0.597
BULGARIA	0.969	10.945	-9.400	6.076	-0.521	2.034	6.270
DENMARK	1.998	5.525	-0.143	1.614	0.525	2.523	0.808
FINLAND	2.498	6.091	-6.244	3.122	-1.472	4.614	1.250
FRANCE	2.218	4.599	-0.913	1.294	-0.211	3.217	0.583
GREECE	2.579	4.854	-2.259	2.091	-1.009	2.955	0.811
HUNGARY	1.668	5.192	-11.892	4.117	-1.956	6.892	2.468
ICELAND	3.172	8.546	-3.374	3.196	-0.124	2.165	1.008
IRELAND	6.082	11.680	-0.428	3.086	-0.052	2.516	0.507
ITALY	1.755	4.194	-0.889	1.336	-0.061	2.301	0.761
LUXEMBOURG	5.177	9.983	1.343	2.912	0.286	1.744	0.563
NETHERLANDS	2.728	4.684	0.076	1.356	-0.358	2.117	0.497
NORWAY	2.837	5.393	-0.173	1.496	-0.002	2.328	0.527
PORTUGAL	3.067	7.489	-2.043	2.493	-0.234	2.385	0.813
SPAIN	3.340	5.547	-1.032	1.541	-1.053	4.459	0.461
SWEDEN	2.205	4.525	-1.995	1.890	-0.861	2.824	0.857
SWITZERLAND	1.528	4.551	-0.829	1.494	0.405	2.227	0.978
UNITED KINGDOM	2.646	4.969	-1.358	1.503	-0.925	3.909	0.568
Average	2.689	6.215	-2.220	2.267	-0.421	2.971	1.095

Source: Author's calculation based on data extracted from World Development Indicators (2008).

From the data, it is clear that mean GDP growth is highest for the East/South Asian and Pacific region, followed by the Latin American and Caribbean region, the Middle Eastern and the North/Sub-Saharan African region, and the European and the Central region. It is noted that mean GDP growth of East/South Asian and Pacific region is twice that of Europe and Central region though the limited data availability allows testing for 11 East/South Asian and Pacific region countries whereas there were 19 Europe and central regional countries.

Table 3.3.6: Statistical analysis on Income in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	2.845	12.670	-10.894	6.738	-0.371	2.052	2.368
BOLIVIA	3.225	5.267	-2.574	1.919	-1.469	5.152	0.595
BRAZIL	2.465	7.988	-4.300	2.720	-0.343	3.476	1.103
CHILE	5.969	12.278	-0.761	3.061	0.081	3.110	0.513
COSTA RICA	4.935	9.152	0.887	2.399	-0.002	2.130	0.486
DOMINICAN REPUBLIC	4.604	10.117	-5.454	3.909	-0.811	3.411	0.849
ECUADOR	2.982	8.366	-6.299	3.321	-0.920	4.472	1.114
EL SALVADOR	3.395	7.545	0.189	2.094	0.673	2.464	0.617
GUATEMALA	3.557	4.994	0.143	1.077	-1.489	6.193	0.303
HONDURAS	3.615	6.232	-1.890	2.462	-0.968	2.914	0.681
MEXICO	2.648	6.776	-6.218	3.231	-1.280	4.373	1.220
PANAMA	3.534	9.419	-13.380	4.961	-1.960	7.827	1.404
PARAGUAY	2.532	6.355	-3.346	2.497	-0.642	2.851	0.986
PERU	2.705	12.822	-11.700	6.067	-0.748	3.272	2.243
URGUAY	2.836	11.820	-11.032	5.284	-0.690	3.560	1.863
VENEZUELA, RB	2.553	18.287	-8.856	6.911	0.042	2.866	2.708
Average	3.400	9.380	-5.343	3.666	-0.681	3.758	1.191

Source: Author’s calculation based on data extracted from World Development Indicators (2008).

The superior performance of East/South Asian and Pacific region is because of few of the countries like India, Indonesia, Korea, Rep., Malaysia and Thailand which performed relatively impressively over the 1986-2005 period.

Table 3.3.7: Statistical analysis on Income in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	2.275	6.900	-2.100	2.627	-0.081	1.811	1.155
BOTSWANA	7.467	19.450	1.916	4.047	1.331	4.939	0.542
CAMEROON	1.093	6.772	-7.824	4.382	-0.579	1.941	4.011
COTE D'LVOIRE	1.475	7.729	-3.700	2.994	0.635	2.730	2.030
EGYPT, ARAB REP.	4.130	6.110	1.079	1.278	-0.544	2.767	0.309
ETHIOPIA	4.471	13.860	-8.673	6.804	-0.257	2.144	1.522
GABON	1.751	12.845	-17.146	6.335	-1.322	5.488	3.618
GHANA	4.613	5.900	3.300	0.751	-0.128	2.116	0.163
IRAN, ISLAMIC REP.	3.444	13.688	-9.171	5.467	-0.394	3.379	1.587
JORDAN	3.939	18.665	-13.452	5.734	-0.609	7.195	1.456
KENYA	3.268	7.178	-0.799	2.307	-0.159	1.896	0.706
MOROCCO	3.638	12.217	-6.579	5.189	-0.220	2.161	1.426
SOUTH AFRICA	2.313	5.096	-2.137	2.011	-0.661	2.534	0.869
SENEGAL	3.318	6.661	-0.676	2.440	-0.206	1.729	0.735
SUDAN	5.542	14.221	-5.470	4.067	-0.634	4.637	0.734
SYRIAN ARAB REPUBLIC	4.086	13.470	-8.958	5.398	-0.574	3.558	1.321
TOGO	2.459	14.982	-15.096	6.508	-0.341	4.482	2.647
TUNISIA	4.236	7.950	-1.447	2.548	-0.497	2.558	0.601
ZAMBIA	1.992	6.946	-8.625	3.979	-0.861	3.488	1.997
ZIMBABWE	0.389	10.361	-10.400	6.111	-0.118	1.993	15.713
Average	3.295	10.550	-5.798	4.049	-0.311	3.177	2.157

Source: Author's calculation based on data extracted from World Development Indicators (2008).

In addition, the coefficient of skewness of all regions is found to be negative which simply implies that the distribution is asymmetric and is not normal where it is actually long left-hand tail distribution. The peakedness of the distribution is found by computing the kurtosis of the distribution. The peakedness of Europe and Central Asian region is closer to the value three but still it is less than the value three, indicating that the distribution is platykurtic where the distribution has a larger probability of values intermediately distant from the mean. The three other regions reported kurtosis greater than three simply implying that the distribution is leptokurtic. Lastly, when the coefficient of variation is compared regionally, it is found that Middle East and North/Sub-Saharan African region is more volatile than the other regions.

3.2.3 Inflation by region

The next variable that is considered is the inflation rate, which is computed using the consumer price indices. Tables 3.3.8, 3.3.9, 3.4.0 and 3.4.1 report the statistical description of inflation rate for each region. In Table 3.4.0, two countries, namely Brazil and Peru, record extraordinary mean inflation rates of 545.9 per cent and 616.a per cent, respectively.

Table 3.3.8: Statistical analysis on Inflation in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	3.851	9.085	0.250	2.699	0.654	2.154	0.701
HONG KONG, CHINA	4.280	11.259	-3.959	5.315	-0.318	1.594	1.242
INDIA	7.648	13.870	3.685	3.286	0.316	1.941	0.430
INDONESIA	11.271	58.387	3.718	11.601	3.601	15.119	1.029
JAPAN	0.645	3.266	-0.895	1.226	0.796	2.641	1.901
KOREA, REP.	4.748	9.300	0.814	2.228	0.414	2.439	0.469
MALAYSIA	2.662	5.270	0.290	1.346	0.094	2.301	0.506
NEW ZEALAND	3.865	15.741	-0.114	4.102	1.860	5.542	1.061
PAKISTAN	7.613	12.368	2.914	3.323	-0.085	1.582	0.437
PHILIPPINES	7.236	18.492	0.752	3.845	1.095	4.981	0.531
THAILAND	3.813	8.072	0.304	2.121	0.031	2.064	0.556
Average	5.239	15.010	0.705	3.736	0.769	3.851	0.806

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Table 3.3.9: Statistical analysis on Inflation in Europe and Central Asian region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	2.212	4.030	0.562	0.914	0.221	2.397	0.413
BELGIUM	2.085	3.453	0.954	0.750	0.204	1.876	0.360
BULGARIA	96.849	1058.374	2.157	239.503	3.512	14.464	2.473
DENMARK	2.545	4.784	1.160	0.988	0.996	3.179	0.388
FINLAND	2.475	6.634	0.187	1.879	0.879	2.680	0.759
FRANCE	2.108	3.498	0.500	0.834	-0.048	2.576	0.396
GREECE	9.896	23.021	2.637	6.728	0.477	1.866	0.680
HUNGARY	15.393	34.234	3.551	9.127	0.445	2.100	0.593
ICELAND	7.723	25.751	1.551	7.833	1.212	2.909	1.014
IRELAND	2.976	5.565	1.401	1.175	0.584	2.523	0.395
ITALY	3.889	6.496	1.656	1.664	0.158	1.542	0.428
LUXEMBOURG	2.105	3.702	-0.134	1.083	-0.344	2.300	0.514
NETHERLANDS	2.035	4.200	-0.708	1.139	-0.575	3.371	0.560
NORWAY	3.173	8.726	0.465	2.141	1.299	3.876	0.675
PORTUGAL	6.076	13.372	2.162	3.932	0.626	1.828	0.647
SPAIN	4.371	8.797	1.834	1.805	0.675	2.949	0.413
SWEDEN	3.091	10.377	-0.267	3.005	1.129	3.408	0.972
SWITZERLAND	1.822	5.879	0.017	1.657	1.314	3.577	0.909
UNITED KINGDOM	3.622	9.476	1.555	2.044	1.585	4.987	0.564
Average	9.181	65.283	1.118	15.169	0.755	3.390	0.692

Source: Author's calculation based on data extracted from World Development Indicators (2008).

This means that Latin America and Caribbean region reports the highest mean of the other entire region over the period of 1986 to 2005. The mean Inflation rate stands at 108.7 per cent for this region, which is almost five times higher than the Middle East and North/Sub-Saharan African region, which reports the inflation rate of 17.1 per cent; ten times more than Europe and Central Asian region and twenty times larger than East/South Asian and Pacific region. Over this period, the highest inflation rate is recorded by the Latin America and Caribbean region, which is far greater than the other regions. This is due to three countries (namely, Argentina, Brazil and Peru) in Latin America and Caribbean region which recorded extremely high mean inflation rate over the period 1986-2005.

Table 3.4.0: Statistical analysis on Inflation in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	311.235	3079.810	-1.167	829.601	2.727	8.768	2.666
BOLIVIA	22.329	276.336	0.923	60.066	4.066	17.722	2.690
BRAZIL	545.931	2947.733	3.199	869.646	1.566	4.259	1.593
CHILE	10.331	26.029	1.052	7.689	0.546	1.983	0.744
COSTA RICA	15.074	28.709	9.165	5.357	0.968	3.147	0.355
DOMINICAN REPUBLIC	18.174	51.461	4.190	17.763	0.989	2.210	0.977
ECUADOR	36.804	96.094	2.408	23.912	0.642	3.210	0.650
EL SALVADOR	10.972	31.935	0.515	9.143	0.744	2.490	0.833
GUATEMALA	13.102	41.222	4.863	10.641	1.857	4.863	0.812
HONDURAS	15.290	48.786	2.487	12.022	1.353	4.078	0.786
MEXICO	29.520	131.827	3.988	36.994	1.865	5.140	1.253
PANAMA	0.951	3.182	-0.066	0.735	1.273	5.271	0.773
PARAGUAY	15.932	37.260	4.323	9.152	0.753	2.679	0.574
PERU	616.095	7481.664	0.192	1785.463	3.243	12.450	2.898
URGUAY	41.380	112.526	4.359	34.407	0.566	2.136	0.831
VENEZUELA, RB	37.400	99.877	11.543	23.440	1.303	4.062	0.627
Average	108.782	905.903	3.248	233.502	1.529	5.279	1.191

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Furthermore, none of the regions have a normal distribution for the inflation rate. The skewness of all regions shows that the regions inflation has a long right-hand distribution. The peakedness of the distribution is shown by the kurtosis of each region and it turns out to be greater than three for all regions, implying that the distribution is leptokurtic. From the above statistical description, it can be seen that Middle East and North/Sub-Saharan African region is most volatile of the four regions.

Table 3.4.1: Statistical analysis on Inflation in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	11.718	31.670	0.341	10.616	0.729	2.046	0.906
BOTSWANA	9.780	16.168	6.559	2.451	0.975	3.731	0.251
CAMEROON	4.407	35.094	-3.207	8.147	2.858	11.314	1.849
COTE D'LVOIRE	5.138	26.082	-0.806	5.987	2.396	8.720	1.165
EGYPT, ARAB REP.	10.786	23.864	2.270	7.256	0.323	1.643	0.673
ETHIOPIA	5.489	35.723	-9.809	9.809	1.253	5.796	1.787
GABON	2.338	36.116	-11.686	9.657	1.995	8.793	4.130
GHANA	26.221	59.462	10.056	12.564	0.956	3.640	0.479
IRAN, ISLAMIC REP.	20.993	49.656	7.628	9.339	1.418	5.452	0.445
JORDAN	5.113	25.713	-0.200	6.043	2.357	8.198	1.182
KENYA	13.045	45.979	1.554	10.740	1.643	5.562	0.823
MOROCCO	3.522	8.734	0.620	2.519	0.672	2.234	0.715
SOUTH AFRICA	9.603	18.655	1.385	4.716	0.236	2.075	0.491
SENEGAL	2.662	32.294	-4.141	7.454	3.335	13.909	2.801
SUDAN	51.320	132.824	5.848	45.500	0.561	1.814	0.887
SYRIAN ARAB REPUBLIC	11.979	59.484	-3.846	15.494	1.725	5.660	1.293
TOGO	4.476	39.163	-1.007	9.153	2.992	11.630	2.045
TUNISIA	4.702	8.226	1.983	2.117	0.388	1.722	0.450
ZAMBIA	58.329	183.312	17.968	50.199	1.367	3.652	0.861
ZIMBABWE	81.083	431.700	7.422	118.037	1.946	5.520	1.456
Average	17.135	64.996	1.447	17.390	1.506	5.655	1.234

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.4 Gross fixed capital formation (GFCF) by region

Gross fixed capital formation (GFCF) measured as annual percentage growth rate is used to proxy capital stock in this study. The mean GFCF is the highest in Latin America and Caribbean region. Basically, there is not much difference between the mean GFCF of this region and East/South Asian and Pacific region. They seem to be performing much alike. For Middle East and North/Sub-Saharan African region and Europe and Central Asian region, the mean GFCF stands at 4.2 and 3.9, respectively, which are weaker in performance compared to the Latin American and the Caribbean region, and the East/South Asian and Pacific region, which have mean GFCF of 5.8 and 5.4, respectively.

Table 3.4.2: Statistical analysis on GFCF in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	4.670	14.353	-10.187	6.617	-1.008	3.237	1.417
HONG KONG, CHINA	4.856	15.045	-16.754	7.686	-1.184	4.408	1.583
INDIA	8.217	18.853	-4.703	5.804	-0.078	2.926	0.706
INDONESIA	6.701	16.737	-33.008	12.187	-2.200	7.309	1.819
JAPAN	1.678	12.962	-7.206	4.921	0.465	2.858	2.932
KOREA, REP.	7.577	25.438	-22.935	9.963	-1.206	5.672	1.315
MALAYSIA	7.327	28.020	-42.966	17.540	-1.138	4.429	2.394
NEW ZEALAND	4.198	17.477	-16.776	8.134	-0.550	3.509	1.937
PAKISTAN	2.757	13.543	-6.130	5.025	0.011	2.615	1.823
PHILIPPINES	4.573	21.608	-14.187	10.316	-0.275	2.328	2.256
THAILAND	6.569	29.600	-44.324	15.977	-1.730	6.538	2.432
Average	5.375	19.422	-19.925	9.470	-0.809	4.166	1.874

Source: Author's calculation based on data extracted from World Development Indicators (2008).

It is also noted that the maximum and minimum GFCF growth rate of 39.2 and -23. 7, respectively, is recorded for Middle East and North/Sub-Saharan African region. Referring to Table 3.4.4, it is very clear that Latin America and Caribbean region is equally alike as Middle East and North/Sub-Saharan African region, with maximum and minimum GFCF growth rates of 35.3 and -23.3, respectively.

Table 3.4.3: Statistical analysis on GFCF in Europe and Central Asian region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	2.462	8.126	-6.025	3.486	-0.456	2.934	1.416
BELGIUM	3.630	16.018	-4.144	4.931	0.718	3.365	1.358
BULGARIA	3.567	35.200	-33.553	18.222	-0.421	2.309	5.109
DENMARK	3.717	19.252	-6.740	6.405	0.556	2.850	1.723
FINLAND	1.900	13.640	-18.434	9.632	-0.874	2.887	5.070
FRANCE	2.950	9.283	-6.194	3.917	-0.387	2.788	1.328
GREECE	3.924	13.318	-5.633	5.271	-0.201	2.236	1.343
HUNGARY	3.880	13.300	-10.400	7.016	-0.778	2.478	1.808
ICELAND	6.228	34.889	-14.858	15.037	0.639	2.260	2.414
IRELAND	7.125	18.079	-6.984	7.822	-0.274	1.828	1.098
ITALY	2.144	7.188	-11.457	4.082	-1.801	7.239	1.904
LUXEMBOURG	7.656	37.134	-15.075	11.229	0.635	3.993	1.467
NETHERLANDS	3.142	9.796	-4.548	4.045	0.073	2.036	1.287
NORWAY	2.509	15.786	-12.085	7.360	0.069	2.258	2.933
PORTUGAL	4.796	17.997	-7.396	6.837	0.108	2.409	1.426
SPAIN	5.748	13.553	-8.906	5.552	-0.916	3.804	0.966
SWEDEN	2.370	12.103	-14.649	7.220	-0.957	3.079	3.046
SWITZERLAND	2.048	8.033	-7.963	4.152	-0.678	2.725	2.028
UNITED KINGDOM	3.858	14.853	-8.237	5.189	0.138	3.811	1.345
Average	3.877	16.713	-10.699	7.232	-0.253	3.015	2.056

Source: Author’s calculation based on data extracted from World Development Indicators (2008).

Moreover, the statistical description also gives information of the type of distribution for each region. The Skewness of Latin America and Caribbean region and the Kurtosis of Europe and Central Asian region imply that these two regions GFCG have a normal distribution. But, it is also noted that Latin America and Caribbean region reported kurtosis greater than three implying it is not a normal distribution and instead it formed a leptokurtic distribution and the same goes with Europe and Central Asian region which reported negative skewness statistics, implying that it has a long left-hand tail distribution, which is essentially an asymmetric distribution.

Table 3.4.4: Statistical analysis on GFCF in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	5.782	38.166	-36.448	20.848	-0.203	2.122	3.606
BOLIVIA	4.965	29.217	-21.449	13.586	-0.090	2.354	2.736
BRAZIL	1.865	22.980	-8.196	8.024	0.889	3.497	4.303
CHILE	9.882	29.999	-18.237	11.140	-0.311	3.364	1.127
COSTA RICA	6.398	25.469	-12.004	9.834	0.204	2.627	1.537
DOMINICAN REPUBLIC	7.553	28.114	-12.600	12.814	0.183	1.937	1.696
ECUADOR	3.186	23.488	-27.670	10.575	-0.844	5.207	3.320
EL SALVADOR	5.853	18.115	-12.785	7.801	-0.437	2.916	1.333
GUATEMALA	6.058	24.917	-10.254	9.529	0.255	2.485	1.573
HONDURAS	6.137	35.842	-18.595	14.314	0.294	2.382	2.332
MEXICO	4.372	21.036	-29.003	11.013	-1.403	5.403	2.519
PANAMA	9.889	92.300	-55.199	30.924	0.408	4.395	3.127
PARAGUAY	1.838	10.674	-14.666	7.062	-0.996	3.098	3.841
PERU	5.902	33.749	-26.873	14.420	0.010	3.174	2.443
URGUAY	5.675	30.249	-32.493	16.539	-0.403	2.503	2.914
VENEZUELA, RB	8.075	100.647	-37.027	31.022	1.328	5.075	3.842
Average	5.839	35.310	-23.344	14.340	-0.070	3.284	2.641

Source: Author's calculation based on data extracted from World Development Indicators (2008).

The kurtosis statistic of greater than three is recorded by East/South Asian and Pacific region and Middle East and North/Sub-Saharan African region, simply meaning it GFCF for these regions has a leptokurtic distribution. Meanwhile, the negative skewness of East/South Asian and Pacific region and positive skewness of Middle East and North/Sub-Saharan African region indicates the long left-hand tail and long right-hand tail distribution, respectively. Furthermore it can be also noted that Middle East and North/Sub-Saharan African region is found to be more volatile as it has the highest coefficient of variation.

Table 3.4.5: Statistical analysis on GFCF in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	0.305	8.100	-16.500	6.678	-1.294	3.992	21.894
BOTSWANA	6.812	40.195	-4.231	12.694	1.419	4.029	1.863
CAMEROON	-1.144	25.343	-27.600	12.749	-0.064	2.644	-11.146
COTE D'LVOIRE	-0.482	31.598	-27.300	13.337	0.244	3.352	-27.694
EGYPT, ARAB REP.	1.133	22.625	-13.357	9.922	0.258	2.221	8.755
ETHIOPIA	6.481	50.245	-25.042	18.900	0.319	2.941	2.916
GABON	0.818	87.688	-50.448	28.789	1.060	5.625	35.174
GHANA	11.737	105.982	-22.993	27.111	2.008	8.443	2.310
IRAN, ISLAMIC REP.	4.894	46.368	-19.668	15.005	0.742	4.243	3.066
JORDAN	5.195	46.107	-18.021	15.120	0.896	3.861	2.910
KENYA	5.307	27.421	-10.188	8.439	0.365	3.898	1.590
MOROCCO	4.676	13.700	-3.406	5.640	-0.044	1.702	1.206
SOUTH AFRICA	2.492	12.584	-18.575	7.986	-0.987	3.389	3.205
SENEGAL	4.239	22.556	-22.805	8.419	-1.197	7.223	1.986
SUDAN	10.682	65.345	-11.907	18.279	1.290	5.026	1.711
SYRIAN ARAB REPUBLIC	2.388	32.559	-32.120	15.417	-0.355	3.129	6.457
TOGO	3.134	40.607	-45.800	19.138	-0.508	3.994	6.106
TUNISIA	2.863	21.831	-17.787	9.245	-0.016	3.230	3.229
ZAMBIA	9.542	40.617	-30.825	20.239	-0.346	2.301	2.121
ZIMBABWE	2.234	43.500	-54.762	23.870	-0.366	3.215	10.685
Average	4.165	39.248	-23.667	14.849	0.171	3.923	3.917

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.2.5 Trade by region

The last variable that needs to be discussed in this study is trade openness, which is measured as trade as percentage of GDP. With reference to Tables 3.4.6 and 3.4.7, it can be seen that East/South Asia and Pacific region and Europe and Central Asia are performing fairly similarly, while Latin America and Caribbean region and Sub-Saharan/North Africa and Middle East region are performing similarly. The data reveals that Europe and Central Asian region is more exposed to other regions. Trade in terms of percentage of GDP is highest by East/South Asia and Pacific region and the minimum is reported by Latin America and Caribbean region.

Table 3.4.6: Statistical analysis on Trade in East/South Asian and Pacific region for the period 1986-2005

EAST/SOUTH ASIAN AND PACIFIC REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRALIA	37.352	45.046	32.464	3.823	0.190	1.927	0.102
HONG KONG, CHINA	275.715	384.963	210.053	43.075	1.284	4.224	0.156
INDIA	22.922	42.609	12.357	8.094	0.800	3.182	0.353
INDONESIA	56.493	96.186	39.974	12.391	1.685	6.329	0.219
JAPAN	19.708	27.297	16.108	2.754	1.147	4.263	0.140
KOREA, REP.	66.441	83.722	52.666	9.905	0.232	1.835	0.149
MALAYSIA	177.513	228.875	104.953	38.718	-0.461	1.939	0.218
NEW ZEALAND	57.839	69.326	49.031	5.107	0.532	3.144	0.088
PAKISTAN	34.560	38.910	28.130	3.033	-0.451	2.404	0.088
PHILIPPINES	83.014	110.935	48.703	22.316	-0.157	1.382	0.269
THAILAND	94.929	148.747	49.171	27.502	0.324	2.125	0.290
Average	84.226	116.056	58.510	16.065	0.466	2.978	0.188

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Table 3.4.7: Statistical analysis on Trade in Europe and Central Asian region for the period 1986-2005

EUROPE and CENTRAL ASIAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
AUSTRIA	79.363	103.816	65.591	11.963	0.618	2.043	0.151
BELGIUM	142.918	169.641	122.940	15.580	0.448	1.774	0.109
BULGARIA	100.192	136.593	69.847	17.118	0.364	2.370	0.171
DENMARK	75.546	92.844	63.846	8.885	0.660	1.966	0.118
FINLAND	61.818	78.061	44.334	10.954	-0.264	1.615	0.177
FRANCE	46.997	56.227	40.640	4.950	0.392	1.814	0.105
GREECE	42.731	54.376	36.613	4.751	0.915	3.297	0.111
HUNGARY	98.534	147.761	59.677	31.662	0.153	1.395	0.321
ICELAND	137.939	184.684	100.307	26.840	0.201	1.825	0.195
IRELAND	69.574	78.870	60.676	4.981	-0.144	2.009	0.072
ITALY	44.151	53.176	35.707	6.154	-0.001	1.482	0.139
LUXEMBOURG	221.972	297.240	183.329	39.064	0.582	1.775	0.176
NETHERLANDS	115.481	134.618	100.347	10.165	0.294	2.006	0.088
NORWAY	71.233	75.964	66.714	2.637	-0.095	2.076	0.037
PORTUGAL	64.402	70.408	57.373	3.603	-0.399	2.556	0.056
SPAIN	46.398	61.196	35.389	9.702	0.094	1.333	0.209
SWEDEN	71.340	89.773	53.462	11.298	0.009	1.704	0.158
SWITZERLAND	74.266	88.975	65.720	7.714	0.542	1.903	0.104
UNITED KINGDOM	53.790	59.182	47.353	3.381	-0.222	2.086	0.063
Average	85.192	107.021	68.940	12.179	0.218	1.949	0.135

Source: Author's calculation based on data extracted from World Development Indicators (2008).

The distribution formed by this variable is not normal for any region. All the four regions reported positive coefficient of skewness, implying that all the regions formed a long right-hand tail distribution, whereas the kurtosis of all regions turned out to be less than the value of three, meaning a platykurtic distribution. From the statistical description reported in the tables above, it can be also be seen that Latin America and Caribbean region is found to be most volatile, as it recorded the highest coefficient of variation amongst the four regions.

Table 3.4.8: Statistical analysis on Trade in Latin America and Caribbean region for the period 1986-2005

LATIN AMERICA and CARIBBEAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ARGENTINA	23.188	44.257	13.753	10.092	1.198	2.954	0.435
BOLIVIA	49.118	66.589	41.906	5.366	1.818	6.853	0.109
BRAZIL	19.538	28.973	14.391	4.862	0.742	2.037	0.249
CHILE	61.089	74.006	54.812	5.957	0.787	2.451	0.098
COSTA RICA	80.410	102.647	53.980	14.680	-0.240	1.906	0.183
DOMINICAN REPUBLIC	79.693	106.589	57.824	15.978	0.393	1.657	0.200
ECUADOR	57.498	68.062	48.375	6.422	0.347	1.812	0.112
EL SALVADOR	57.493	72.913	36.928	10.904	-0.307	2.081	0.190
GUATEMALA	48.328	69.545	30.644	11.918	0.787	2.244	0.247
HONDURAS	92.233	136.489	48.790	26.840	0.046	1.923	0.291
MEXICO	49.322	63.872	30.775	12.822	-0.185	1.215	0.260
PANAMA	156.413	198.767	122.140	26.074	0.444	1.679	0.167
PARAGUAY	88.341	130.676	58.458	20.600	0.370	2.182	0.233
PERU	31.957	43.878	23.686	5.170	0.665	3.086	0.162
URGUAY	42.761	60.529	37.326	6.621	1.903	5.344	0.155
VENEZUELA, RB	50.741	59.634	40.062	6.059	-0.212	1.855	0.119
Average	61.758	82.964	44.616	11.898	0.535	2.580	0.201

Source: Author's calculation based on data extracted from World Development Indicators (2008).

