Analysis of Great Moderation based on Quantile Regression Approach

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Abstract

In this paper, we study causes and nature of Great Moderation (GM) using the quantile regression approach combined with a structural break test. We estimate timing and size of structural breaks in each quantile of distribution of GDP growth rate in selected 24 OECD countries from the 1960s to 2014. We find that almost half of the sample countries have experienced GM, and that GM still continues even after the current financial crisis in these countries. We also find that GM has typically come together with contractionary changes in distribution of GDP growth rate. The moderation were typically accompanied by a fall in median and/or disproportionately large decline in upper quantile of GDP growth rate. We show that developments of GM are closely linked to how inflation rate during the 1970s has been controlled and discuss that effective monetary policy can be an explanation for changes in developments of both GDP growth and inflation rate.

Keywords: Quantile Regression; Structural Breaks