Table 3.4.9: Statistical analysis on Trade in Middle East and North/Sub-Saharan African region for the period 1986-2005

MIDDLE EAST and NORTH/SUB-SAHARAN AFRICAN REGION							
Country	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Coefficient of Variation
ALGERIA	51.713	71.048	32.685	9.895	-0.040	2.554	0.191
BOTSWANA	93.892	123.572	78.737	13.104	0.907	2.753	0.140
CAMEROON	39.265	46.006	31.745	3.659	-0.352	3.096	0.093
COTE D'LVOIRE	70.916	94.749	55.349	10.784	0.376	2.503	0.152
EGYPT, ARAB REP.	48.480	63.611	35.325	8.473	0.280	1.974	0.175
ETHIOPIA	27.461	50.579	10.831	11.657	0.381	2.008	0.424
GABON	89.943	101.702	76.897	7.432	-0.212	1.957	0.083
GHANA	70.570	116.048	36.712	26.291	0.232	1.603	0.373
IRAN, ISLAMIC REP.	38.406	68.151	13.772	13.021	0.130	3.045	0.339
JORDAN	121.095	154.645	84.748	17.429	-0.074	2.644	0.144
KENYA	56.499	72.858	47.703	7.753	1.053	3.021	0.137
MOROCCO	57.418	69.420	49.785	5.088	0.354	2.693	0.089
SOUTH AFRICA	48.975	62.137	38.645	6.237	0.004	2.437	0.127
SENEGAL	60.674	70.821	49.637	6.705	-0.200	1.749	0.111
SUDAN	26.181	46.348	12.962	9.592	0.455	2.175	0.366
SYRIAN ARAB REPUBLIC	62.449	80.974	34.194	11.786	-0.637	3.178	0.189
TOGO	78.507	99.673	56.478	11.033	0.000	2.596	0.141
TUNISIA	89.020	99.940	67.485	8.093	-1.372	4.605	0.091
ZAMBIA	71.136	86.016	59.474	7.113	0.323	2.787	0.100
ZIMBABWE	65.217	129.781	19.350	24.843	0.651	3.564	0.381
Average	63.391	85.404	44.626	11.000	0.113	2.647	0.192

Source: Author's calculation based on data extracted from World Development Indicators (2008).

3.3 CONCLUDING REMARKS

In this chapter, basic statistics (or descriptive statistics) relating to each variable used in this study are discussed in finer details for better understanding of these variables. It is seen that mean growth rate of energy type variables are found to be highest mostly in East/South Asian and the Pacific Islands. The Latin America and Caribbean region is found to be most volatile in many cases. The highest growth rate of these energy variables are found for the Middle East and North/Sub-Saharan African region.

In the next chapter, the empirical model and the theoretical framework of these variables used in this study will be discussed.

CHAPTER 4

EMPIRICAL MODEL AND THEORETICAL FRAMEWORK

4.0 INTRODUCTION

In this chapter, the empirical model that is used to examine the dynamic relationship between energy and economic growth is discussed. In the second part of this chapter, the conceptual framework is discussed that motivates the econometric model.

The rest of the chapter is divided into three more sections. The next section will discuss the empirical model which is used to model the relationship between energy and economic growth for regional panels and the global panel. Section 4.2 discusses the theoretical framework of this study. This section is further divided into sub-sections, where the impact of energy, trade openness, capital stock, and inflation on income or on the economic growth will be discussed. Finally, section 4.3 finishes with some concluding remarks.

4.1 EMPIRICAL MODEL

In many previous studies, the main focus has been on bi-variate or multivariate time series models of energy-GDP for single countries. While growth models have not been previously estimated, the GDP-energy nexus in a bi-variate framework has been very popular, as seen in Chapter 2. The proposed model is as follows:

$$GDP = f\left(INF, GFCF, Trade, Energy\right) \tag{1}$$

Which essentially states that GDP is a function of inflation, gross fixed capital formation (or capital stock), trade, and energy (as explained earlier, six proxies for energy). Writing Equation (1) in growth form and in a time series specification amounts to:

$$gy_t = \alpha_0 + \alpha_1 INF_t + \alpha_2 GFCF_t + \alpha_3 Trade_t + \alpha_4 Energy_t + \varepsilon_t \tag{2}$$

Since this study is a panel data study, Equation (2) can be written in panel data model form as follows:

$$gy_{it} = \alpha_0 + \alpha_1 INF_{it} + \alpha_2 GFCF_{it} + \alpha_3 Trade_{it} + \alpha_4 Energy_{it} + \varepsilon_{it} \qquad (3)$$

Where i represents country (in this study, 66 countries are considered); t represents time (the time frame is 1986-2005); gy represents growth rate of GDP; INF represents the inflation rate; $GFCF$ represents the growth rate of gross fixed capital formation (capital stock); $Trade$ represents trade openness, measured as exports plus imports as a percentage of GDP; $Energy$ represents the six types of energy variables (namely, energy use (kg of oil equivalent per capita), energy use (kt of oil equivalent), electric power consumption (kWh), electricity production (kWh), energy production (kt of oil equivalent), fossil fuel energy consumption (as a percentage of total consumption) used in this study. All these energy variables are measured in growth form.

4.2 THEORETICAL FRAMEWORK

4.2.1 Energy - GDP nexus

4.2.1.1 Electricity – GDP

Electricity is a component of energy which is widely used in every country for household and industrial consumption. Electricity is widely used for the production of goods and services, which has a direct link to a country's GDP. The link could effectively be through consumption, investment or exports and imports, as electricity production and consumption affects all these components of aggregate demand.

Many developing countries lack energy resources and they generally depend on imports of crude oil, natural gas, and coal for their residential and industrial energy needs, transportation and electricity whereas. Electricity plays major role in manufacturing, communication, education, commercial, and construction. So conceptually, there is likely to be a positive association between electricity consumption and GDP (or economic growth).

Moreover, according to Narayan and Smyth (2005); Asafu-Adjaye (2000) and Ghosh (2002) the direction of causality between these variables plays vital role while making energy policies. For instance, if there runs a positive unidirectional causality from GDP to electricity consumption or if there is no causality in either direction then this implies that the country is not dependant on electricity. This also means that electricity conservation policies have no impact on economic growth. However, if unidirectional causality runs from electricity consumption to GDP, then reducing electricity could lead to a fall in income. This results because of the strong positive correlation and causation between electricity and GDP. On the other hand, this also implies that any negative shocks to electricity, such as a rise in electricity prices or the impact of electricity conservation policies, will have negative impacts on GDP.

In terms of the findings from the literature on electricity-GDP relationship, this is reviewed in detail in Chapter 2. Briefly, the results are mixed. Some studies have shown that causality runs from GDP to electricity (see, for example, Jumbe, 2004; Narayan and Smyth, 2005; Mozumder and Marathe, 2007) while other studies (see, for example, Shiu and Lam, 2004; Yuan *et al*., 2007; Yoo, 2005; Altinay and Karagol, 2005) have found that causality runs from electricity to GDP, which implies that increased in electricity consumption will raise the economic growth of a country

So, *a priori*, it is expected that the relationship between electricity and economic growth to be positive.

4.2.1.2 Non-electricity energy variables – GDP

There is a large number of studies that examine the relationship between non-electricity type energy variables (for example, coal, petroleum, oil, gas, coke, etc) and economic growth for a wide range of countries. These studies not only show the impact of these energy type variables on economic growth but it forms the basis for further discussions on environmental and energy policies. For example, if energy is a crucial factor in economic growth either directly or as a complement to other factors of production, then energy conservation policies which reduce energy consumption may have unpleasant negative impact on a country's growth prospects. Or rather, if energy consumption is hugely reliant on economic growth, there will be no adverse impact of energy conservation policies designed for the reduction in energy (non-electricity energy type variables) consumption on economic growth.

According to Squalli (2007), the emergent economy which is restrained by political, infrastructural or mismanagement of resources could bring up inefficiencies and the diminution in the demand for goods and services, including energy consumption.

So, as discussed earlier about the electricity-GDP relationship, if unidirectional Granger causality runs from energy to GDP, then this entails that economic growth is dependent on energy and if there is any shortage of energy, this will lead to a fall in GDP or in other words there will be a fall in income. And, for instance, if there exists unidirectional Granger causality running from GDP to energy or if it is found that there is no causality in either direction, then this implies that energy conservation policies would not affect the economic growth of a country or the globe as a whole.

In this literature, the impacts of energy on economic growth have generally shown mixed empirical evidence. Ever since the pioneering work of Kraft and Kraft (1978), many more studies have been done on this topic, and still there is no consensus on the relationship between energy and GDP. Some studies have found that GDP Granger caused these energy type variables (see, for example, Lee and Chang, 2005; Cheng and Lai, 1997; Lee, 2006; Lise and Montfort, 2007; among others – see Chapter 2) whereas in some studies it is noted that energy variables Granger caused GDP (see, for example, Wolde-Rufael, 2004; Lee and Chang, 2005; Yuan *et al*., 2008; Morimoto and Hope, 2004; Stern, 2000).

So, *a priori*, it can be expected that the relationship between energy and economic growth to be positive.

4.2.2 Inflation - GDP nexus

The relationship between inflation and GDP is still found to be conflicting as there exists causation from inflation to GDP and even a reverse causation. Four major components of GDP are government spending, consumer consumption, net exports and direct investment into a country. If for any reason these components are affected, there will be an impact on GDP or on economic growth directly.

Inflation can promote real growth by redistributing income from workers with low saving proclivities to entrepreneurs with higher inclination to save and invest by adjusting idle real wage. According to Johnson (1969), in economies with elastic prices, inflation can reallocate capital from holders of the money balances to the fiscal authorities who may use the earnings of this inflationary tax to expand their investment programmes which will indeed promote economic growth.

There are several arguments to support that inflation impedes real economic growth. Firstly, the increase in inflation can potentially raise the cost and riskiness of prolific investment, whereas it can also lead to misallocation of investment funds to less productive uses. Secondly, the rise in inflation leads to more anxiety on government and demands controls on the prices of food supplies which indeed result in indefinite resource allocation. Finally, the output and growth will be reduced if government attempts to initiate or reinforce exchange controls. In open economies, high inflation with managed exchange rates results in trade imbalances and tentative capital outflows in eagerness of exchange rate depreciation.

Additionally, another case could be where the economic growth may cause the general price level to rise. For example, by allowing supply shortages in certain sectors may lead to a rise in prices of relevant commodities or services. According to

Dorrance (1964) and Lewis (1964), the rise in general price level may be inescapable cohort of economic growth which become a hypothesis for further testing which been tested in the studies of Harberger (1963) and Vogel (1974).

In this literature, generally studies have found mixed results on the impact of inflation on GDP. Some studies have found that inflation has a negative effect on economic growth (see, for example, Smyth, 1994, 1995, De Gregorio, 1993, Barro, 1995, 1996, Paul *et al*., 1997, Fischer, 1993, Bruno and Easterly, 1998) and many more) while others have argued that a positive relationship exists between inflation and economic growth (see, for example, Felix, 1961; Seers, 1962; Baer, 1967; and Taylor, 1979, 1983). So it can be concluded that the relationship between inflation and economic growth is ambiguous, and can only be ascertained empirically.

So, *a priori*, it can be expected that the relationship between inflation and economic growth to be ambiguous; inflation can either have a positive effect or a negative effect on economic growth.

4.2.3 GFCF - GDP nexus

GFCF is used to proxy capital stock in this study. Capital can be seen in two ways- Human capital and public capital. Human capital mainly deals with the skills and qualification of people which is acquired through explicit training on the job experience, by providing better education and also by maintaining good health. On the other hand, public capital is mainly provided by government, which includes telecommunication, electricity, and water for public to use. GFCF is part of public capital which impacts economic growth. A higher level of capital stock, thus, reflects greater productivity and efficiency, which are positively related to economic growth. So conceptually, it can be expected to have a positive association between capital stock and economic growth.

Hence, it is normally assumed that public capital appears to be a crucial component of macroeconomic production function; where the stock enters the production function directly or its stock at times influence the multifactor productivity and thereby production in an indirect way. To identify these effects it all depends how the production function is appearing whereas both ways capitulate similar equations to be estimated in most of the models which reveals that the impact of public capital either it's direct or indirect can frequently not be separated in pragmatic work.

The production depends on the flow of services provided by the comprehensive stock of government capital (roads) and the stock of vehicles in the transport zone whereas Fernald (1999) assumed that it depends on (private) transport services.

A vital attribute of contemporary infrastructure is the supply of services through networked delivery structure intended to serve a large number of users. This networking system plays very systematic role between the relationship of public capital and economic growth as once the fundamental parts of networks are developed, prospects for higher productive investment reduces where Fernald (1999) shows that after 1973, once the highway system in the US was almost accomplished, the hypothesis that the marginal productivity of roads is zero cannot be rejected which in simple terms mean that before 1973, there was a boost in productivity growth but afterwards investment did not gave the same benefits at the margin.

So, *a priori*, it can be expected that the relationship between capital and economic growth to be positive.

4.2.4 Trade - GDP nexus

Trade openness can be explained in two ways; revealed openness and policy openness. Revealed openness basically means the ratio of total foreign trade (exports plus imports) to GDP. This is the measure that is most frequently used in empirical studies, which is also used in this study. Studies which use this measure are always concerned with this very common question – Are the countries that engage in more foreign trade perform superior economically compared to the countries that trade less? Well, this question does not take into account why some countries might trade more and why some trade less. It could be countries that have smaller trading market and have easy access to foreign markets results in trading more which clearly defines policy openness

To define policy openness, Sachs and Warner (1995) attempts to estimate the policy openness effects on economic. They categorize a country as having an open trade system if it does not hold the following characteristics in the period of 1970s to 1980s: average tariff rates of 40 per cent or more on imports of intermediate and capital goods; non-tariff barriers covering 40 per cent or more of imports of intermediate and capital goods; a black market exchange rate premium of 20 per cent or more; a socialistic economic system; a state monopoly or major exports. Well this is indeed disparaged by Rodriguez and Rodrik (2001) and they argue that the export monopoly and black market premia are measured using essential components of the index and they argue that the links of the other variables with trade policy are questionable and their links with revealed openness are even weaker.

Furthermore, other two gains from international trade are; 1) existence of trade between two or more countries ensures availability of more varieties of same product for consumption, which is a source of gain for consumers. 2) More varieties of same product increase the competition which lowers the equilibrium price as the increased size of the market allows understandable economies of scale. The lower prices also raise the real wages which again is another source of gain for consumers.

Recent econometric studies (for example, Sachs and Warner, 1995; Frankel and Romer, 1999; Dollar and Kray, 2003) have found a positive relationship between trade openness and economic growth. Sachs and Warner showed that open economies experienced faster growth in GDP per capita over the period 1970-1989. He showed that the growth premium is recorded highest for poorer countries which imply that openness brings about convergence in incomes. Franker and Romer used geographical variables as exogenous mechanisms to control for the possible endogenous trade openness to examine the differences in levels of development across 150 countries in 1985 which is measured by real GDP per capita. And they reported that a 10 per cent increase in trade increases real income per capita by 20 per cent whereas Dollar and Kraay use the same measure as Frankel and Romer to study decadal growth of GDP per capita and reported that when the trade integration is doubled, it raises the annual growth rate by 2.5 per cent.

So, a priori, a positive relationship can be expected between trade openness and economic growth.

4.3 CONCLUSION

In this chapter, the main focus was on defining the empirical model and providing a theoretical framework for the econometric model. In the next chapter, the empirical findings of this study will be discussed and also the results will be discussed in greater details. Together with this, the econometric approach/ methodology used in obtaining these results will be discussed.

CHAPTER 5

ECONOMETRIC APPROACH AND FINDINGS

5.0 INTRODUCTION

This chapter is about the results of this thesis. It has two objectives: (a) to outline the econometric methodology and (b) to present and discuss the results of the relationship between energy and economic growth for the various panels of the globe.

The remainder of this chapter is organised as follows. The next section outlines the econometric methodology. Section 5.2 presents the empirical findings. Section 5.3 provides a summary of the main findings. In the final section, some concluding comments regarding the key findings of this chapter are summarised.

5.1 METHODOLOGY

This study has a dynamic panel specification where lagged levels of the economic growth are taken into account by using the Arellano and Bond (AB, 1991) GMM estimator. The proposed model is as follows:

$$gy_{i,t} = a_0 gy_{i,t-1} + \beta X'_{i,t} + \psi ENERGY_{i,t} + \mu_{i,t} + \varepsilon_{i,t}\,,\ i = 1,\ldots,N\,;\ t = 1,..,T$$

where $gy_{i,t}$ stands for the economic growth rate of country i at time t, α_0 is the parameter to be estimated; X is a vector of core explanatory variables used to model economic growth (inflation, GFCF, and trade openness); μ is country specific effects; and ε is the error term. Finally, ψ captures the effect of energy type variables. These are energy use (kg of oil equivalent per capita), energy use (kt of oil equivalent), electric power consumption (kWh), electricity production (kWh), energy production (kt of oil equivalent), and fossil fuel energy consumption (as a percentage of total consumption)).

Since the lagged dependant variable is correlated with the error term, the use of panel ordinary least squares (OLS) estimator (with fixed and random effects) is in a kind problematic. The Arrellano and Bond (1991) approach solves this problem by first differentiating the above equation. This removes country-specific effects.

$\mathrm{E}(\varepsilon_{i,t} - \varepsilon_{i,t-1}) = 0)$ but $(gy_{i,t-1} - gy_{i,t-2})$ is not independent of $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$. With the use of AB method it is possible to solve this problem by using two or more lags of the first difference of economic growth. With the assumption that the energy and the control values are predetermined with respect to $(X_{i,t} - X_{i,t-1})$ and $(ENERGY_{i,t} - ENERGY_{i,t-1})$, in the sense that $\mathrm{E}(X_{i,t}, \varepsilon_{i,s}) \neq 0$ and $\mathrm{E}(ENERGY_{i,t}, \varepsilon_{i,s}) \neq 0$ for $s \prec t$ but zero for $s \geq t$.

5.2 REGIONAL RESULTS

Table 5.1 reports the results for the East/South Asian and the Pacific panel. In total, seven different models are estimated as explained earlier. Briefly, the objective is to examine the role of different forms of energy on economic growth. The results are organised by columns. In column 1, results from the core model of economic growth are reported. Here, economic growth is specified as a function of inflation, capital stock and trade openness. As explained in the Chapter on the theoretical framework, this specification is fairly standard and there is a voluminous literature on this. The motivation for starting with this model is purely to set the scene for the rest of the estimations, in that it establishes the conventional roles of the core variables on economic growth.

Beginning with model 1, it is found that while inflation has a statistically significant negative effect and capital has a statistically significant positive effect on Asian economic growth, trade openness has a statistically insignificant effect on economic growth.

In models 2 and 3, energy use (kg of oil equivalent per capita) and energy use (kt of oil equivalent) are used - all in growth form, respectively. It is found that both these energy variables have a statistically insignificant effect on economic growth in Asia. Meanwhile, it is noticed that both inflation and capital have statistically significant negative and positive effects, respectively, on economic growth. Despite the change in model specification, trade openness remains a statistically insignificant determinant of Asian economic growth.

In models 4 and 5, the form of the energy variable is changed in that the growth form of electric power consumption (model 4) and electricity production (model 5) are used. Now, it is found that electric power consumption has a statistically significant (at the 1 per cent level) effect on economic growth. To be more precise, the findings imply that a 1 per cent increase in electric power consumption increases economic growth by about 0.17 per cent.

In model 5, when electricity production is used, again it is found that it has a statistically significant (at the 5 per cent level) effect on economic growth. The results imply that a 1 per cent increase in electricity production increases economic growth by approximately 0.14 per cent. While these electricity variables have a positive effect on economic growth, the role of inflation and capital is unchanged compared with results from earlier models. That is, inflation has a statistically significant negative effect and capital has a statistically significant positive effect on Asian economic growth.

The robustness of the impact of trade openness is also maintained in that it has a statistically insignificant effect on economic growth consistent with all the earlier models.

In the last two models, different forms of energy, namely energy production (model 6) and fossil fuel energy consumption (model 7) are used- both in growth form. The impact of both these energy variables turns out to be positive but statistically insignificant. The core variables inflation and capital, however, are statistically significant, confirming the robustness of their impact on economic growth. Finally, like in the previous four models, trade openness remains statistically insignificant.

Two other features of the results stand out and deserve particular mention. First, it can be seen that the magnitude of the impact of inflation is very similar in all the seven models; it ranges from -0.11 to -0.12, implying two things: (a) that the impact is robustness and not dependent on model specification; and (b) that a 1 per cent increase in inflation reduces economic growth by around 0.12 per cent. Second, the correlation between capital stock and economic growth, like in the case of inflation, is fairly robust as well: a 1 per cent increase in capital increases economic growth by about 0.25 per cent.

Table 5.1: Results for the East/South Asia and Pacific panel for the period 1986-2005

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Inflation	-0.119* (0.000)	-0.118* (0.000)	-0.119* (0.000)	-0.120* (0.000)	-0.117* (0.000)	-0.118 (0.000)	-0.12* (0.000)
GFCF	0.257* (0.000)	0.244* (0.000)	0.244* (0.000)	0.234* (0.000)	0.238* (0.000)	0.255* (0.000)	0.254* (0.000)
Trade	-0.01 (0.556)	-0.007 (0.64)	-0.007 (0.661)	-0.001 (0.947)	-0.005 (0.681)	-0.009 (0.561)	-0.009 (0.588)
E1	-	0.695 (0.308)	-	-	-	-	-
E2	-	-	0.071 (0.302)	-	-	-	-
E3	-	-	-	0.169* (0.002)	-	-	-
E4	-	-	-	-	0.139** (0.034)	-	-
E5	-	-	-	-	-	0.027 (0.543)	-
E6	-	-	-	-	-	-	0.088 (0.528)

Source: Authors estimation based on EVIEWS.

Notes: * (**) denotes statistical significance at the 1 per cent and 5 per cent levels, respectively. GFCE – gross fixed capital formation; E1 – Energy use (kg of oil equivalent per capita); E2 – Energy use (kt of oil equivalent); E3 – Electric power consumption (kWh); E4 – Electricity production (kWh); E5 – Energy production (kt of oil equivalent); E6 – Fossil fuel energy consumption (% of total).

To summarise the main findings for the Asian panel then, the following results emerge:

1. Inflation has a statistically significant negative effect on economic growth in all the seven models;
2. Capital has a statistically significant positive effect on economic growth in all the seven models;
3. Trade openness has a statistically insignificant effect on economic growth in all the seven models;
4. In terms of the role of energy variables, it was found that only electric power consumption and electricity consumption have a statistically significant positive effect on economic growth; and
5. The rest of the four energy type variables, while having a positive effect on economic growth, are statistically insignificant.

The results for the European and central Asian panel are reported in Table 5.2. The organisation of the results follows the same as for the Asian panel discussed earlier. To begin with the discussion of the results with the core model, where capital stock and trade openness have a statistically significant positive effect on economic growth for the European panel; both effects are statistically significant at the 1 per cent level. A 1 per cent increase in capital stock increases economic growth by almost 0.2 per cent, while a 1 per cent increase in trade openness increases economic growth by around 0.02 per cent. On the other hand, the impact of inflation is found to be statistically insignificant.

In model 2, the growth rate in energy use per capita was used as a proxy for energy and find that it has a positive and statistically significant effect on economic growth; this result is significant at the 5 per cent level. The magnitude of 0.061 implies that a 1 per cent increase in the growth rate of energy use increases economic growth by 0.06 per cent. Like in model 1, capital and trade have statistically significant and positive effects on economic growth, while inflation remains statistically insignificant.

Model 3 finds that the total energy use also has a statistically significant (at the 5 per cent level) on economic growth. The magnitude of effect is the same as in the case of energy use per capita-about 0.06 per cent. Trade openness and capital are also statistically significant effects of economic growth.

Model 4 uses the growth rate of electricity power consumption as a proxy for energy and find that its growth rate also has a statistically significant effect on economic growth-a 1 per cent increase in the growth rate of electric power consumption increases economic growth by around 0.1 per cent. Again, capital and trade openness have statistically significant positive effects on economic growth.

Table 5.2: Results for the Europe and Central Asian Panel for the period 1986-2005

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Inflation	0.000 (0.967)	0.001 (0.462)	0.001 (0.468)	0.000 (0.620)	0.000 (0.949	0.000 (0.775)	0.000 (0.944)
GFCF	0.189* (0.000)	0.188* (0.000)	0.188* (0.000)	0.182* (0.000)	0.189* (0.000)	0.193* (0.000)	0.191* (0.000)
Trade	0.016* (0.004)	0.015** (0.014)	0.015** (0.015)	0.017* (0.002)	0.015* (0.007)	0.018* (0.004)	0.016* (0.002)
E1	-	0.061** (0.015)	-	-	-	-	-
E2	-	-	0.062** (0.017)	-	-	-	-
E3	-	-	-	0.104* (0.007)	-	-	-
E4	-	-	-	-	0.005 (0.319)	-	-
E5	-	-	-	-	-	0.04** (0.016)	-
E6	-	-	-	-	-	-	-0.038 (0.197)

Source: Authors estimation based on EVIEWS

Notes: * (**) denotes statistical significance at the 1 per cent and 5 per cent levels, respectively. GFCE – gross fixed capital formation; E1 – Energy use (kg of oil equivalent per capita; E2 – Energy use (kt of oil equivalent); E3 – Electric power consumption (kWh); E4 – Electricity production (kWh); E5 – Energy production (kt of oil equivalent); E6 – Fossil fuel energy consumption (% of total)

Models 5 and 7 used electricity production and fossil fuel energy consumption – both in growth form, as proxies for energy, respectively, and find that their growth rates have statistically insignificant effects on economic growth. However, their magnitudes are positive and negative, respectively. Despite the change in model specifications, trade and capital in both these models remain positive and statistically significant at the 1 per cent level.

Model 6 uses the growth rate of energy production and finds that its growth rate has a statistically significant (at the 5 per cent level) positive effect on economic growth. Again, like in the rest of the six models, capital and energy consumption remain statistically significant and positive, while inflation turns out to be statistically insignificant.

The main findings for the European panel can then be summarised as follows:

1. Inflation has a statistically insignificant effect on economic growth in all the seven models;
2. Capital has a statistical significant positive effect in all the seven models and the impact is robust, in that a 1 per cent increase in the growth rate of capital increases economic growth by around 0.19 per cent;
3. Trade openness has a statistically significant and positive effect on economic growth in all the seven models—the results are also robust, in that a 1 per cent increase in trade results in approximately a 0.02 per cent increase in economic growth across all the seven models;
4. The role of energy in economic growth of the Asian panel is fairly strong, in that in five out of the seven models, energy has a statistically significant positive effect on economic growth.

Table 5.3 reports the results for the Latin American and the Caribbean panel. The organisation of results remains same as before. The findings reveal that inflation and capital stock have a statistically significant effect on economic growth at one per cent level. Inflation has a negative impact on economic growth, whereas capital stock has a positive impact. This means that a one per cent increase in capital increases economic growth by almost 0.2 per cent. The impact of trade openness is found to be positive but statistically insignificant for the Latin American and the Caribbean panel.

The growth rate of energy use per capita and the growth rate of total energy use are used in models 2 and 3, respectively. In both models, the findings are that these energy variables have a positive effect and are statistically significant at one per cent level. The magnitude of 0.172 in model 2 and 0.169 in model 3 implies that a one per cent increase in the growth rate of these two energy variables increases economic growth of the Latin American and Caribbean panel by around 0.17 per cent. Again, the inflation and capital stock variables have a statistically significant impact on economic growth.

In the remaining four models (models 4, 5, 6 and 7), electric power consumption, electricity production, energy production and fossil fuel energy consumption are used-all in growth form-respectively. The results of these four models remain the same, in that they show that growth rates of these energy variables in each model have statistically insignificant effect on economic growth of Latin America and Caribbean panel, though the impact of these energy variables on economic growth remains positive. Inflation and capital remain negative and positive, respectively, and they are statistically significant at one per cent level.

Table 5.3: Results for the Latin America and Caribbean panel for the period 1986-2005

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Inflation	-0.001* (0.000)	-0.001* (0.001)	-0.001* (0.001)	-0.001* (0.005)	-0.001* (0.000)	-0.001* (0.000)	-0.001* (0.000)
GFCF	0.177* (0.000)	0.159* (0.000)	0.159* (0.000)	0.170* (0.000)	0.175* (0.000)	0.176* (0.000)	0.175* (0.000)
Trade	0.011 (0.653)	0.008 (0.767)	0.009 (0.723)	0.01 (0.644)	0.011 (0.651)	0.008 (0.72)	0.012 (0.634)
E1	-	0.172* (0.000)	-	-	-	-	-
E2	-	-	0.169* (0.000)	-	-	-	-
E3	-	-	-	0.119 (0.088)	-	-	-
E4	-	-	-	-	0.034 (0.455)	-	-
E5	-	-	-	-	-	0.058 (0.112)	-
E6	-	-	-	-	-	-	0.039 (0.559)

Source: Authors estimation based on EVIEWS

Notes: * (**) denotes statistical significance at the 1 per cent and 5 per cent levels, respectively. GFCE – gross fixed capital formation; E1 – Energy use (kg of oil equivalent per capita); E2 – Energy use (kt of oil equivalent); E3 – Electric power consumption (kWh); E4 – Electricity production (kWh); E5 – Energy production (kt of oil equivalent); E6 – Fossil fuel energy consumption (% of total)

The summary of the main findings for the Latin American and Caribbean panel are as follows:

1. Inflation has a statistically significant negative effect on economic growth in all the seven models;
2. Capital has a statistically significant positive effect on economic growth in all the seven models;
3. Trade openness has a statistically insignificant effect on economic growth in all the seven models;
4. Only growth rate of energy use per capita and total energy use is found to be statistically significant and positively correlated with economic growth; and

5. The remaining four energy type variables are found to be statistically insignificant but having positive effects on economic growth.

Table 5.4 contains results for the Sub-Saharan/North Africa and Middle East panel. The core variables (inflation, capital stock and trade openness), which are modelled in the previous three panels are retained here. The results show that these variables are statistically significant at one per cent level. It is found that inflation has a statistically significant negative effect while capital and trade openness have a statistically significant positive effect on economic growth of Sub-Saharan/North Africa and Middle East panel.

In models 2, 3 and 6, energy use per capita, total energy use and energy production are used—all in growth form—to proxy energy. The results show that these energy type variables are statistically insignificant but all have positive effects on economic growth of Middle East and African panel. Trade openness is found to be statistically significant at 5 per cent, whereas inflation and capital growth remain statistically significant with the expected signs.

In models 4 and 5, the core variables are again found to be statistically significant (at one per cent). The energy variables used in models 4 and 5 are the growth rates of electric power consumption and electricity production, respectively. The results of these models are that these two energy types of variables are statistically insignificant and have negative effects on the economic growth.

The final model uses a different form of energy variable, namely the growth rate of fossil fuel energy consumption. The impact of this energy variable on economic growth of Middle East and African panel is positive and statistically significant at the five per cent level. The magnitude of 0.065 implies that a one per cent increase in the growth rate of fossil fuel energy consumption increases economic growth by 0.07 per cent. Again, the core variables are found to be statistically significant.

Another feature of these results that is worth highlighting is about the robustness of capital stock and trade openness in all seven models. It can be seen that the magnitude of capital and trade openness implies that the one per cent increase in the growth rate of capital and trade openness will increase economic growth by 0.1 and 0.05 per cent, respectively. The magnitudes of these variables are fairly consistent across all the seven models.

Table 5.4: Results for the Sub-Saharan/North Africa and Middle East panel for the period 1986-2005

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Inflation	-0.024* (0.000)	-0.023* (0.000)	-0.023* (0.000)	-0.024* (0.000)	-0.024* (0.000)	-0.024* (0.000)	-0.051* (0.000)
GFCF	0.107* (0.000)	0.103* (0.000)	0.104* (0.000)	0.107* (0.000)	0.107* (0.000)	0.106* (0.000)	0.103** (0.000)
Trade	0.058* (0.010)	0.0528** (0.023)	0.055** (0.020)	0.059* (0.009)	0.059* (0.009)	0.058** (0.011)	0.051* (0.009)
E1	-	0.072 (0.275)	-	-	-	-	-
E2	-	-	0.061 (0.375)	-	-	-	-
E3	-	-	-	-0.001 (0.984)	-	-	-
E4	-	-	-	-	-0.006 (0.885)	-	-
E5	-	-	-	-	-	0.004 (0.936)	-
E6	-	-	-	-	-	-	0.065** (0.049)

Source: Authors estimation based on EVIEWS

Notes: * (**) denotes statistical significance at the 1 per cent and 5 per cent levels, respectively. GFCE – gross fixed capital formation; E1 – Energy use (kg of oil equivalent per capita); E2 – Energy use (kt of oil equivalent); E3 – Electric power consumption (kWh); E4 – Electricity production (kWh); E5 – Energy production (kt of oil equivalent); E6 – Fossil fuel energy consumption (% of total)

The main findings for Sub-Saharan/North Africa and Middle East panel are as follows:

1. Inflation is statistically significant and it has a negative effect on economic growth in all seven models;

2. Capital stock and trade are found to have positive effects and are statistically significant in all seven models;
3. Except for fossil fuel energy consumption, the remaining five energy type variables are found to be statistically insignificant; and
4. Except for electric power consumption and electricity production, all the other energy type variables are found to have positive effects on economic growth, whereas electric power consumption and electricity production have negative effects.

Table 5.5 reports the results for the global panel. The result for global panel is significantly different from the various regional panels discussed earlier. The core model shows that inflation and capital stock are statistically significant and have negative and positive effects on economic growth, respectively. Trade openness has a positive impact on economic growth, but it is statistically insignificant.

In models 2 and 3, energy use per capita and total energy use are used to proxy energy. These two energy variables are found to be statistically significant at one per cent level and have positive effects on economic growth. In model 2, it can be noted that capital remains significant at the one per cent level, whereas inflation and trade openness are found to be statistically insignificant. Again in model 3, inflation is found to have a negative effect on economic growth and it is statistically insignificant. The other two core variables (namely, capital and trade openness) are found to be statistically significant at the one per cent and the five per cent levels, respectively, and both have positive effects on economic growth of the globe.

In models 4, 5 and 7, the pattern of results are very similar. Electric power consumption, electricity production and fossil fuel energy consumption, respectively, are used in these models. The growth rates of all these energy type variables are found to be statistically insignificant but all have positive effects on economic growth of the globe. Inflation and capital stock in all these three models are found to be statistically significant at the five per cent and the one per cent levels, respectively. Inflation has a negative effect on the economic growth, whereas capital stock has a positive impact on the economic growth of the globe. Trade openness has a positive effect on the economic growth but it is statistically insignificant in all these three models.

In model 6, energy production is used to proxy energy and the results show that this variable has a positive effect on economic growth and is statistically significant at the five per cent level. Only capital is statistically significant in this model, whereas inflation and trade openness are found to be statistically insignificant, although capital and trade openness have positive effects on economic growth and inflation has a negative effect.

Table 5.5: Results for the Global Panel for the period 1986-2005

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Inflation	-0.003* (0.036)	-0.002 (0.164)	-0.003 (0.164)	-0.003** (0.043)	-0.003** (0.034)	-0.003 (0.101)	-0.003** (0.039)
GFCF	0.163* (0.000)	0.142* (0.000)	0.140* (0.000)	0.158* (0.000)	0.163* (0.000)	0.159* (0.000)	0.161* (0.000)
Trade	0.019 (0.137)	0.023 (0.165)	0.026** (0.045)	0.021 (0.115)	0.019 (0.132)	0.018 (0.186)	0.019 (0.129)
E1	-	0.209* (0.000)	-	-	-	-	-
E2	-	-	0.223* (0.000)	-	-	-	-
E3	-	-	-	0.043 (0.621)	-	-	-
E4	-	-	-	-	0.011 (0.765)	-	-
E5	-	-	-	-	-	0.112** (0.010)	-
E6	-	-	-	-	-	-	0.054 (0.129)

Source: Authors estimation based on EVIEWS

Notes: * (**) denotes statistical significance at the 1 per cent and 5 per cent levels, respectively. GFCE – gross fixed capital formation; E1 – Energy use (kg of oil equivalent per capita); E2 – Energy use (kt of oil equivalent); E3 – Electric power consumption (kWh); E4 – Electricity production (kWh); E5 – Energy production (kt of oil equivalent); E6 – Fossil fuel energy consumption (% of total)

In sum, the main findings from the global panel of economic growth are as follows:

1. Only capital has a robust effect on economic growth in that it is positive and statistically significant across all the seven models;
2. While inflation has a negative sign in all the seven models, it is statistically significant in only four of the models;
3. Trade openness has a positive effect on economic growth in all the seven models but it is statistically significant in only one of the models, hence its relationship with economic growth is surprisingly not robust; and
4. In terms of the impact of energy variables on economic growth, electricity type variables are statistically insignificant while non-electricity type variables are statistically significant and have positive effects on economic growth.

5.3 SUMMARY OF THE MAIN FINDINGS

Across all panels, it was found that electricity production and electric power consumption are only statistically significant in East/South Asia and the Pacific panel; no other panel revealed this significance except for Europe and Central Asian panel where only electric power consumption is found to be statistically significant at the one per cent level. Another observation that is made about East/South Asian and the Pacific panel is that apart from the electricity variable, no other energy type variable is statistically significant.

Energy use per capita and total energy use are statistically significant in most of the panels. These two energy variables are significant in the European and the Central Asian panel, the Latin American and the Caribbean panel, and also in the global panel. Basically, this means that apart from other energy variables used to proxy energy in this study, energy use has a very strong impact on the economic growth.

Fossil fuel energy consumption seems to have very weak impact on economic growth of all panels except for Sub-Saharan/North Africa and Middle East panel where this variable is found to be statistically significant. Furthermore, there is no such energy variable in this study that has a negative impact on economic growth in any particular panel. The impact is always found to be positive regardless of the significance of these variables.

Table 5.6: Summary of the impact of energy variables on economic growth.

Panel	Statistically Significant Energy Variables
East/South Asia and the Pacific	E3, E4
Europe and Central Asian	E1, E2, E3, E5
Latin American and Caribbean	E1, E2
Sub-Saharan/North Africa and Middle East	E6
Global	E1, E2, E5

Note: E1 – Energy use (kg of oil equivalent per capita); E2 – Energy use (kt of oil equivalent); E3 – Electric power consumption (kWh); E4 – Electricity production (kWh); E5 – Energy production (kt of oil equivalent); E6 – Fossil fuel energy consumption (% of total)

Furthermore, the results of the core variables (namely, inflation, GFCF, and trade openness) show that Inflation is statistically significant and has negative impact on economic growth for all regional panels, except for Europe and Central Asian panel where inflation is found to be statistically insignificant and it has positive impact on economic growth. In the global panel, inflation is found to be statistically significant for four out of seven models, and it has negative impact on economic growth. Capital stock is found to be statistically significant and it has a positive impact on economic growth in all the four regional panels and also in the global panel. Trade openness has a positive impact on economic growth of all the panels except for the East/South Asia and the Pacific panel where the impact is found to be negative. In addition, trade openness is only statistically significant in Europe and Central region and Sub-Saharan/North Africa and Middle East region. In other three panels, trade openness is statistically insignificant.

In Chapter 2, the literature reviewed 54 papers on the relationship between energy and economic growth for individual countries as well as panels of countries. From this literature review, it was noted that studies examining the relationship between the electricity variable and economic growth are mainly done for Asian countries and the results show that out of 18 studies, 11 studies found that causality runs from electricity to economic growth (where GDP is taken as a proxy for the economic growth) (see Table 5.7). Comparatively, this study also shows that electricity is statistically significant in the Asian panel. In addition to Asian countries, the literature review revealed that there were studies on this relationship for seven other panels and they also mostly found that electricity was statistically significantly related to economic growth.

Table 5.7: Summary of electricity-GDP based studies for chapter 2

Regions	Total number of studies done	Number of studies show statistically significant relationship
East/South Asia & Pacific	18	11
Europe and Central Asian	1	1
Latin American and Caribbean	0	0
Middle East and North/sub-Saharan Africa	2	1
North American	2	2
Mixed countries from different regions	2	2

Source: Author's calculation based on 54 articles reviewed in chapter 2.

From altogether 54 studies that have been reviewed in Chapter 2, 29 studies are on the relationship between energy and economic growth, where non-electricity type energy variables are used to proxy energy. From these 29 studies, 22 studies find that energy type variables strongly influence the economic growth in general.

From this study, it seems that non-electricity type variables have a greater influence on economic growth compared with electricity variables. For example, in the models this study estimated, the results reveal that when electricity variables are used, in only 30 per cent of the cases, electricity appears to have a statistically significant relationship with economic growth. On the other hand, when non-electricity type variables are used, it is found that in 45 per cent of the cases, these variables exert a statistically significant effect on economic growth.

5.4 CONCLUSION

This Chapter focused on the empirical findings and the methodology of this study. The results are discussed in detail and are presented in tabular form for various regional panels and for the globe. This study also compared findings with the literature. The key findings were highlighted.

The next chapter will conclude this study and will also discuss some policy implications and recommendations for further research.

CHAPTER 6
CONCLUSION AND POLICY IMPLICATIONS

6.0 INTRODUCTION

In this chapter, the entire work will be concluded and it will discuss how this study can help in policy making. In this thesis, the Arellano and Bond (AB, 1991) Generalised Method of Moments (GMM) estimator is used to examine the relationship between energy and economic growth. The main focus of this study has been on: (1) the impact of electricity on economic growth and (2) the impact of non-electricity energy type variables on economic growth. A dynamic panel data model specification is used and six energy type variables together with core explanatory variables (GFCF, trade openness, and inflation) to model economic growth. The panel consists of 66 countries, and the countries lead to a classification of four different regions, apart from the global panel consisting of 66 countries.

The rest of the chapter is organized as follows: the next section discusses the main findings of this study. Section 6.2 discusses policy implications of this study and the final section provides recommendations for further research.

6.1 MAIN FINDINGS

There are altogether six energy type variables (all in growth form) that are used to proxy energy in this study. These energy variables are examined in each of the four regions and for the globe as a whole. In East/South Asian and the Pacific region, it is found that only electric power consumption and electricity production is statistically significant and no other non-electricity type energy variables are statistically significant in this region.

Out of all four regions, it is found that in Europe and Central Asian region there is a very strong impact of energy on economic growth. Out of six energy type variables, four (namely, total energy use; energy use per capita; electric power consumption and energy production) are found to be statistically significant. Energy production is also found to be statistically significant for the global panel.

Electric power consumption is found to be only statistically significant in the Asian and the Pacific region, whereas in other regions electricity is statistically insignificant. Again, total energy use and energy use per capita is found to be statistically significant in Latin America and Caribbean region and also in the global panel. Fossil fuel energy consumption is only found to be statistically significant in Sub-Saharan/North Africa and Middle East region, which implies that fossil fuel energy consumption have a very weak impact on economic growth in all other four regions of the globe.

In addition, it is found that all six energy variables have positive impacts on economic growth regardless of their significance. There is no such variable that has a negative impact on the economic growth in any of the five panels. From this study, it can be also seen that non-electricity type energy variables have stronger impact on economic growth compared with electricity.

Furthermore, inflation is found to be statistically significant in East/South Asian and the Pacific region, Latin America and Caribbean region and Sub-Saharan/North Africa and Middle East region and also it is been found that inflation has negative impact on economic growth of all the regions and the globe as a whole except for Europe and Central Asian region. Capital stock is found to be statistically significant and it has positive impacts in all the regions and also in the global panel. Trade openness is statistically significant only in Europe and Central Asian region and Sub-Saharan/North Africa and Middle East region. Except for East/South Asian and the Pacific region, trade openness has positive impacts on economic growth of all the other regions and also the globe.

6.2 POLICY DISCUSSIONS

The policy implication that results from this study is based on the results of each region. For example, for the East/South Asian and the Pacific region, only electricity variables are found to be statistically significant. This implies that if electricity conservation policies are implemented in this region, then they will have a negative impact on economic growth of this region. Since the non-electricity energy type variables are insignificant in this region, it is wise to enforce the energy conservation policies here. The enforcement of energy conservation policy in this region will have no effect on the economic growth of the East/South Asian and the Pacific region. This policy will positively help this region to save energy and make efficient use of it as energy is one of the major source for goods and services production.

Europe and Central Asian regions economic growth is found to be significantly affected by energy. The result of this region shows that four out of six energy type variables are statistically significant in this region. Out of those four statistically significant energy variables, three are of non-electricity type and the fourth one is electric power consumption which implies that both electricity and non-electricity type energy variables have strong impacts on economic growth of Europe and Central Asian region. It is wise that neither energy conservation policy nor electricity conservation policy should be enforced in this region if the objective is to maximize economic growth because energy conservation policies will reduce the energy consumption and it will have a negative impact on the economic growth.

In Latin America and Caribbean region, it is wise to implement electricity conservation policies but not energy conservation policies as in this region it is found that non-electricity type variables are found to be statistically significant. Energy conservation policies will reduce the energy consumption of this region and it will have a negative impact on economic growth, whereas electricity conservation has no impact on the economic growth. In addition, Sub-Saharan and Caribbean region is found to performing very weakly as except for fossil fuel energy consumption none other energy variables have an impact on economic growth. In this region, both the electricity conservation policies and the energy conservation policies can be enforced without concern for economic growth. The enforcement of these two policies will not affect the economic growth enormously.

6.3 RECOMMENDATIONS FOR FURTHER RESEARCH

In this study, only the relationship between energy and the economic growth of a country is tested, which has formed the basis for further research and discussions for energy policies. But once we talk about energy, we need to consider our natural surroundings. If energy has a direct impact on economic growth, it does not mean that a country needs to keep increasing the consumption of energy, as this also creates problem for our environment. For instance, the emission of greenhouse gas is not only polluting our environment but it is also producing so many diseases and affecting the health of people and also destroying the natural habitat of the animals. Further research should, thus, consider the impact of energy on environment and health aspects of human beings.

Furthermore, it would be wise to explore for the short-run and long-run relationship between energy and economic growth for each region and also for the global panel. This hypothesis can be tested using asymmetric cointegration and panel cointegration techniques. It can be also further analysed using the test for Granger causality either based on a vector autoregressive model or a vector error correction model. This will further enhance our understanding of the dependency between energy and economic growth of different regions and the globe as a whole.

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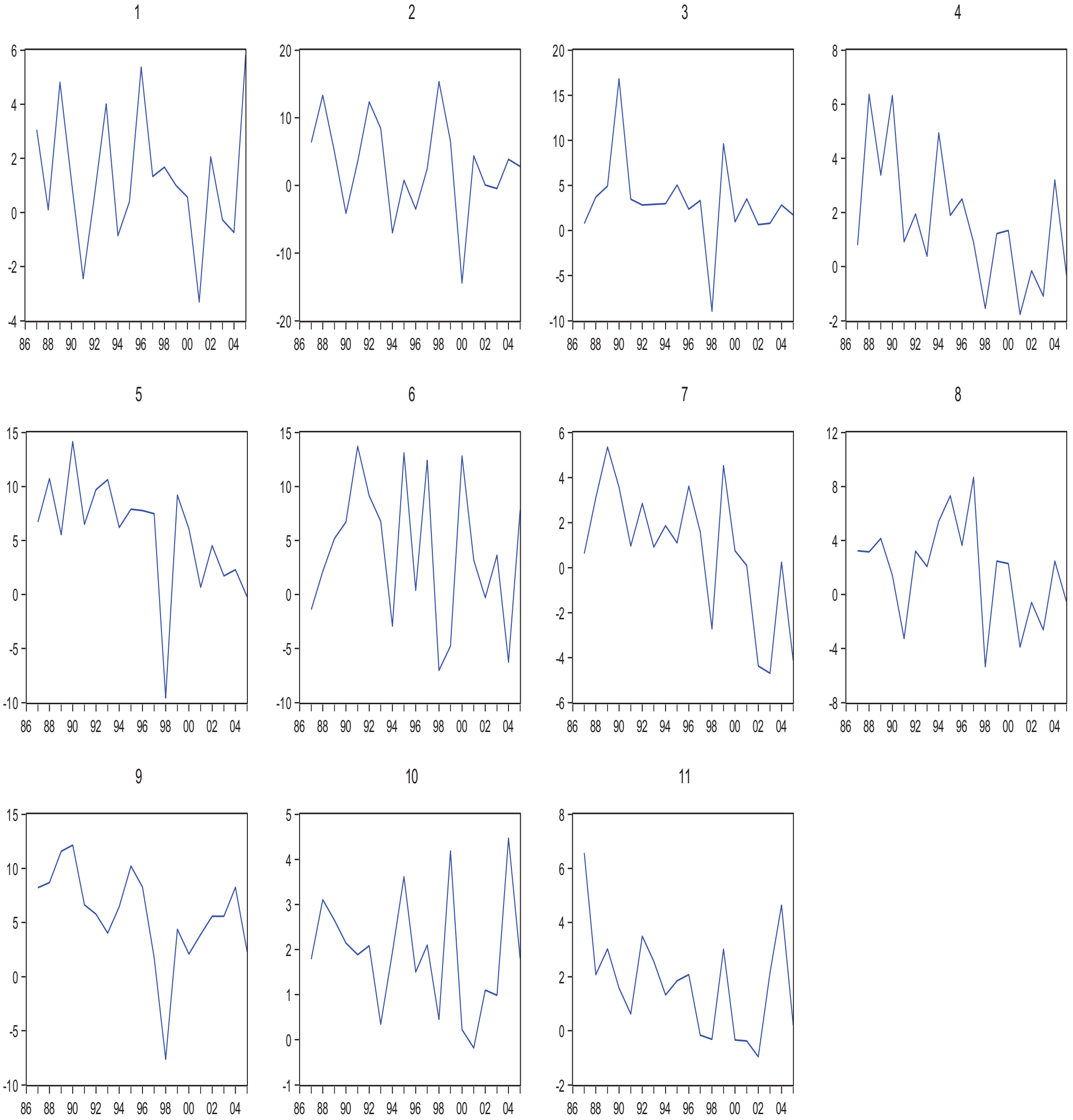
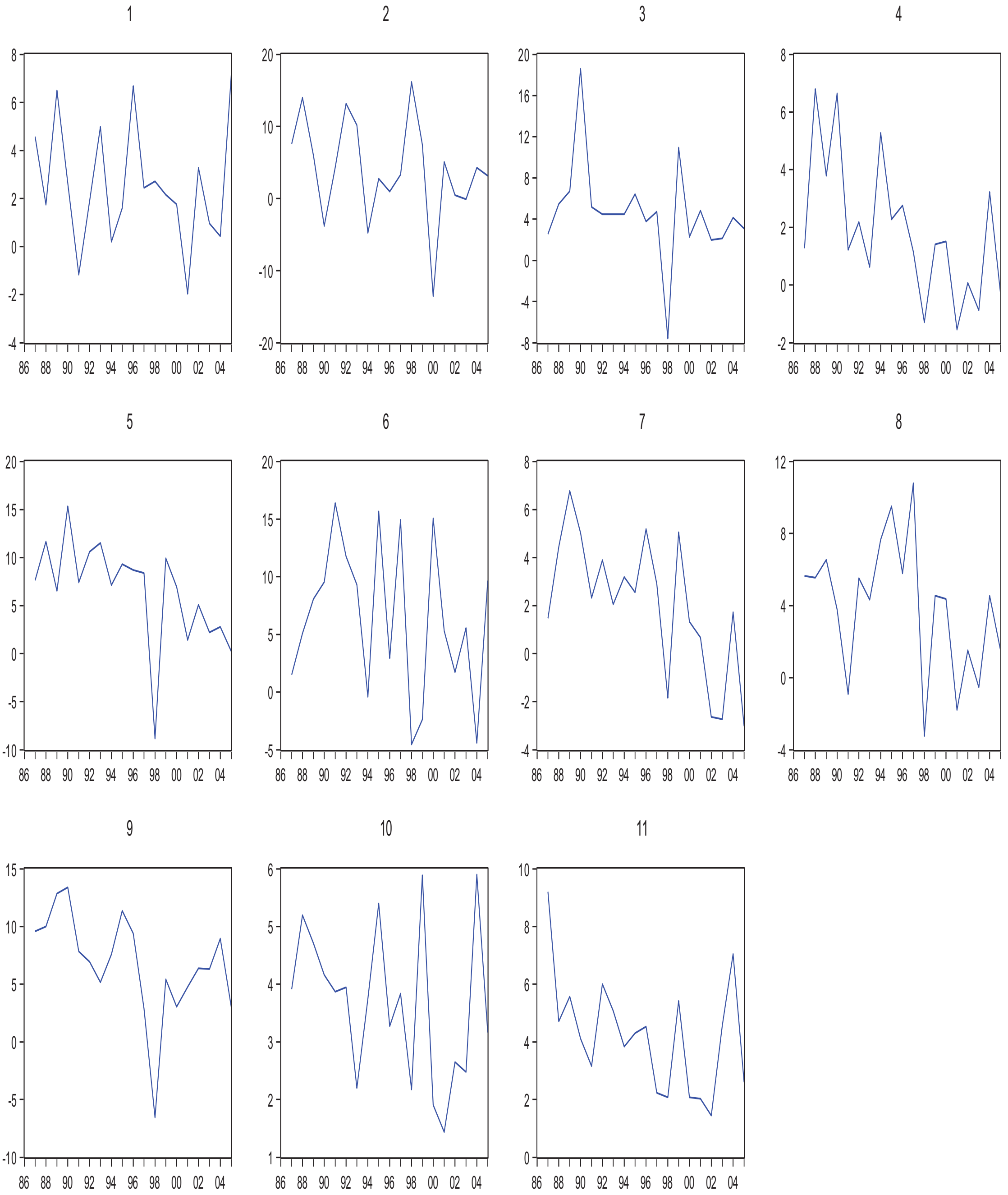
APENDIX

Plot of the growth rate of energy use (kg of oil equivalent per capita) for the East/South Asian and the Pacific panel



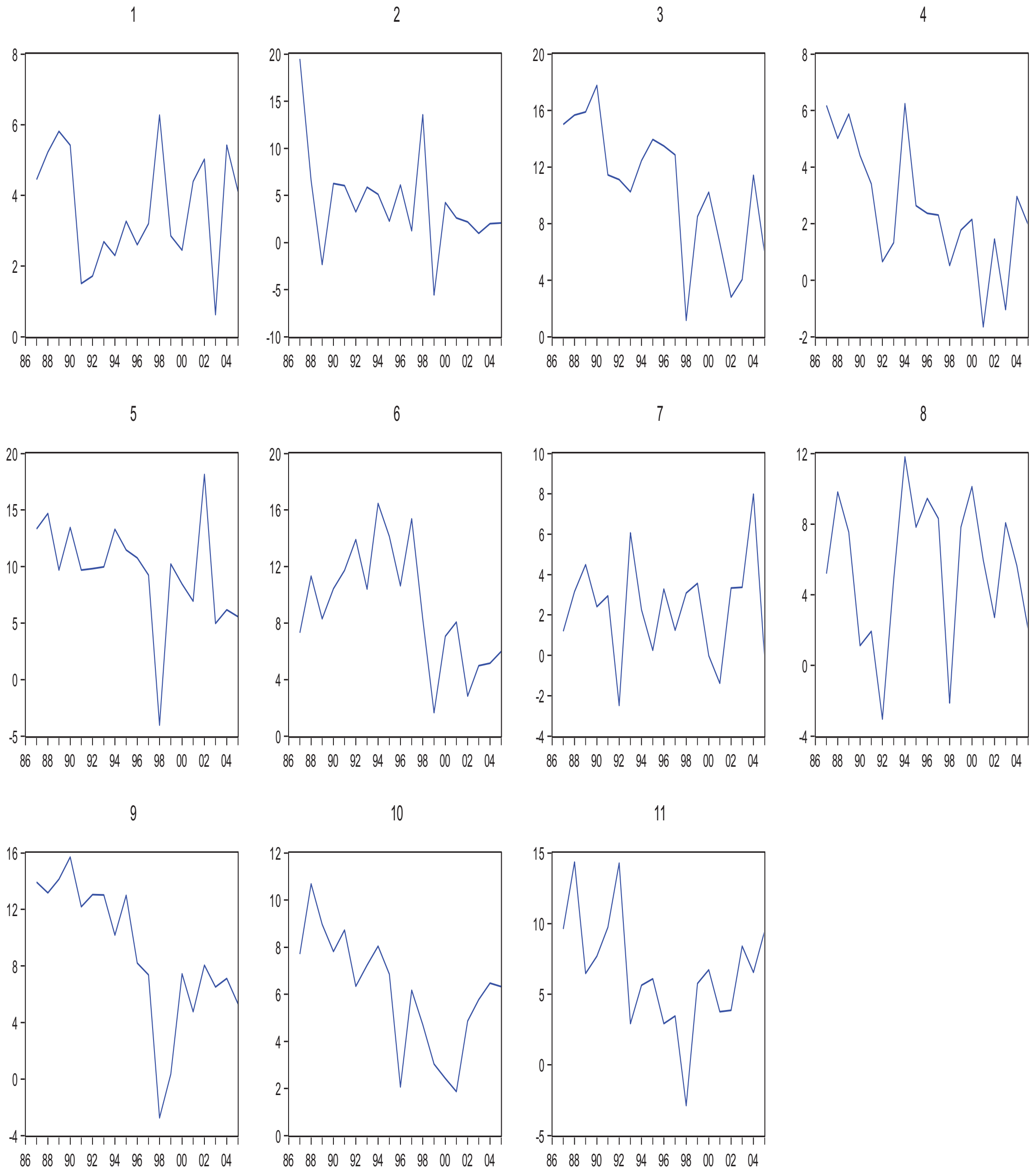
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the growth rate of energy use (kt of oil equivalent) for the East/South Asian and the Pacific panel



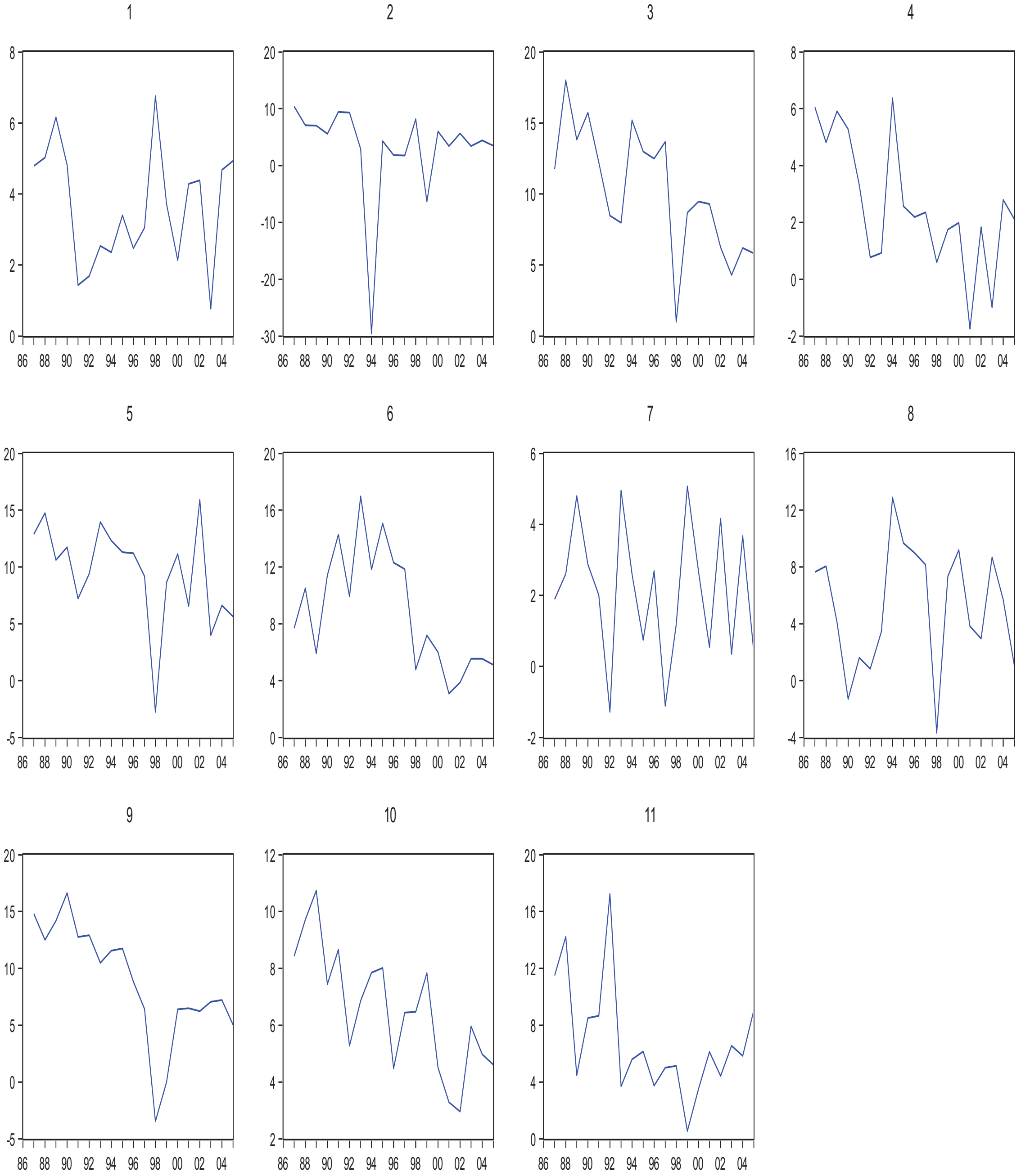
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the growth rate of Electric power consumption (kWh) for the East/South Asian and the Pacific panel



Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the growth rate of electricity production (kWh) for the East/South Asian and the Pacific panel



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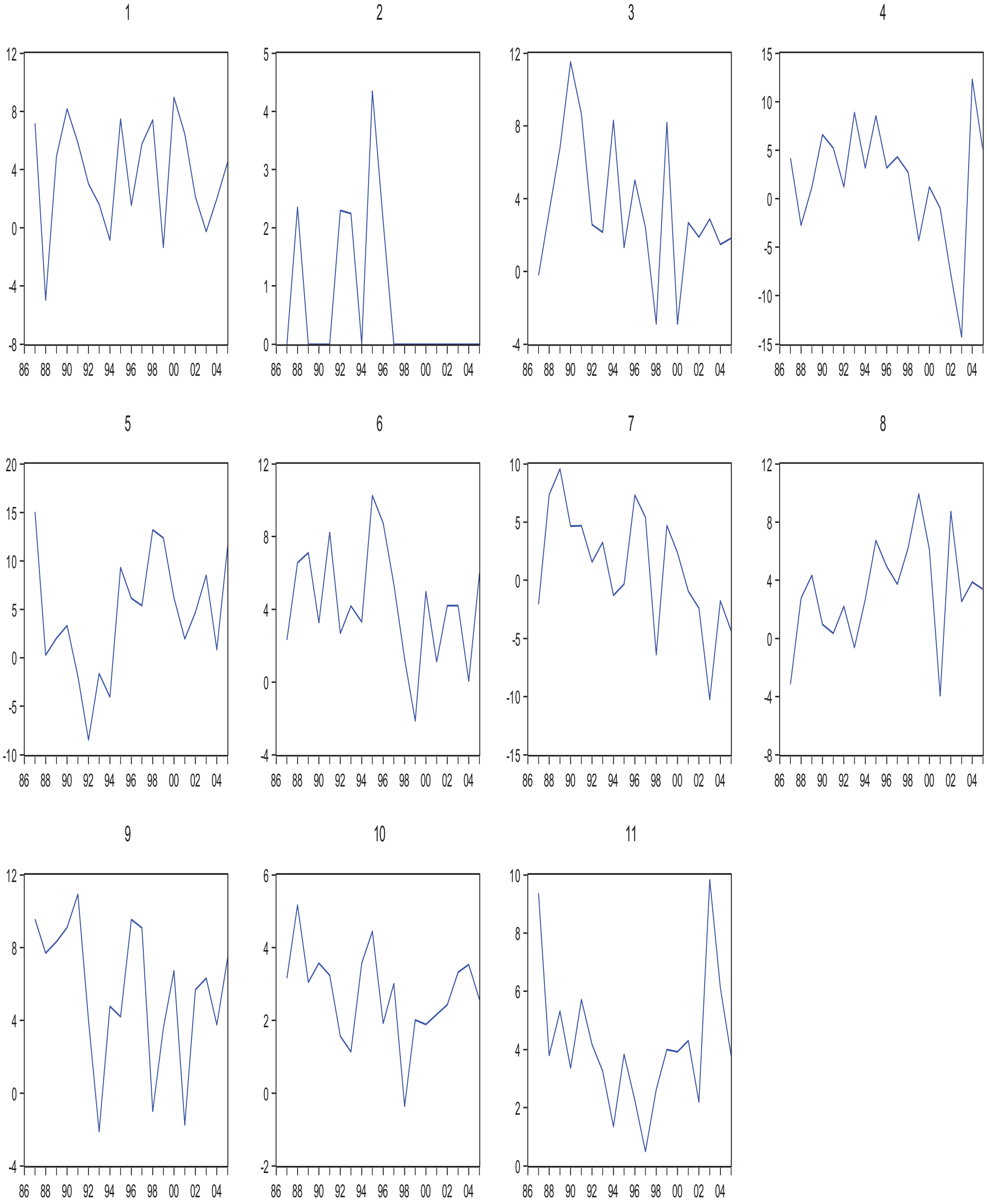
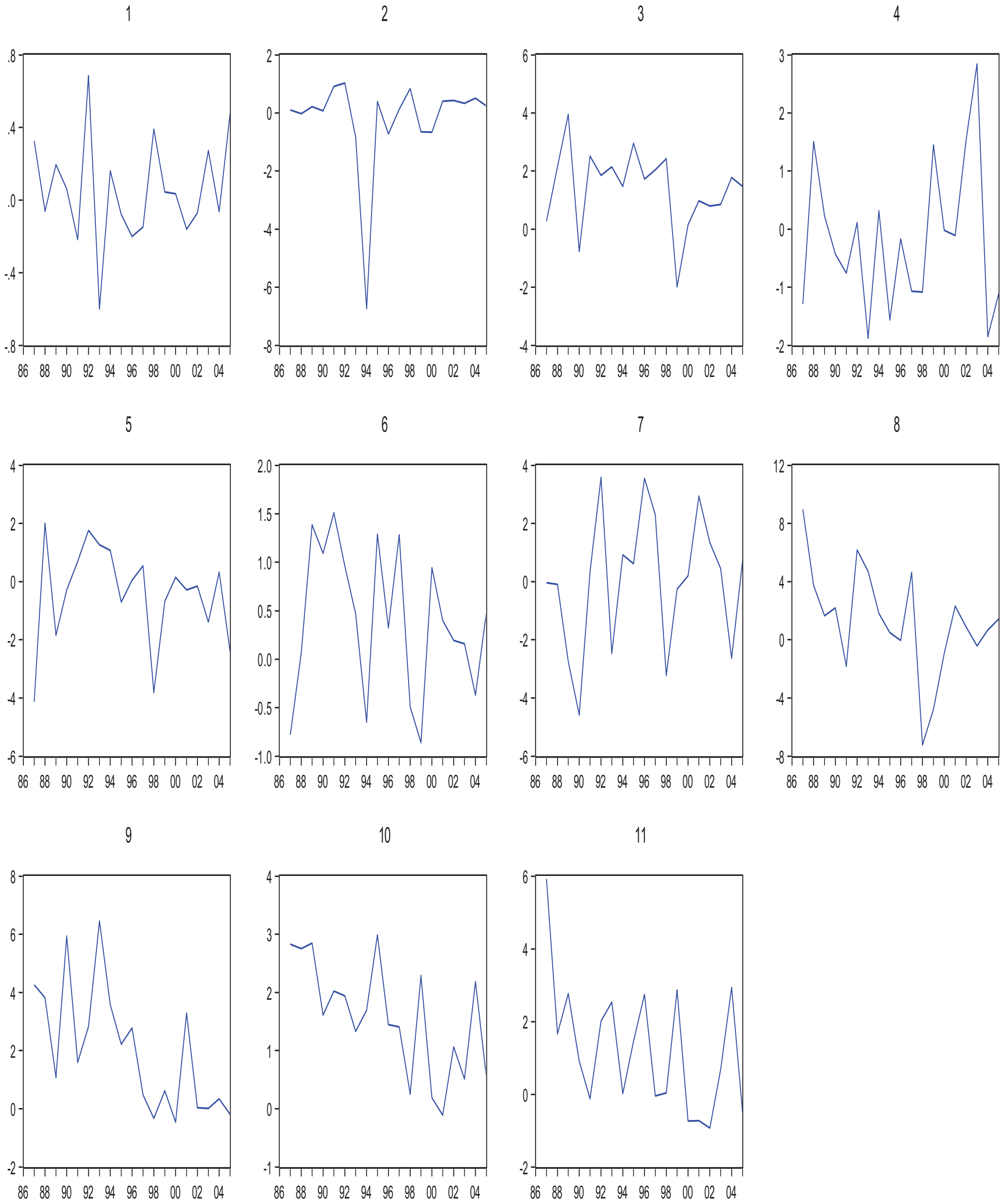
Plot of the growth rate of energy production (kt of oil equivalent) for the East/South Asian and the Pacific panel



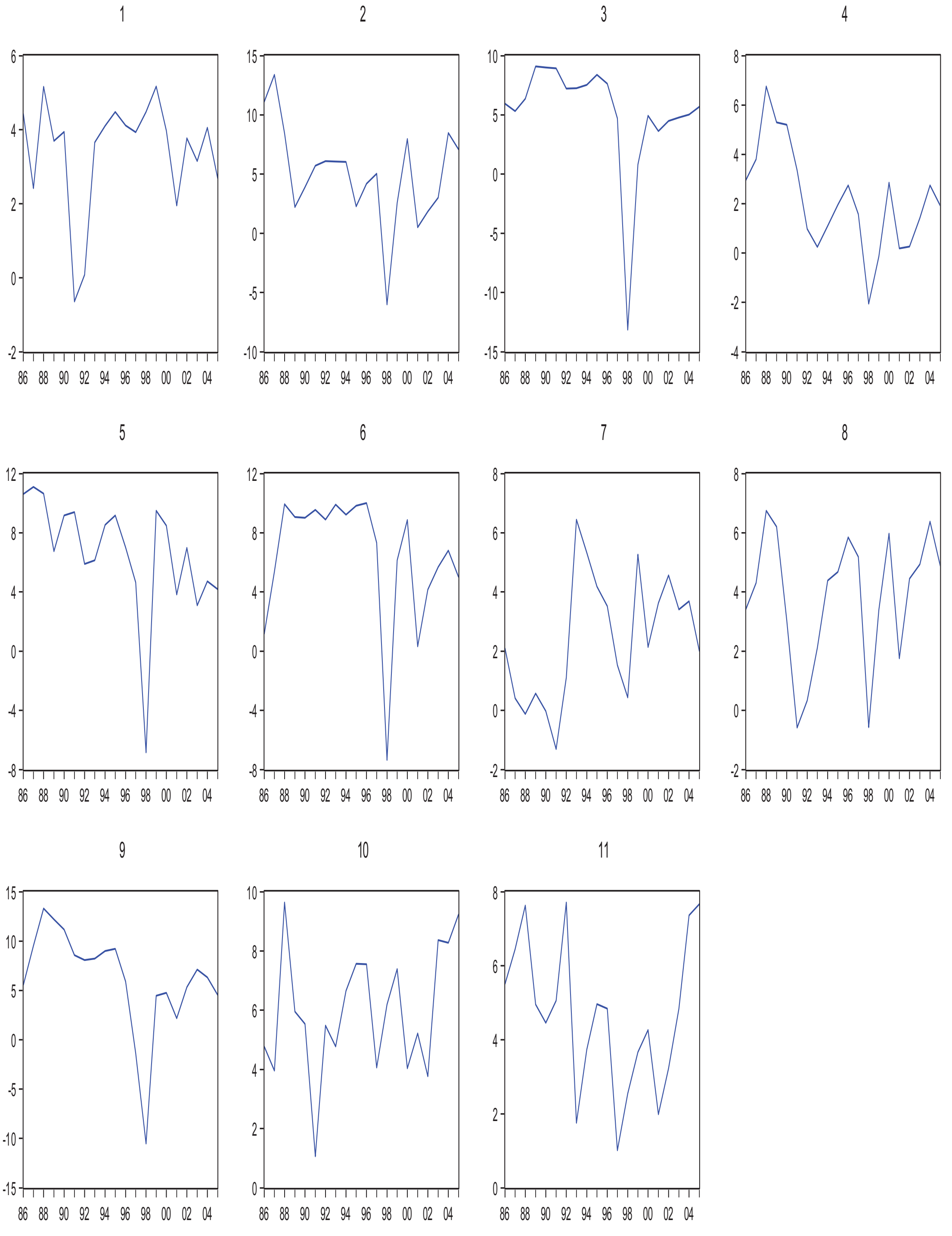
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the growth rate of fossil fuel energy consumption (percentage of total energy consumption) for the East/South Asian and the Pacific panel



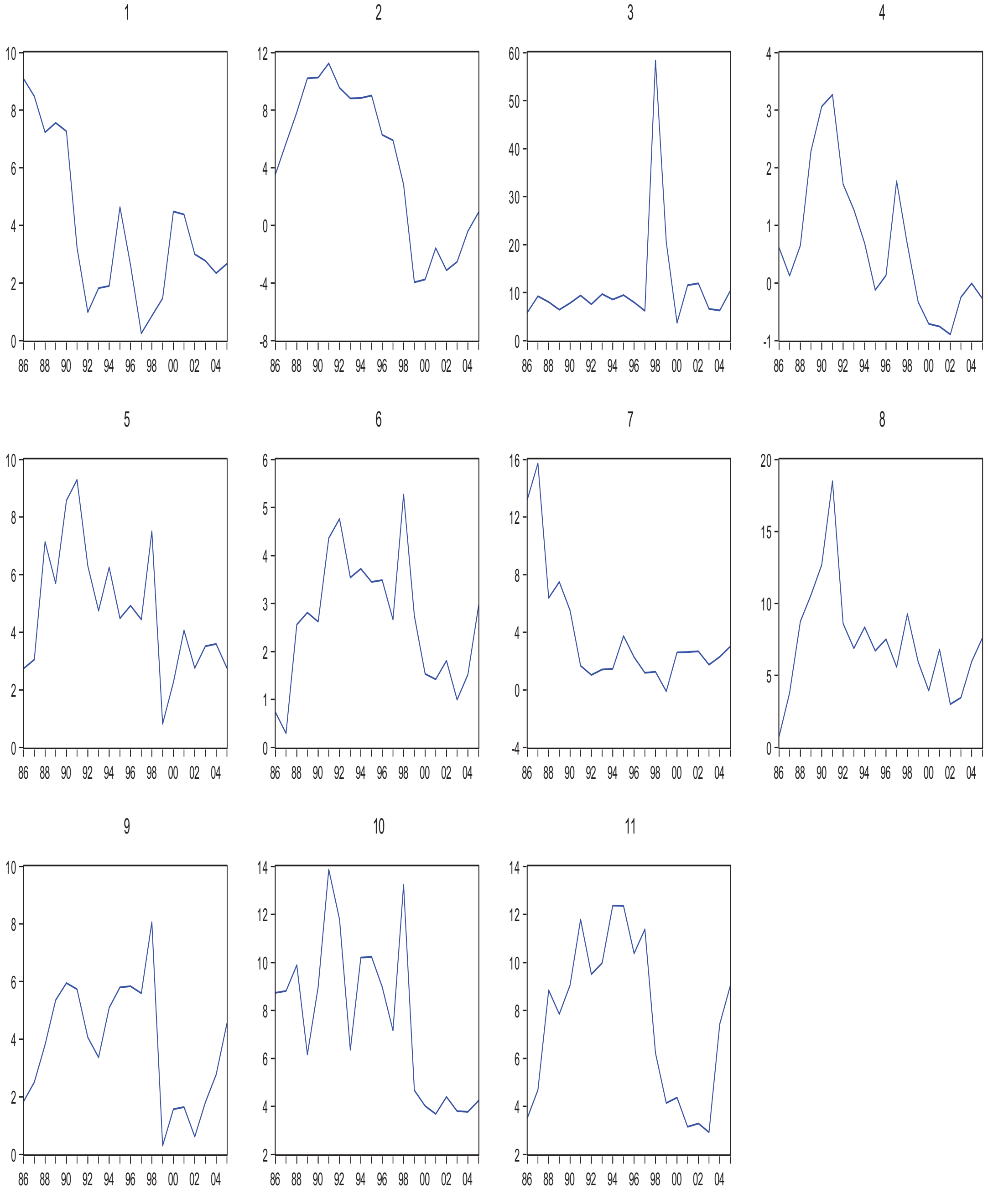
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the GDP growth rate for the East/South Asian and the Pacific panel



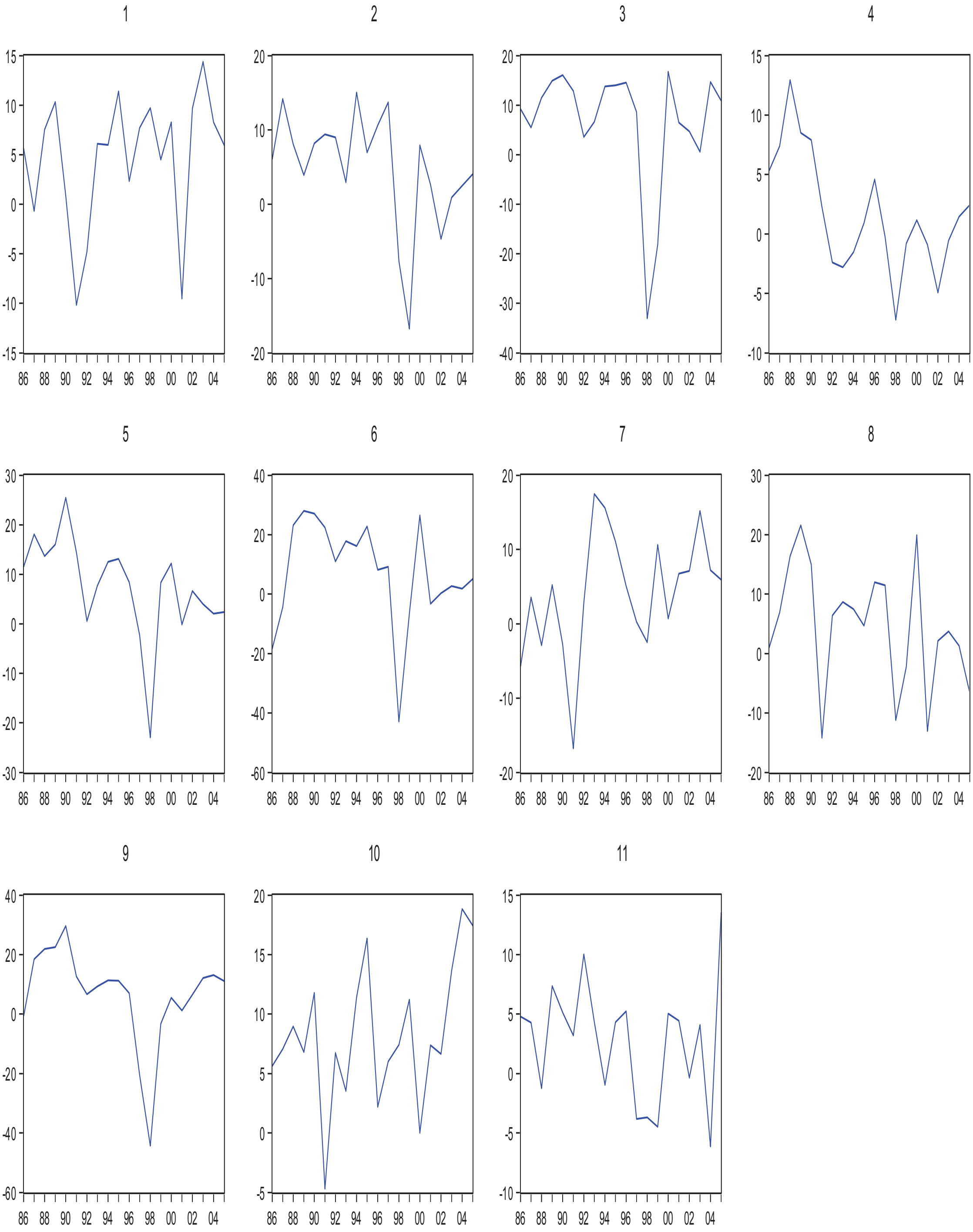
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the inflation rate for the East/South Asian and the Pacific panel



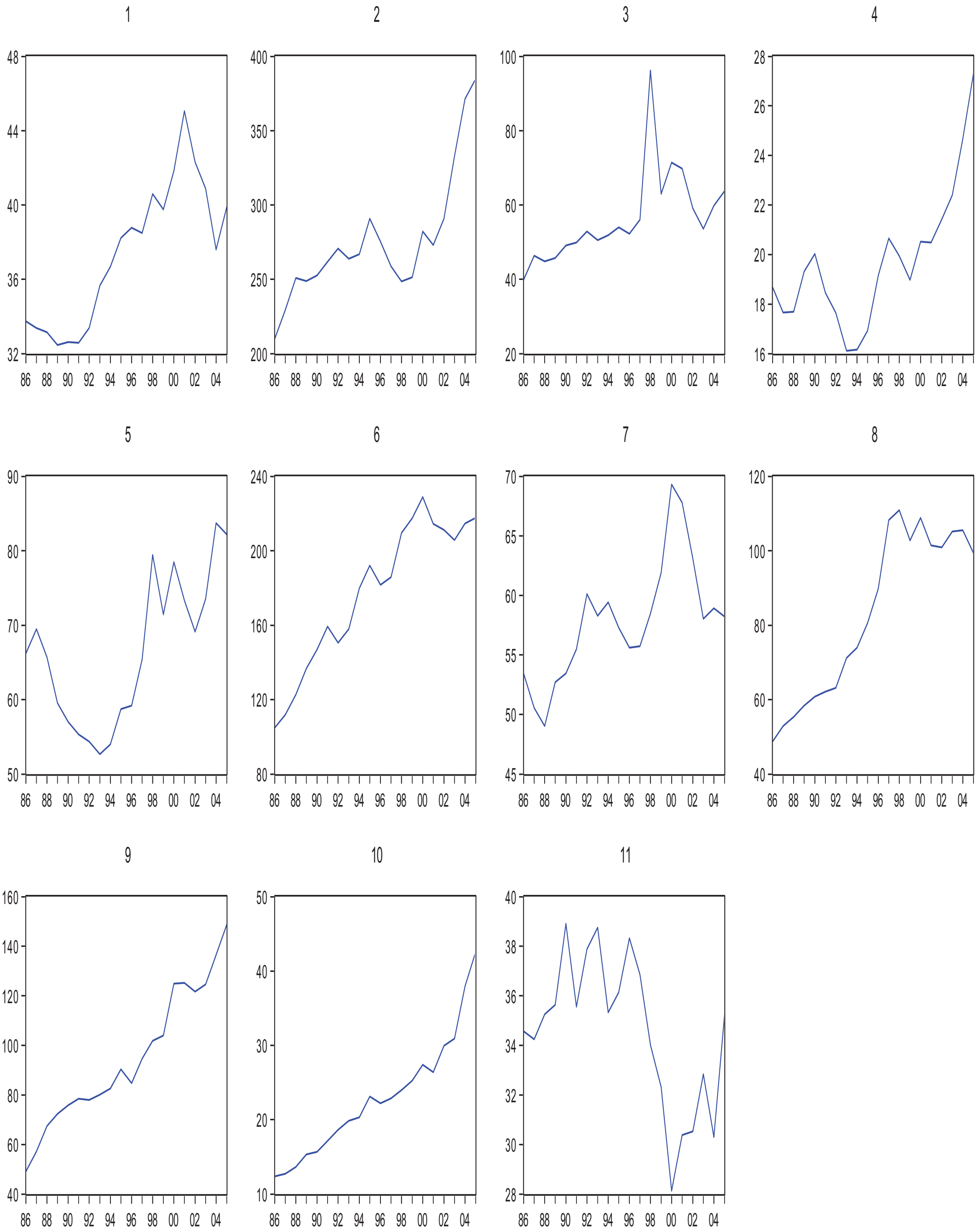
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the growth rate of GFCF for the East/South Asian and the Pacific Panel



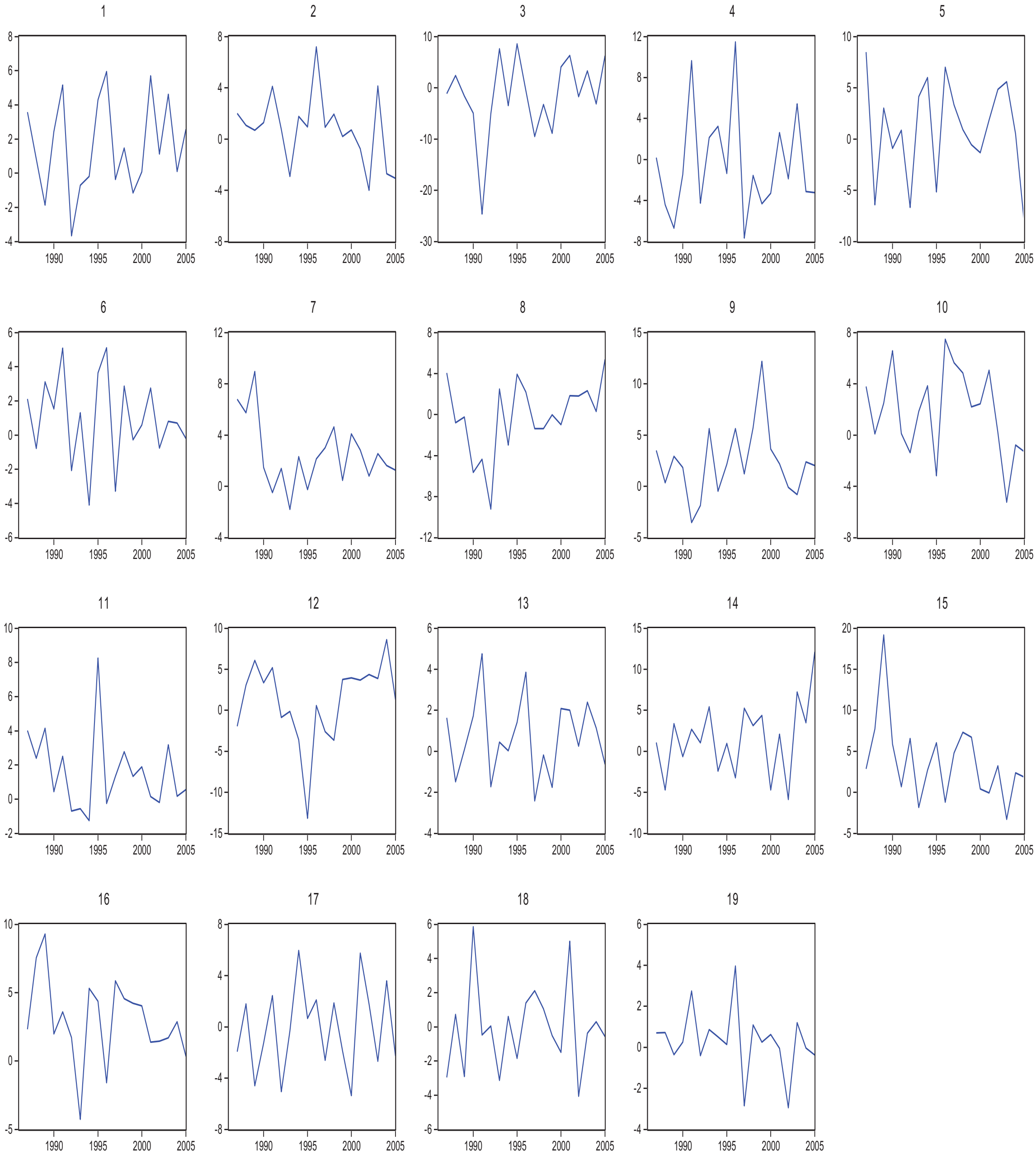
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of trade as a percentage of GDP for the East/South Asian and the Pacific panel



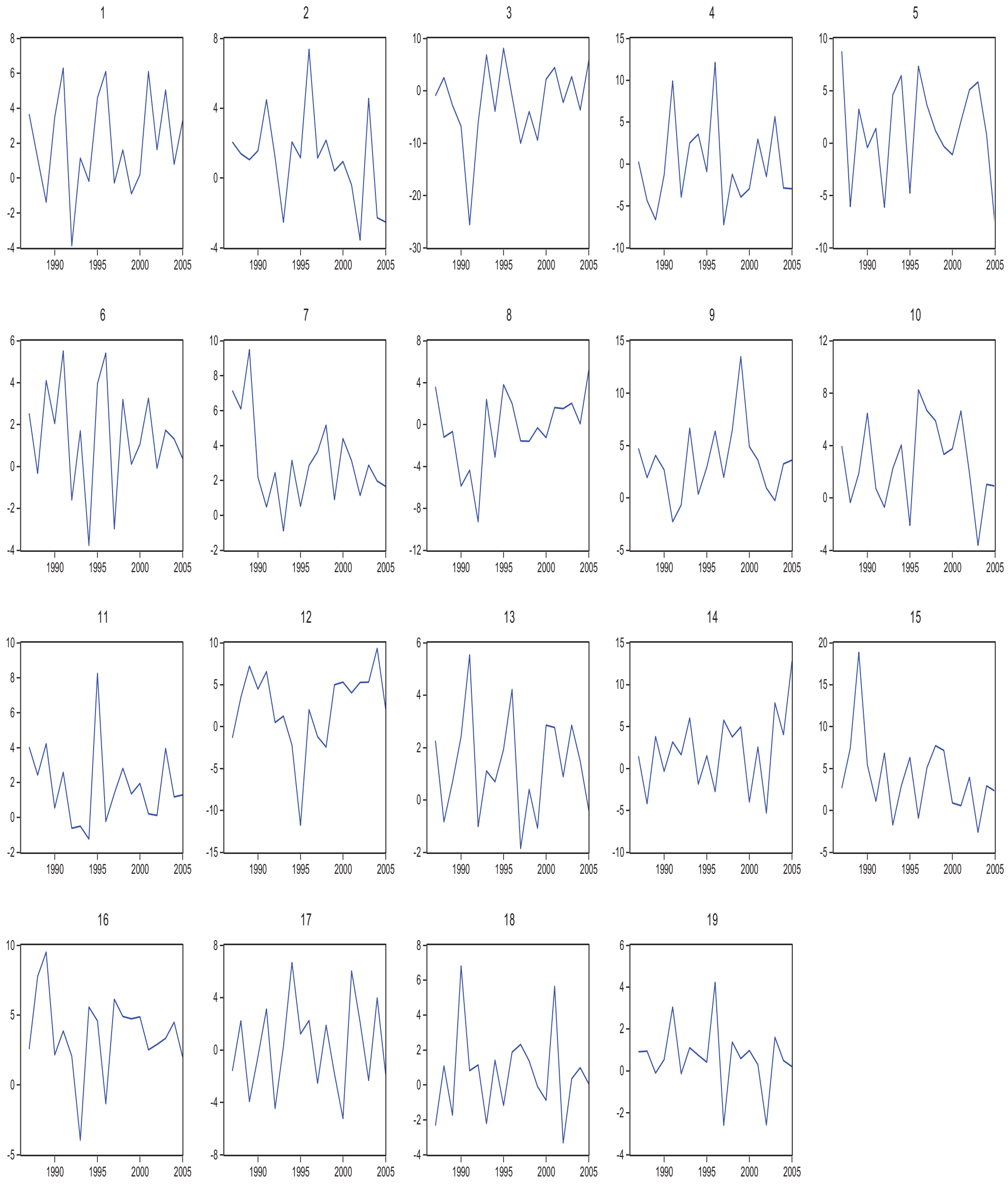
Notes: 1=Australia; 2=Hong Kong, China; 3=Indonesia; 4=Japan; 5=Korea, Rep.; 6=Malaysia; 7=New Zealand; 8=Philippines; 9=Thailand; 10=India; 11=Pakistan

Plot of the growth rate of energy use (kg of oil equivalent per capita) for the Europe and Central Asian panel



Notes: 1=Austria; 2=Belgium; 3=Bulgaria; 4=Denmark; 5=Finland; 6=France; 7=Greece; 8=Hungary; 9=Iceland; 10=Ireland; 11=Italy; 12=Luxembourg; 13=Netherlands; 14=Norway; 15=Portugal; 16=Spain; 17=Sweden; 18=Switzerland; 19=United Kingdom.

Plot of the growth rate of energy use (kt of oil equivalent) for the Europe and Central Asian panel



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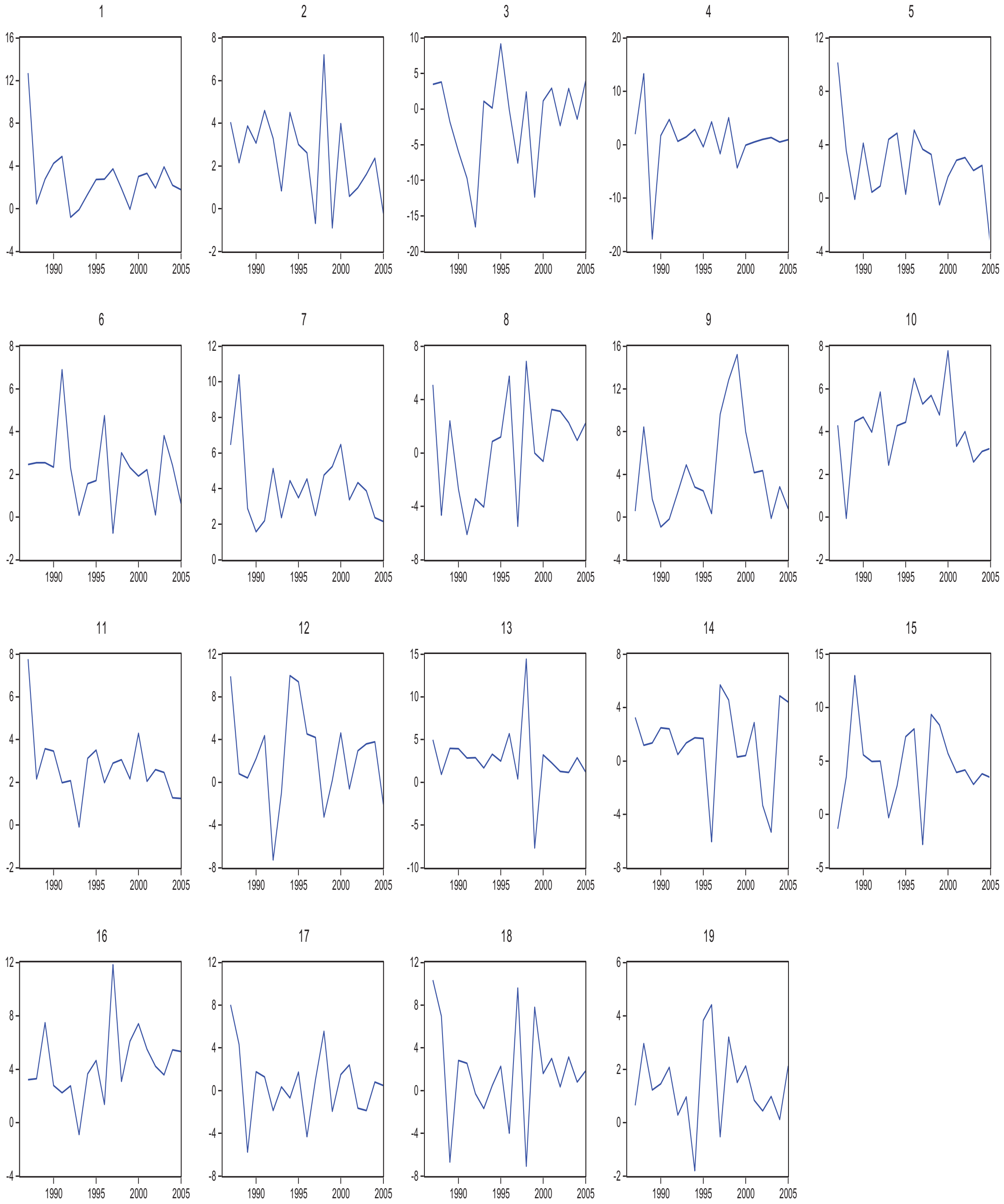
Plot of the growth rate of Electric power consumption (kWh) for the Europe and Central Asian panel



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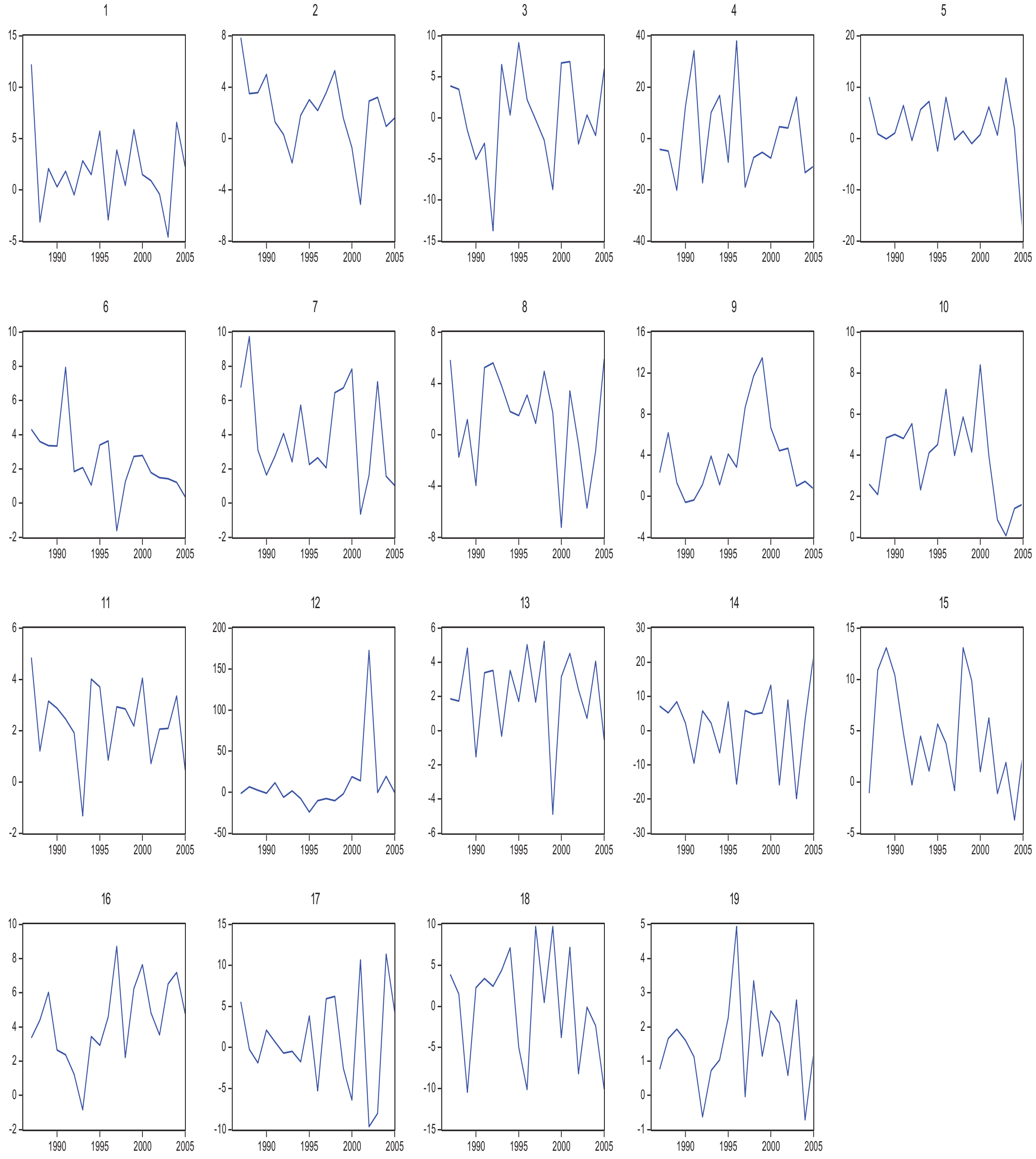
Plot of the growth rate of electricity production (kWh) for the Europe and Central Asian Panel



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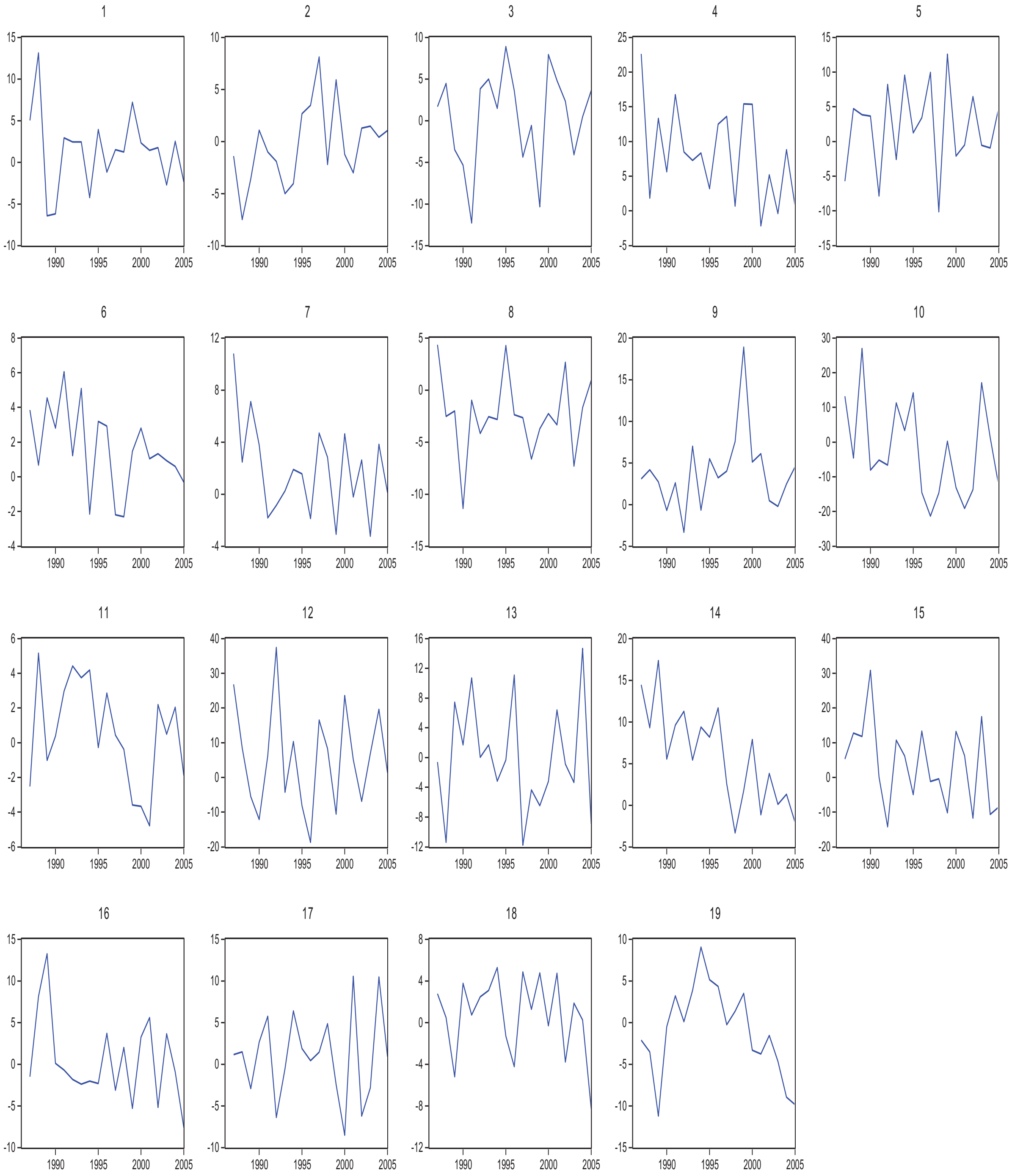
Plot of the growth rate of energy production (kt of oil equivalent) for the Europe and Central Asian Panel



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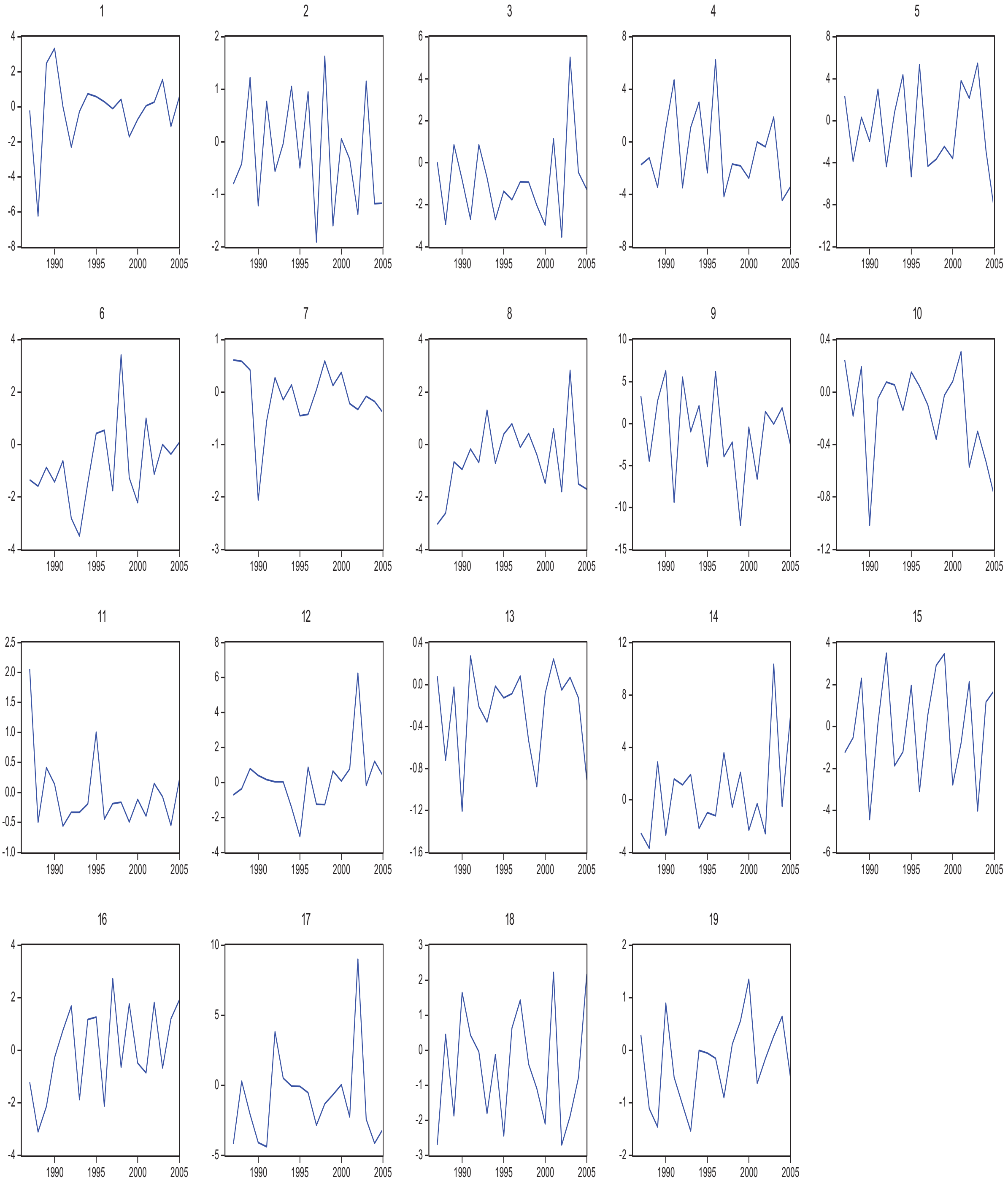
Plot of the growth rate of fossil fuel energy consumption (percentage of total energy consumption) for the Europe and Central Asian panel



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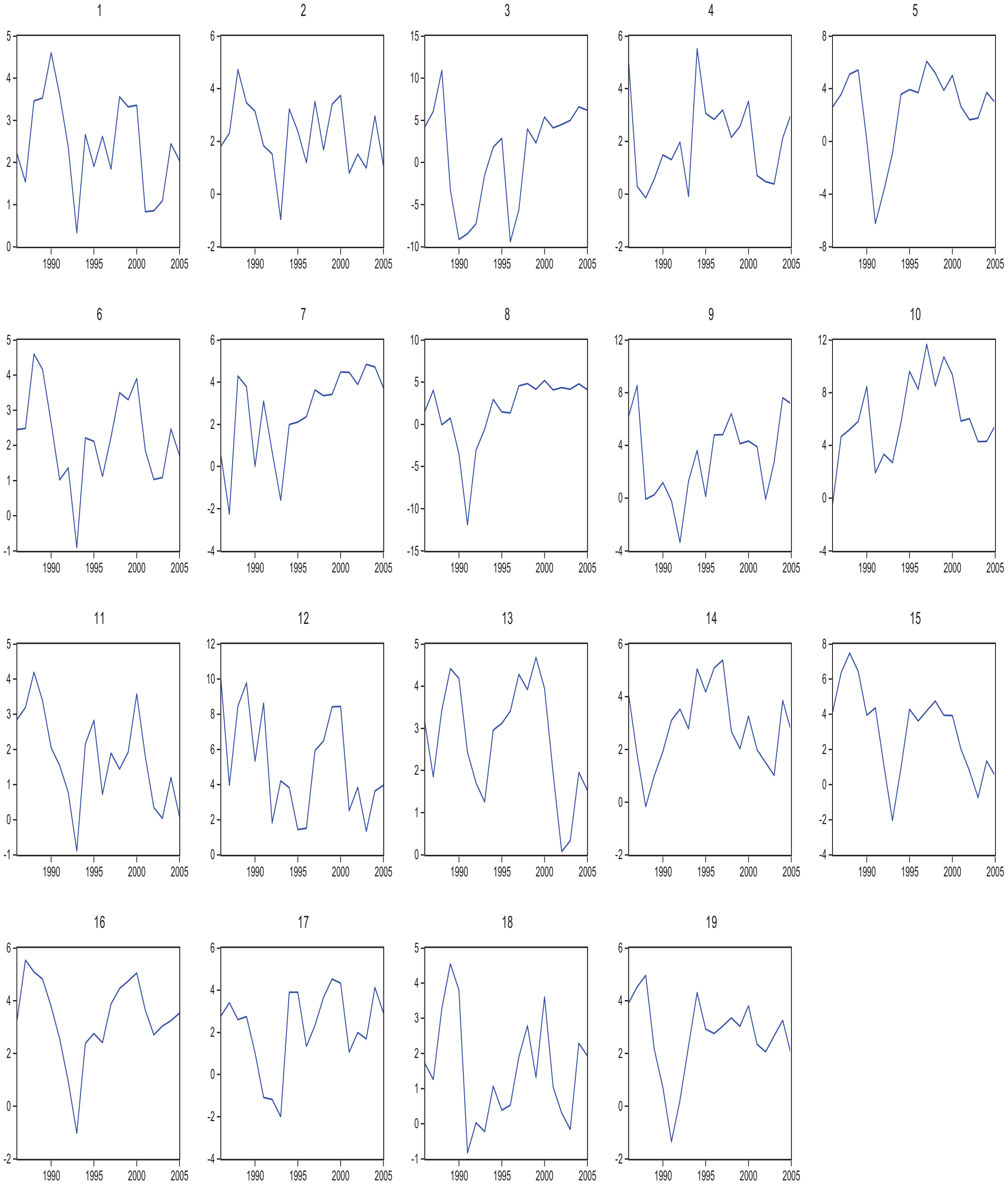
Plot of the GDP growth rate for the Europe and Central Asian panel



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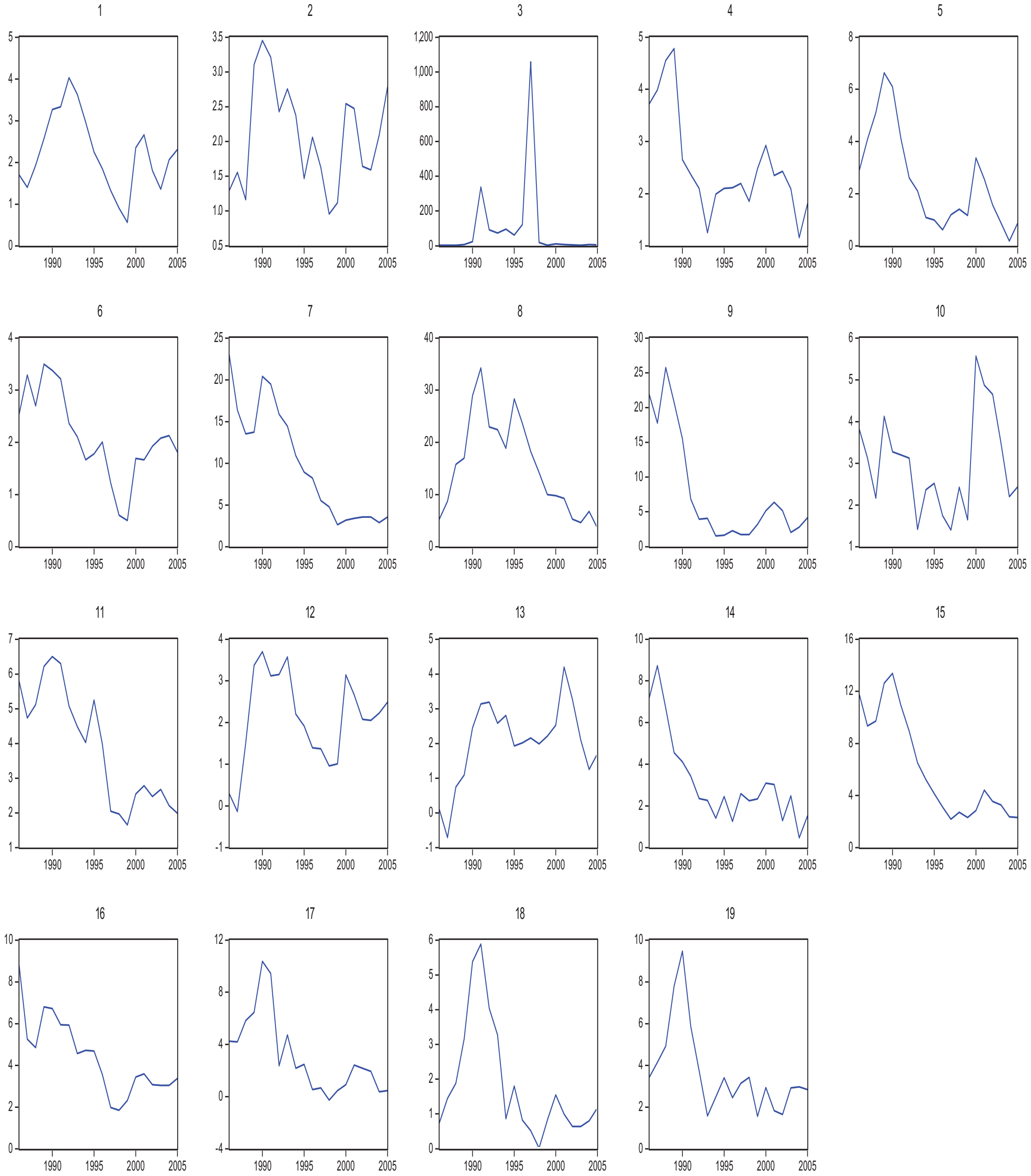
Plot of the inflation rate for the Europe and Central Asian panel



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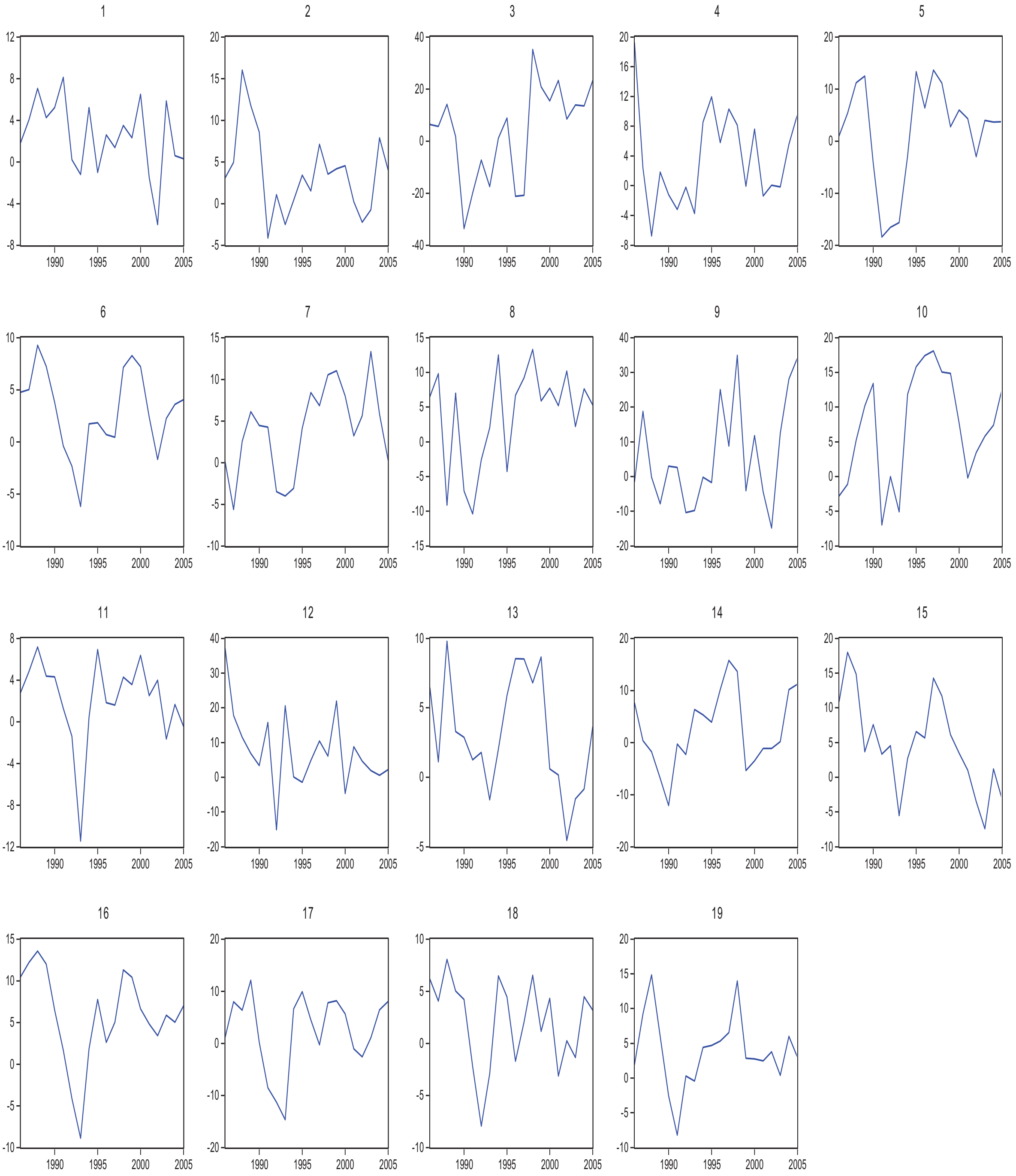
Plot of the growth rate of GFCF for the Europe and Central Asian panel



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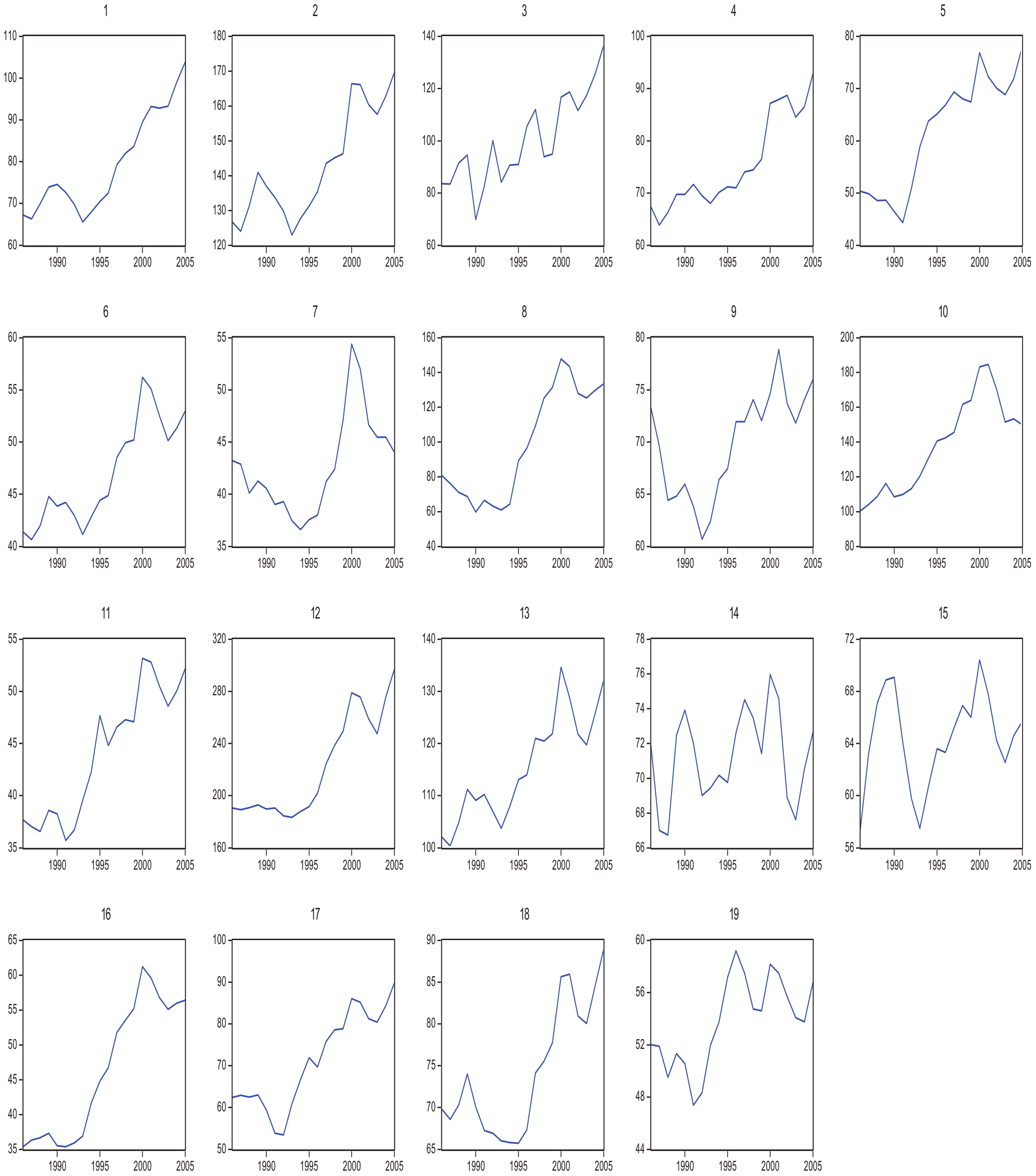
Plot of the trade as a percentage of GDP for the Europe and Central Asian panel



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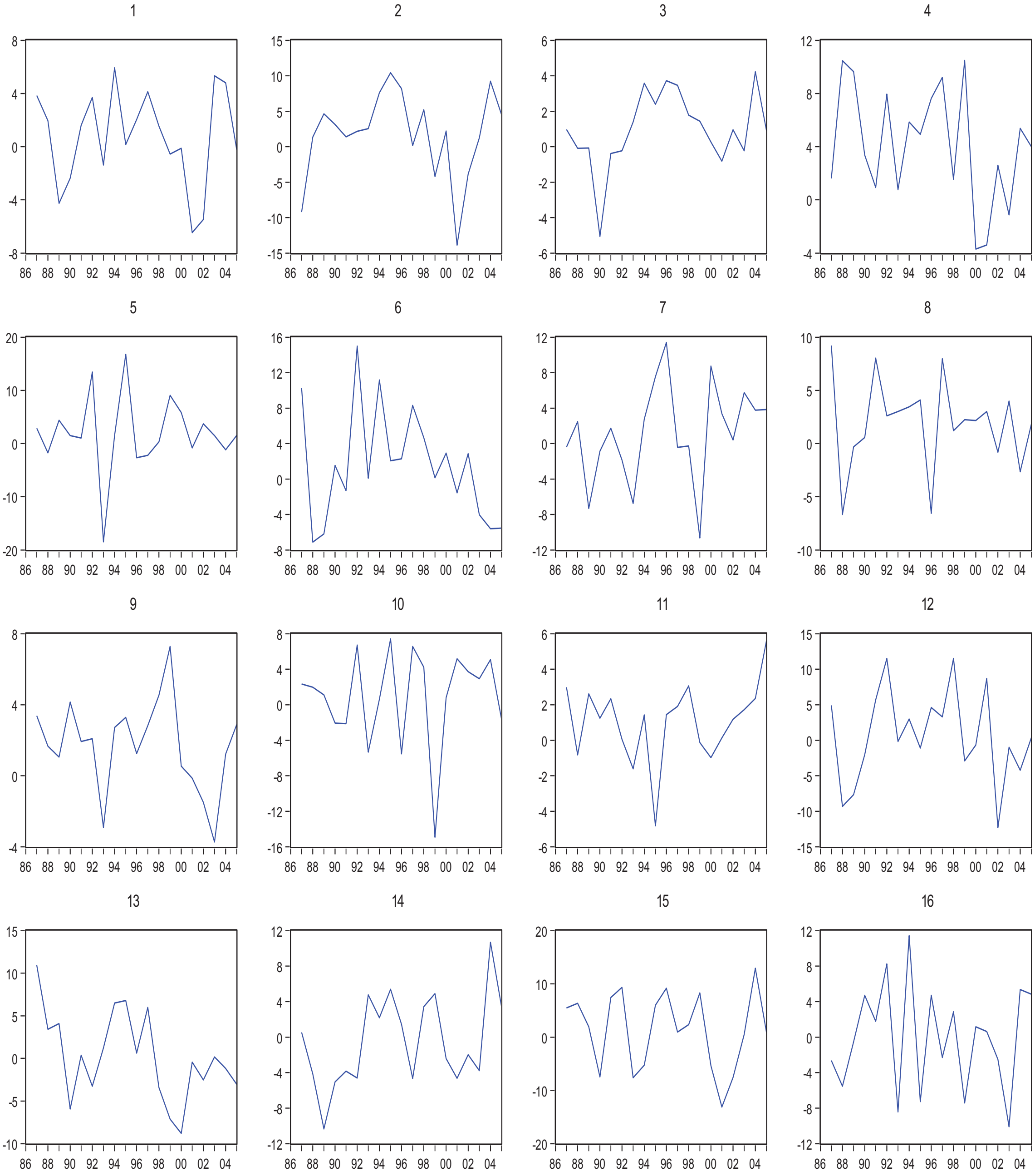
Plot of the growth rate of energy use (kg of oil equivalent per capita) for the Latin America and Caribbean panel



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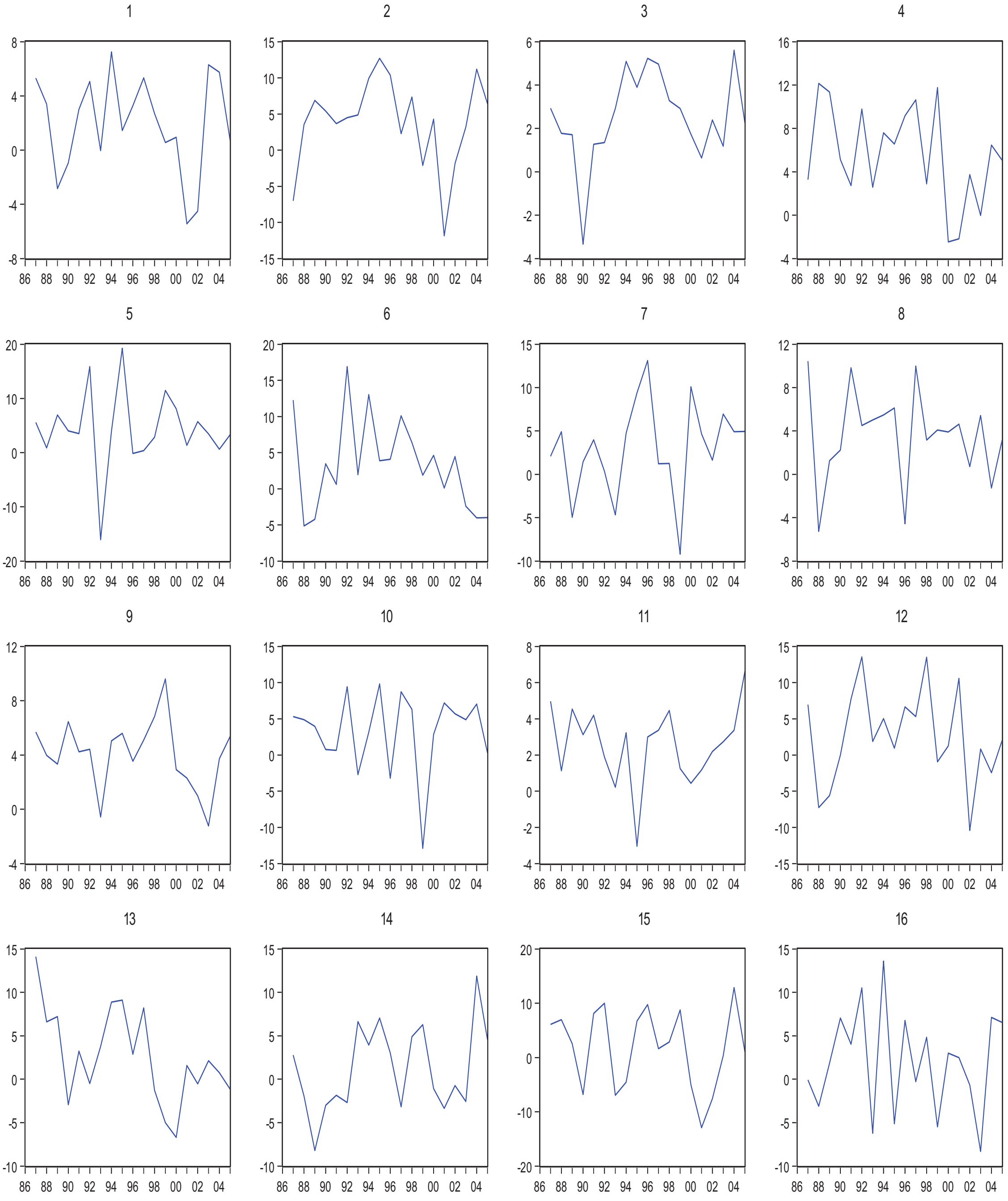
Plot of the growth rate of energy use (kt of oil equivalent) for the Latin America and Caribbean panel



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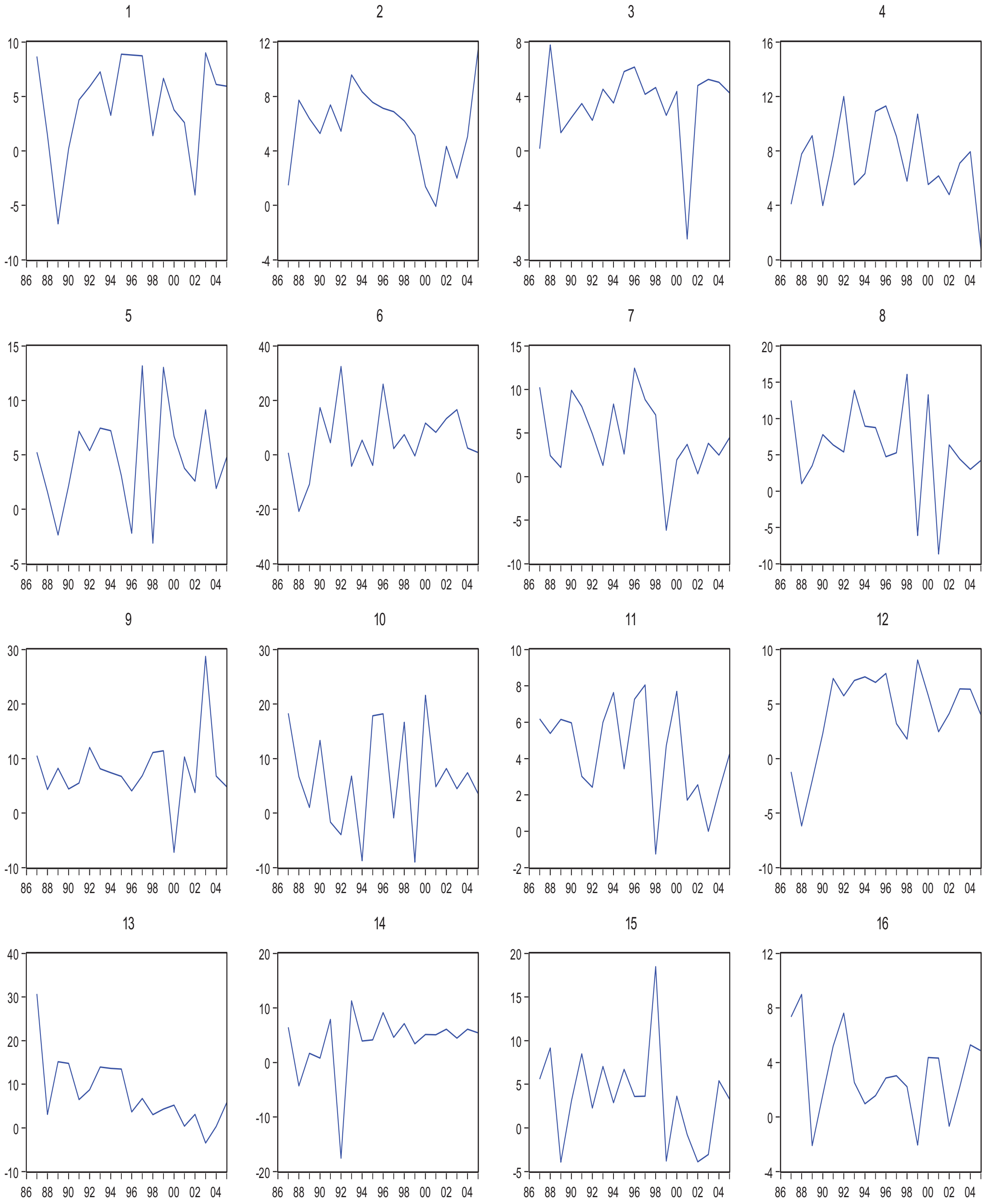
Plot of the growth rate of Electric power consumption (kWh) for the Latin America and Caribbean panel



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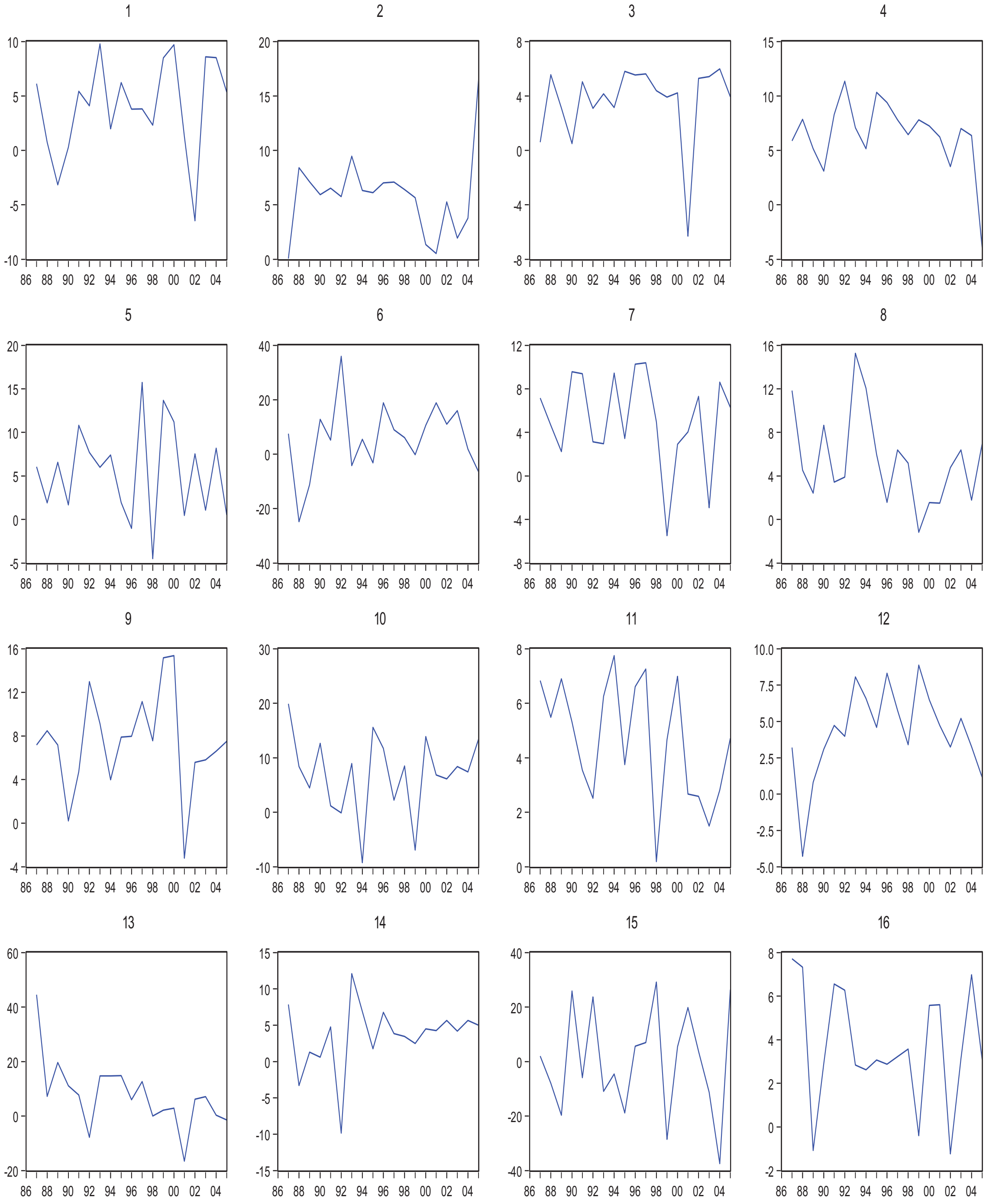
Plot of the growth rate of electricity production (kWh) for the Latin America and Caribbean panel



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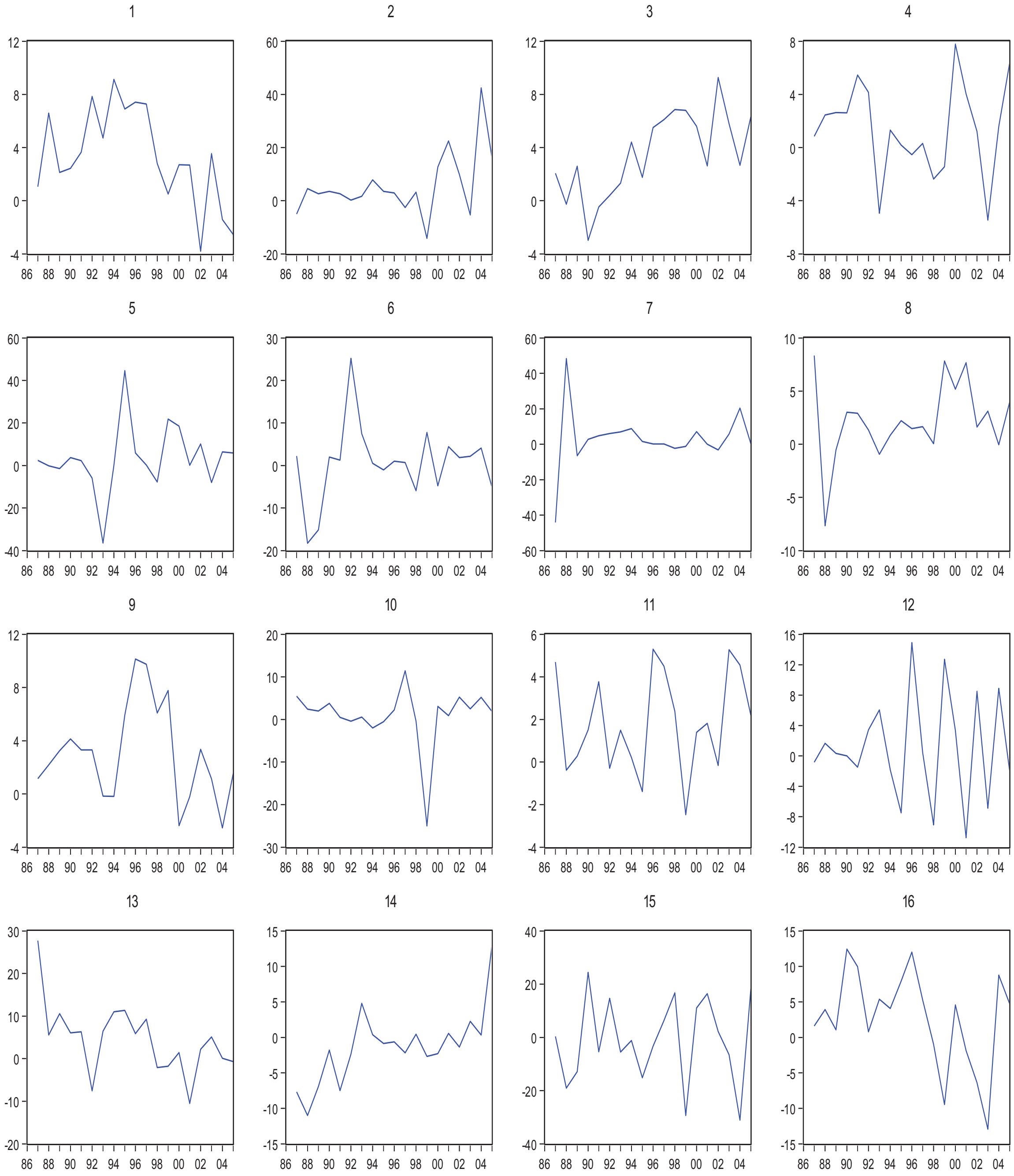
Plot of the growth rate of energy production (kt of oil equivalent) for the Latin America and Caribbean panel



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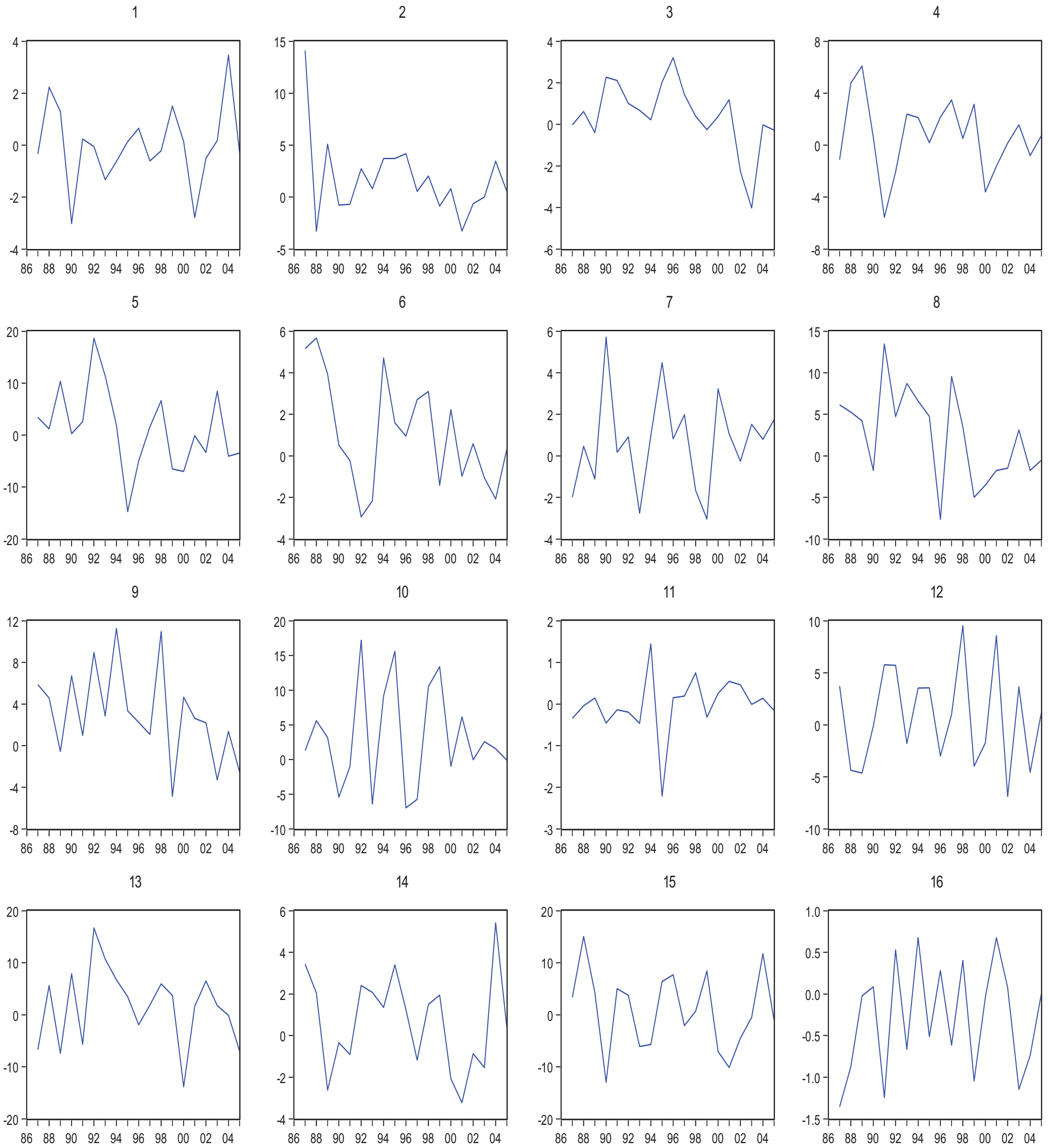
Plot of the growth rate of fossil fuel energy consumption (percentage of total energy consumption) for the Latin America and Caribbean panel



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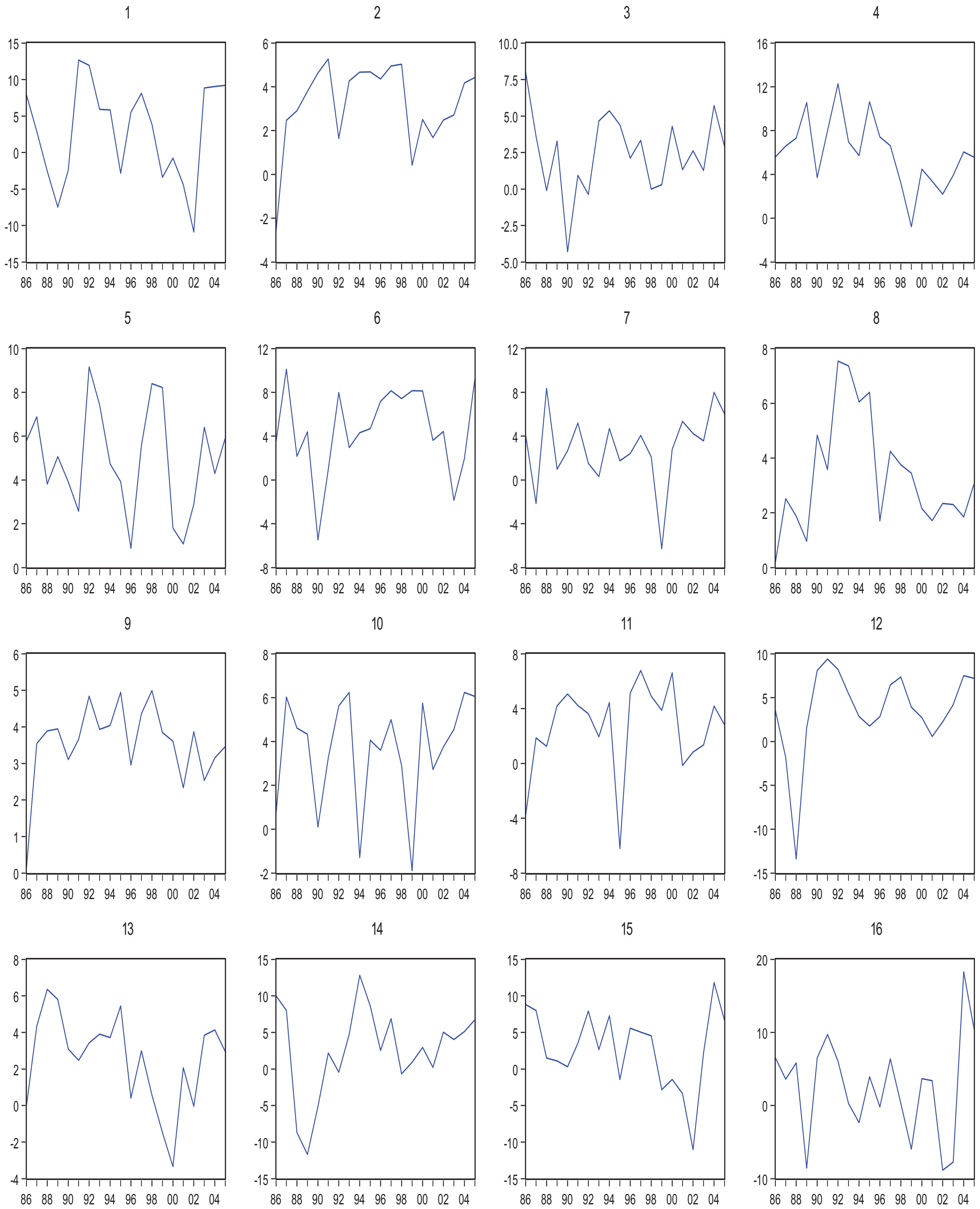
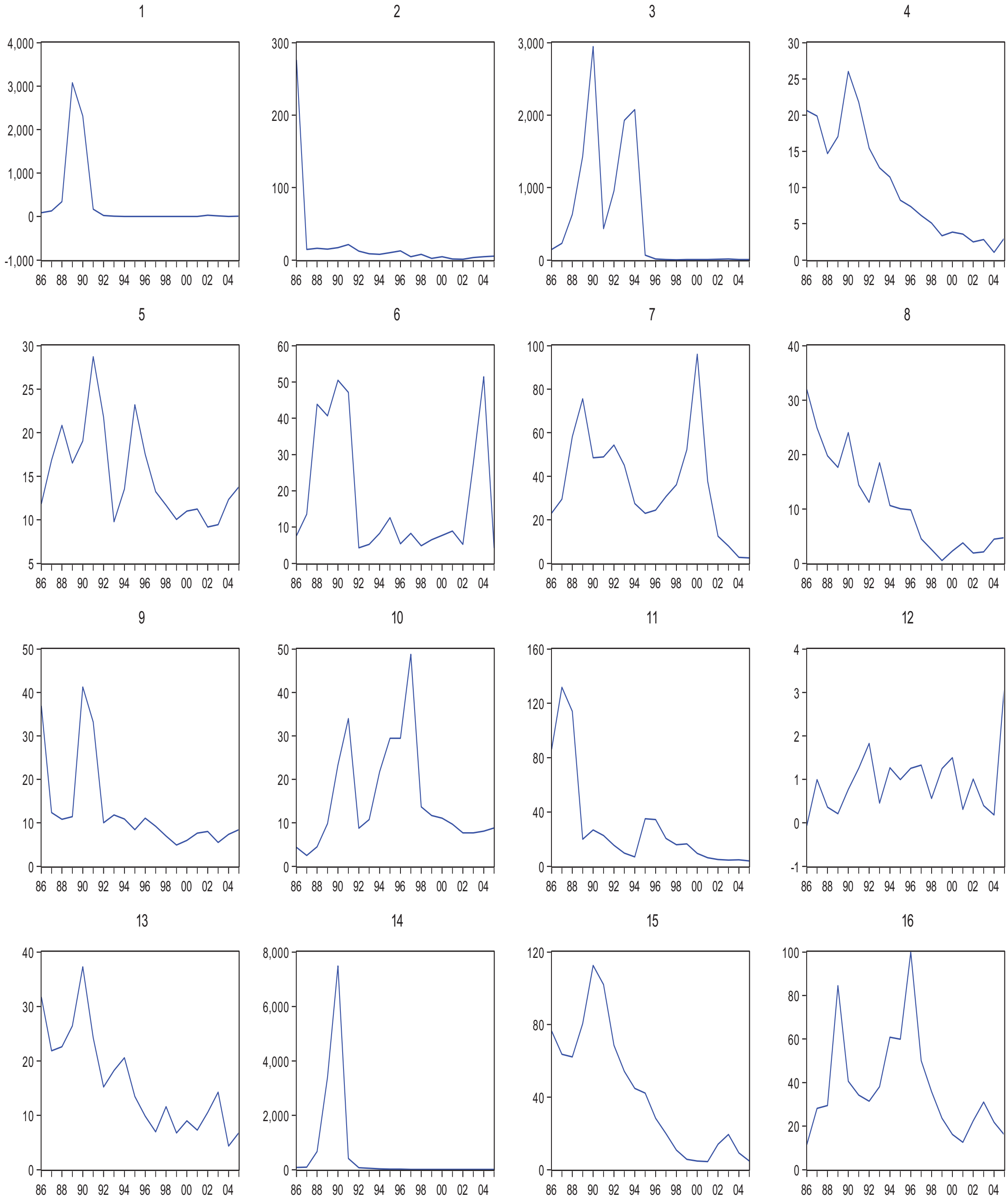
Plot of the GDP growth rate for the Latin America and Caribbean panel



Notes: 1=Argentina; 2=Bolivia; 3=Brazil; 4=Chile; 5=Costa Rica; 6=Dominican Republic; 7=Ecuador; 8=El Salvador; 9=Guatemala; 10=Honduras; 11=Mexico; 12=Panama; 13=Paraguay; 14=Peru; 15=Uruguay; 16=Venezuela, RB.

Plot of the inflation rate for the Latin America and Caribbean panel



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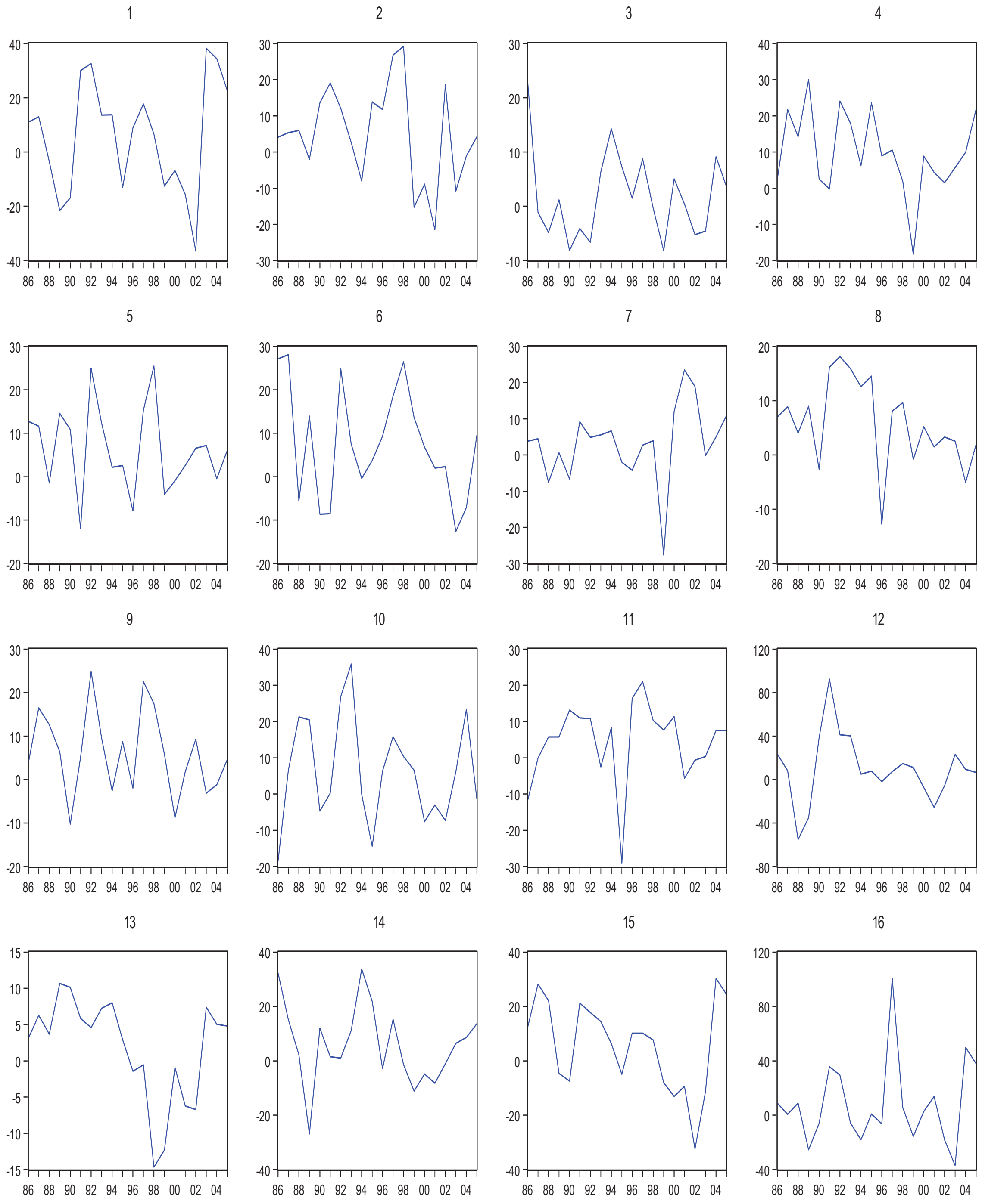
Plot of the growth rate of GFCF for the Latin America and Caribbean panel



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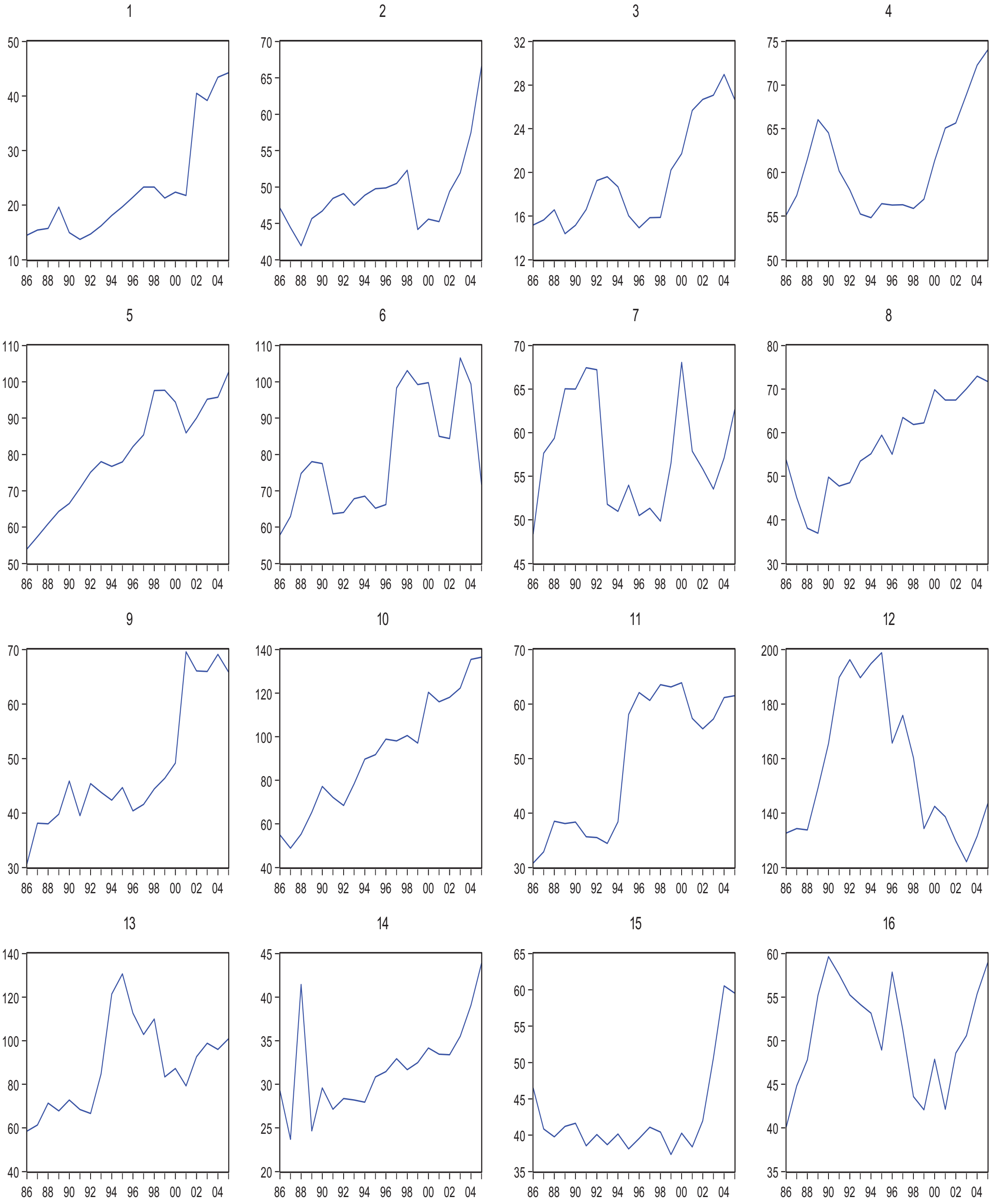
Plot of the trade as a percentage of GDP for the Latin America and Caribbean panel



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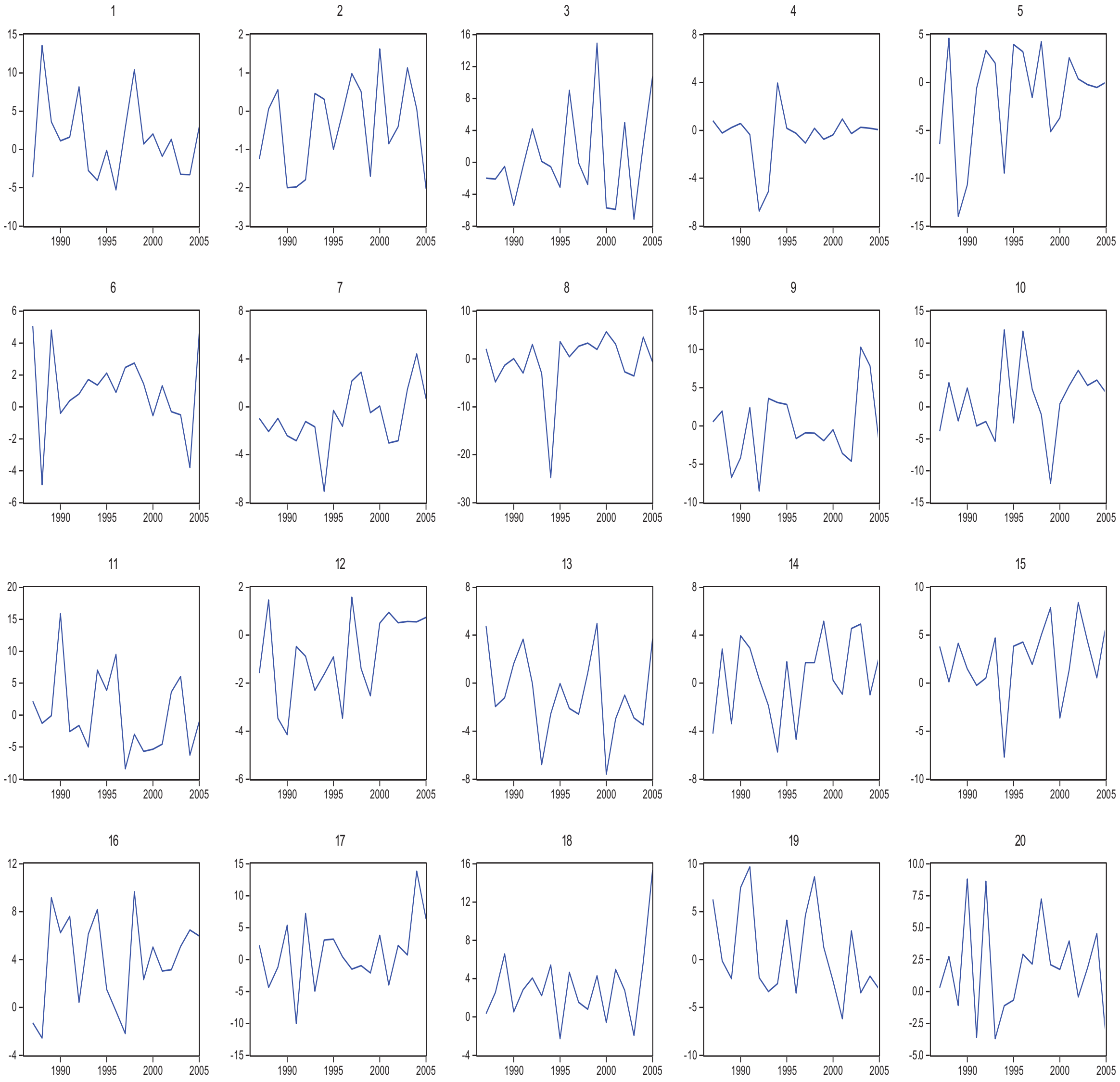
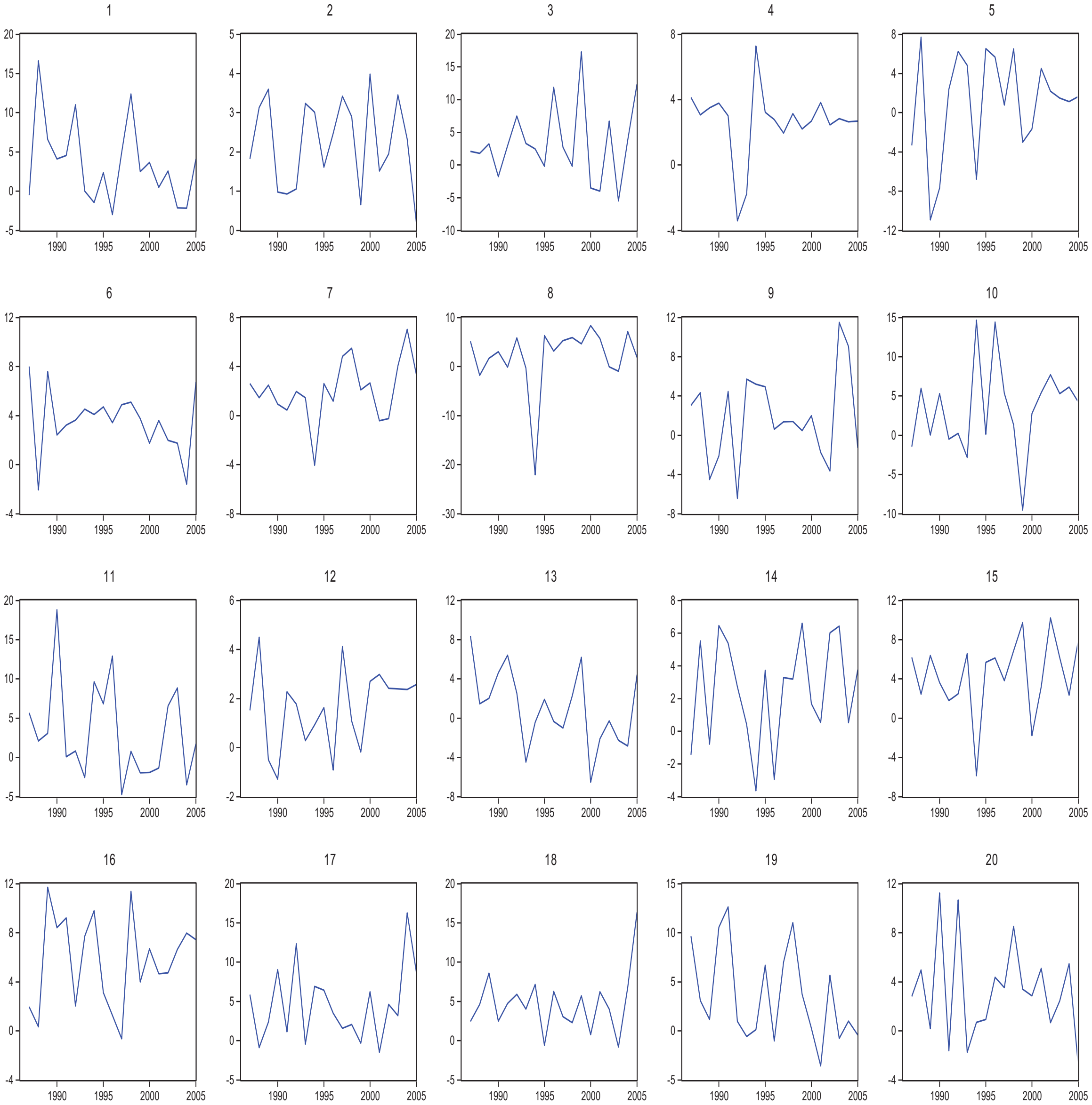
Plot of the growth rate of energy use (kg of oil equivalent per capita) for the Sub-Saharan/North African and Middle Eastern panel



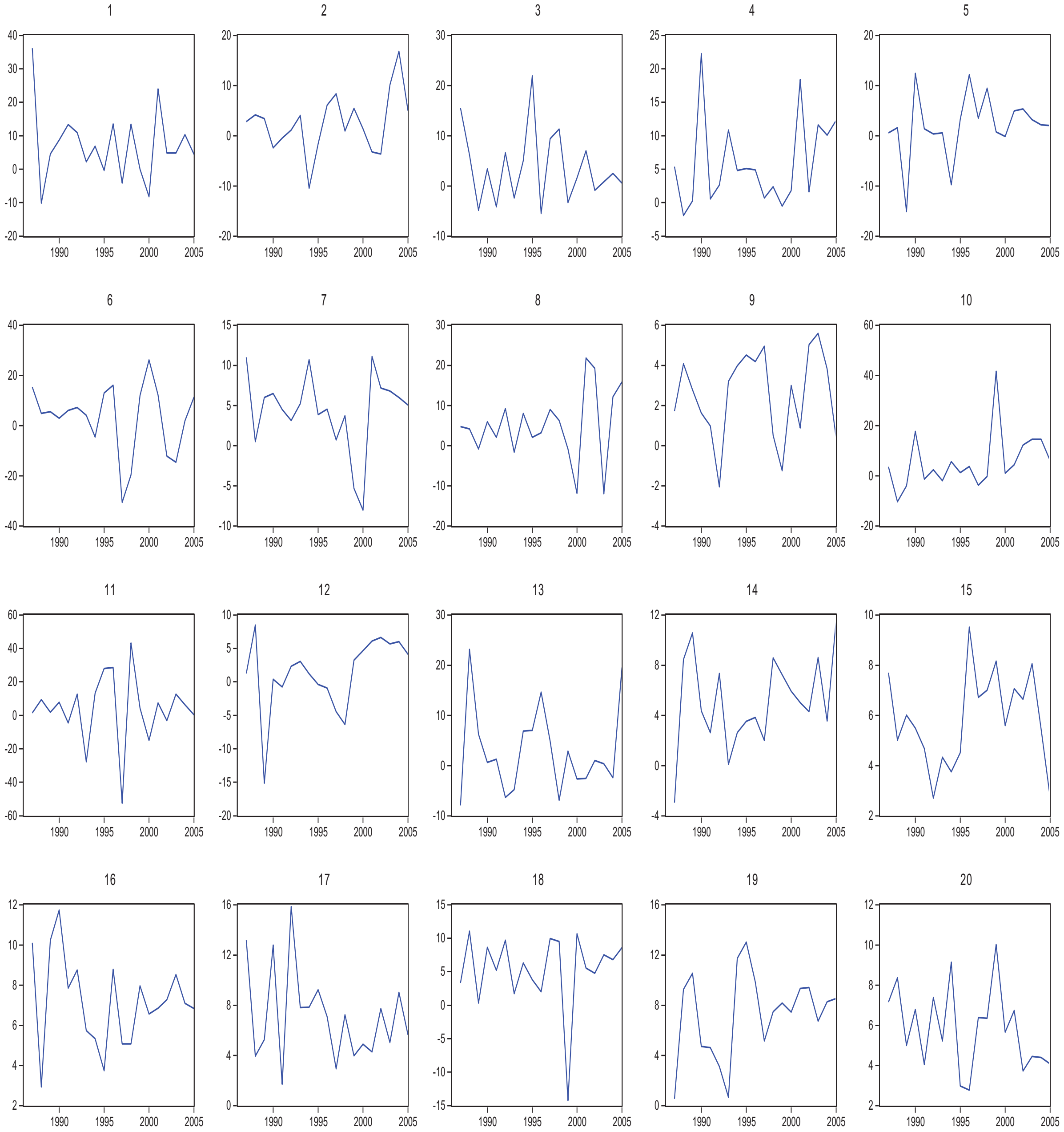
Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the growth rate of energy use (kt of oil equivalent) for the Sub-Saharan/North African and Middle Eastern panel



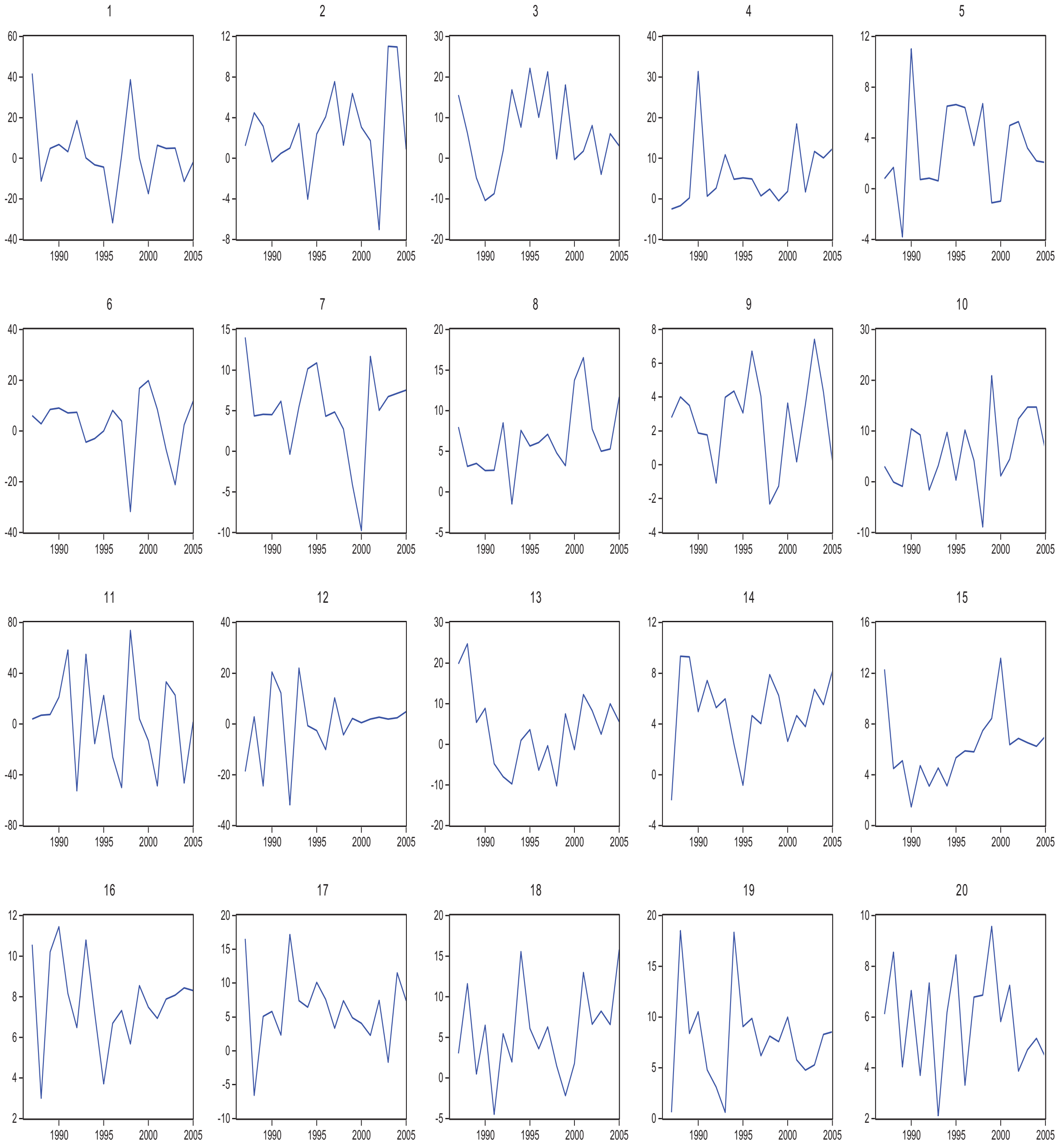
Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the growth rate of Electric power consumption (kWh) for the Sub-Saharan/North African and Middle Eastern panel



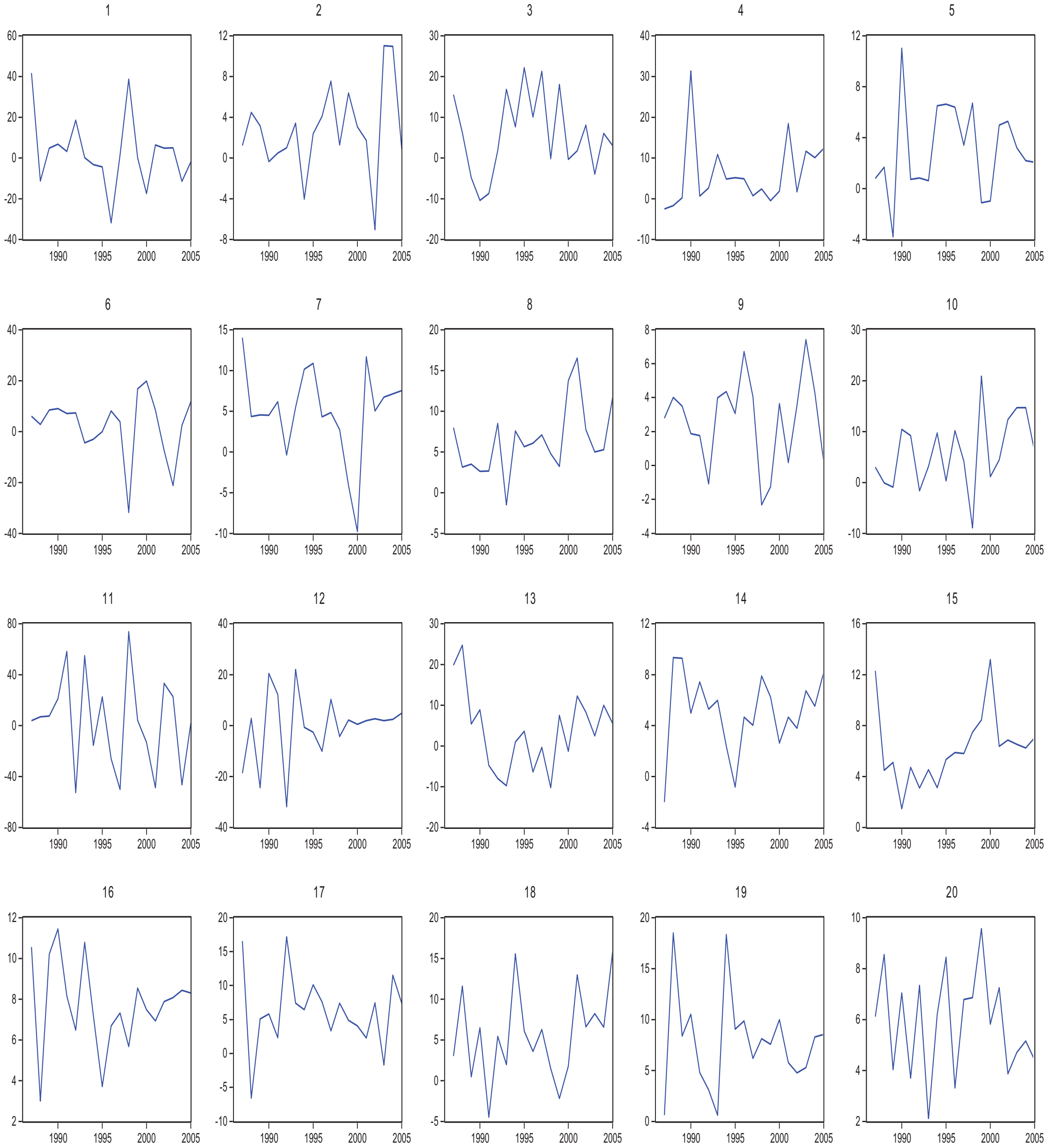
Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the growth rate of electricity production (kWh) for the Sub-Saharan/North African and Middle Eastern panel



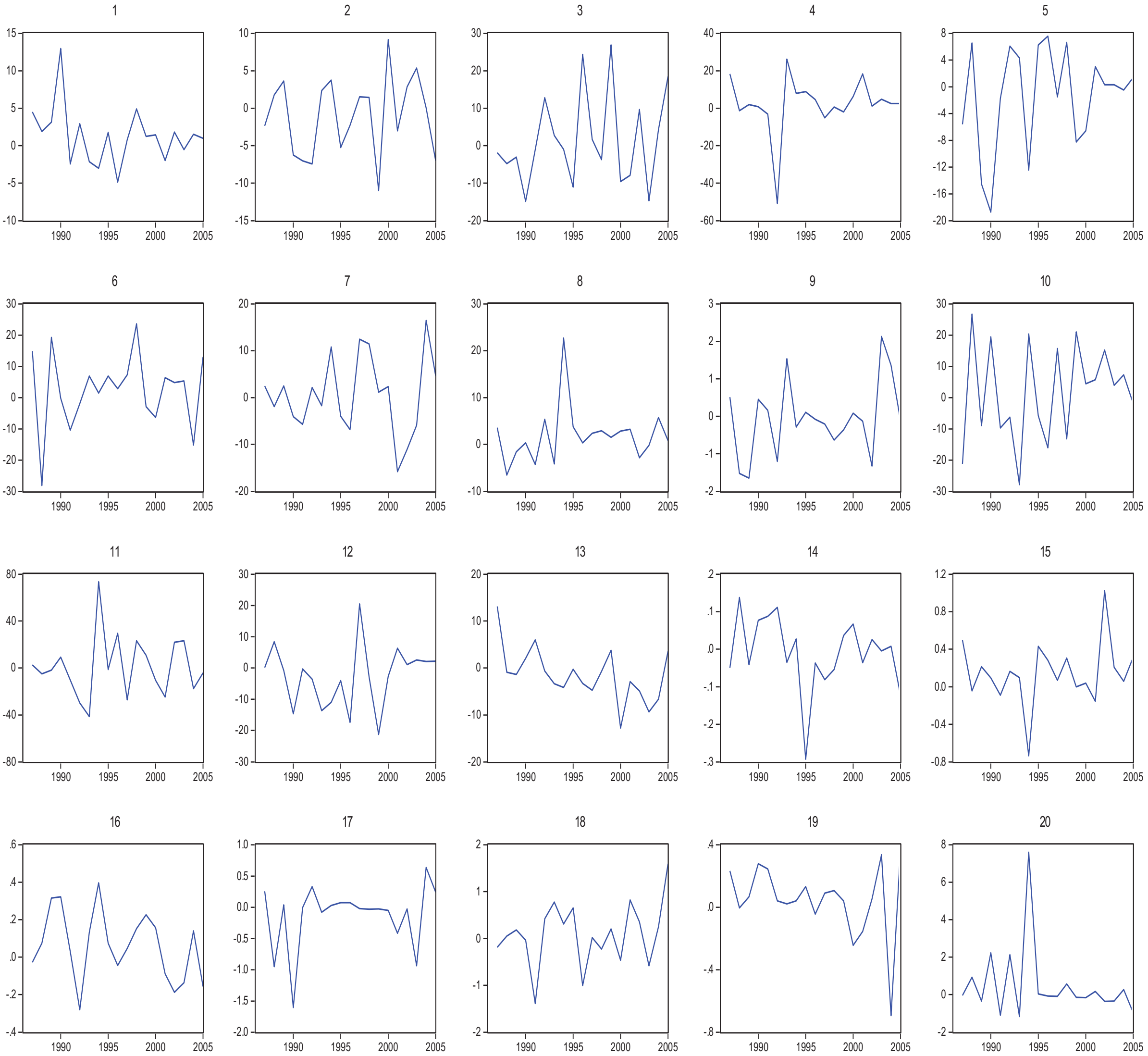
Notes: 1=Botswana; 2=Cameroon; 3=Cote d’lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the growth rate of energy production (kt of oil equivalent) for the Sub-Saharan/North African and Middle Eastern panel



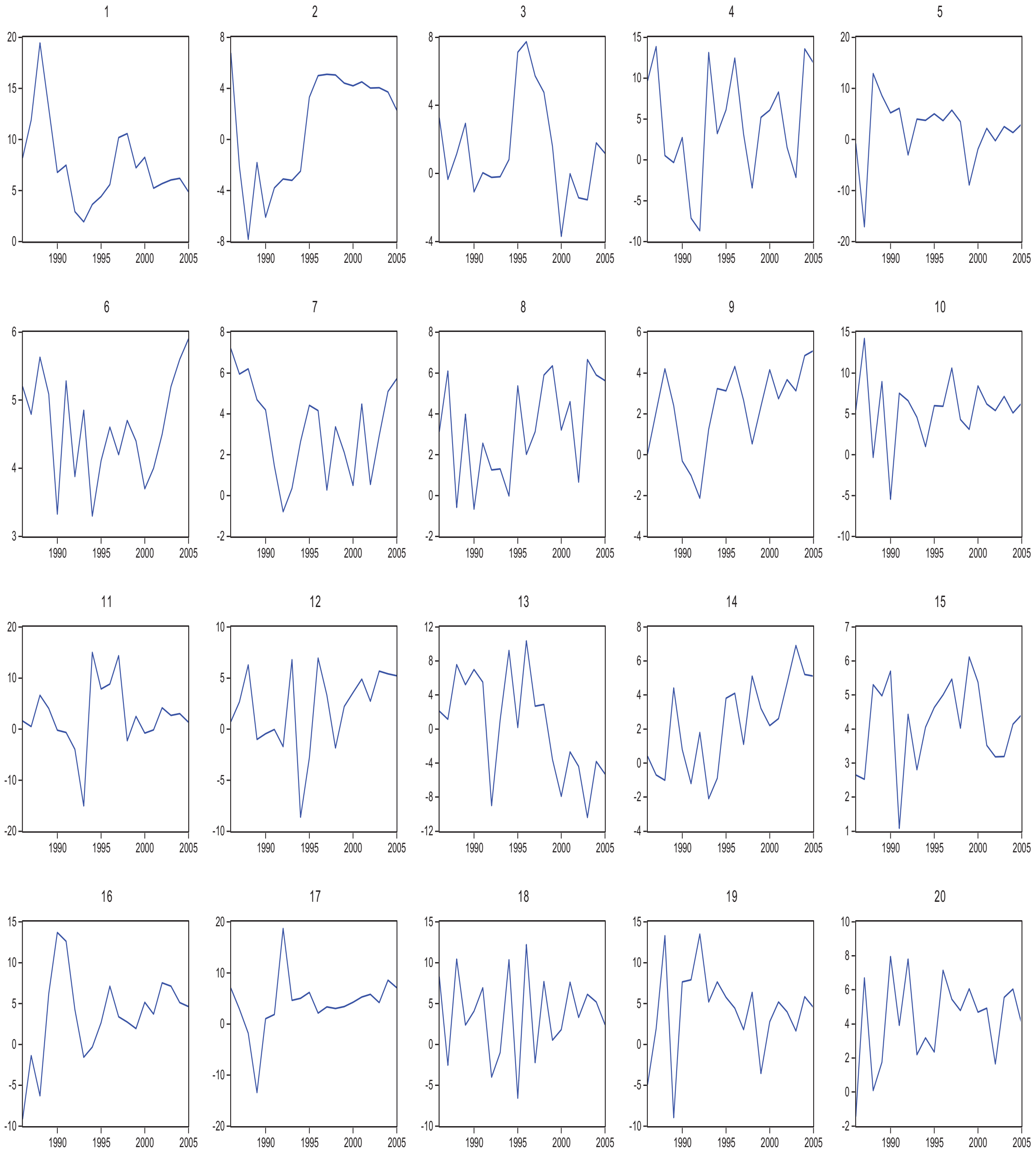
Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the growth rate of fossil fuel energy consumption (percentage of total energy consumption) for the Sub-Saharan/North African and Middle Eastern panel



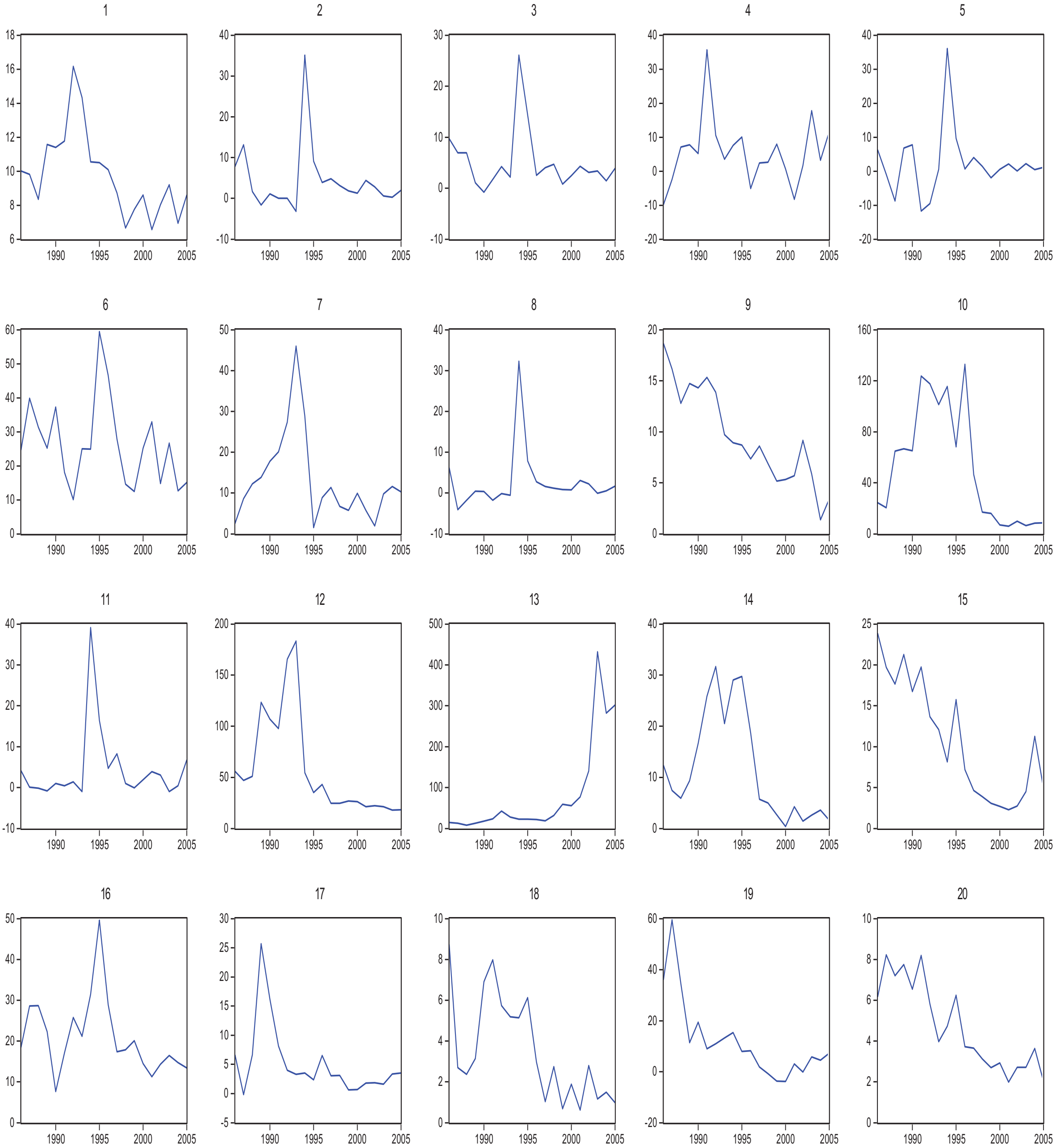
Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the GDP growth rate for the Sub-Saharan/North African and Middle Eastern panel



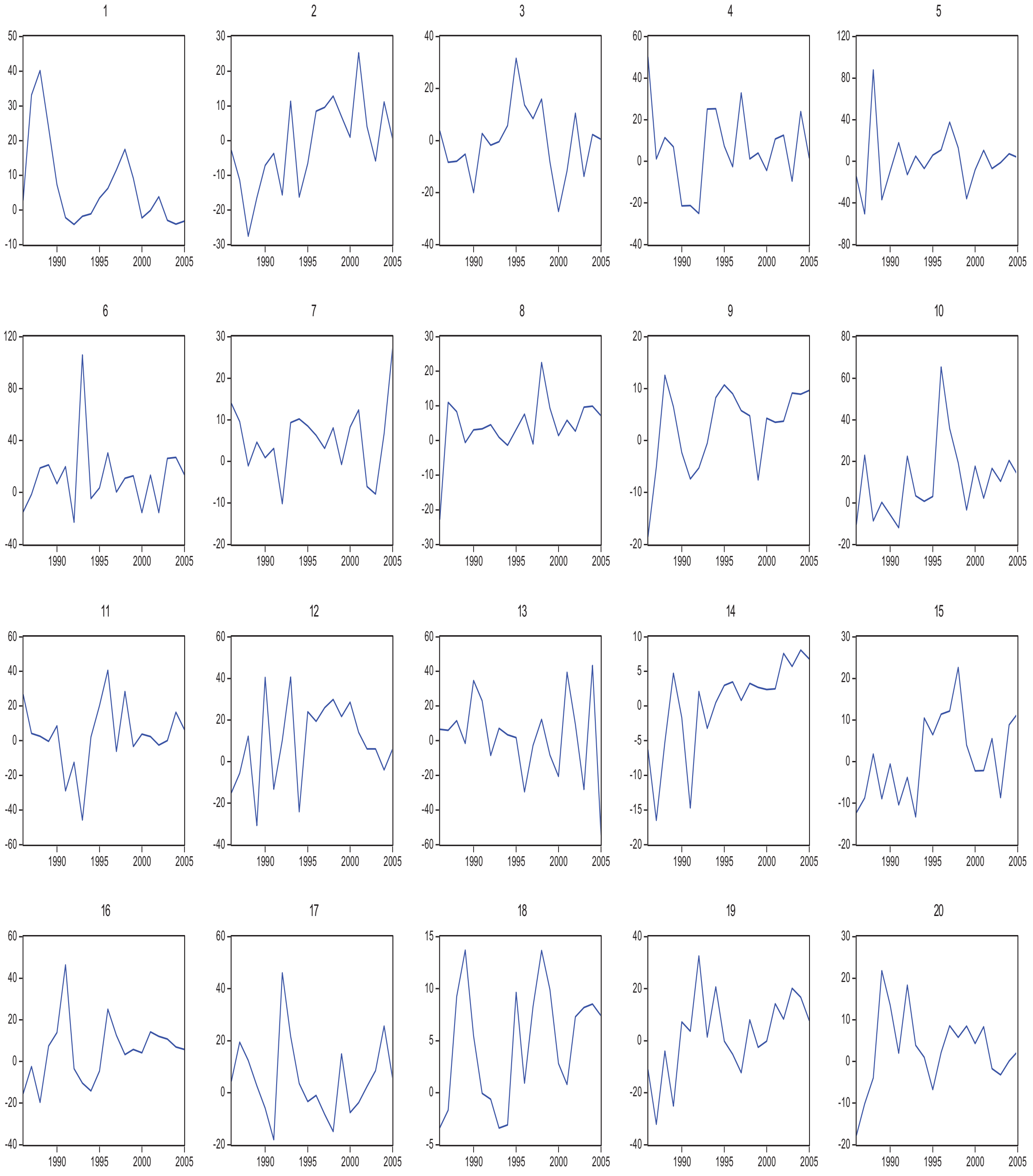
Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the inflation rate for the Sub-Saharan/North African and Middle Eastern panel



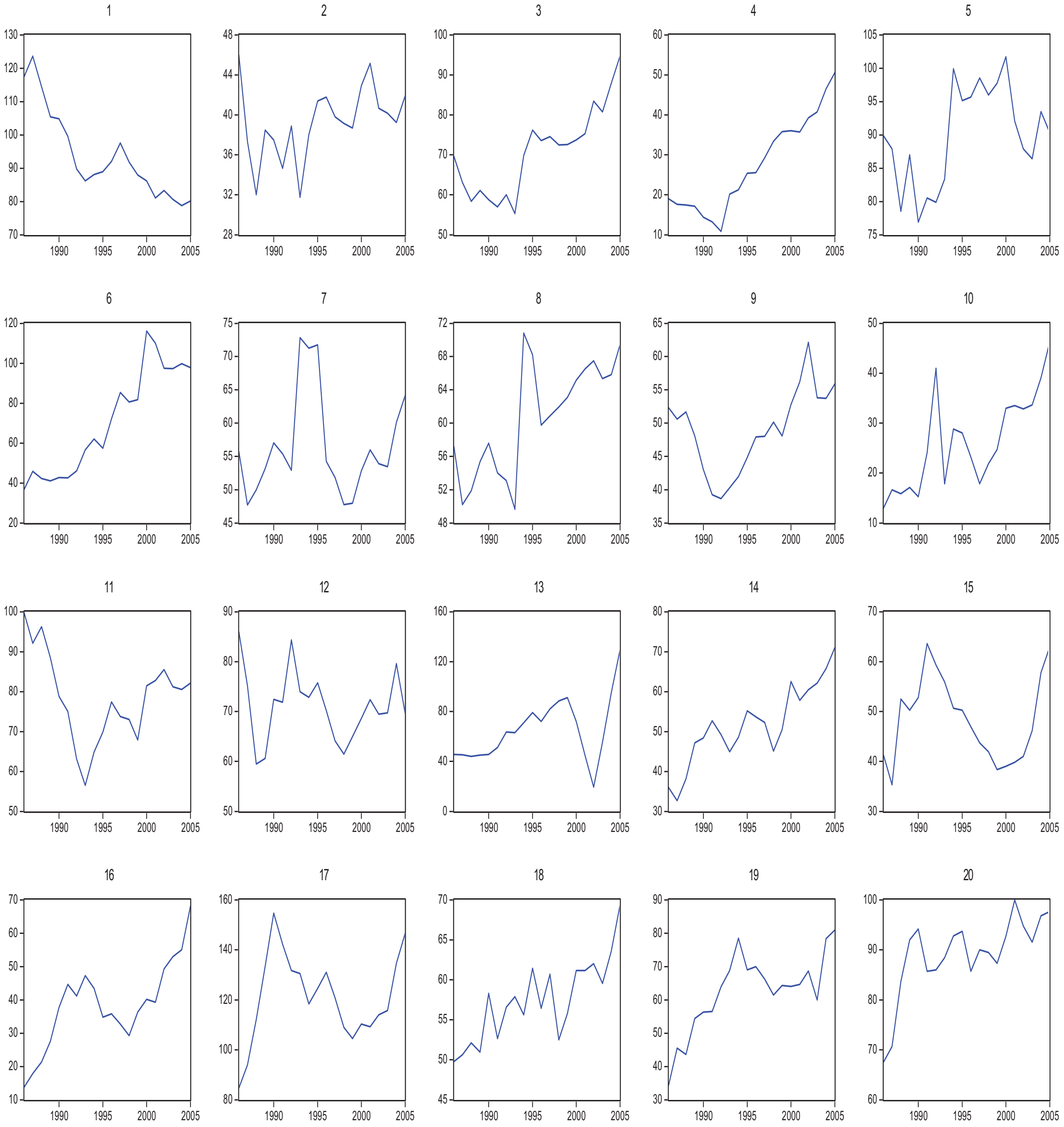
Notes: 1=Botswana; 2=Cameroon; 3=Cote d’lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the growth rate of GFCF for the Sub-Saharan/North African and Middle Eastern panel



Notes: 1=Botswana; 2=Cameroon; 3=Cote d'lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia

Plot of the trade as a percentage of GDP for the Sub-Saharan/North African and Middle Eastern panel



Notes: 1=Botswana; 2=Cameroon; 3=Cote d’lvoire; 4=Ethiopia; 5=Gabon; 6=Ghana; 7=Kenya; 8=Senegal; 9=South Africa; 10=Sudan; 11=Togo; 12=Zambia; 13=Zimbabwe; 14=Algeria; 15= Egypt, Arab Rep.; 16=Iran, Islamic Rep.; 17=Jordan; 18=Morocco; 19=Syrian, Arab Rep., 20=Tunisia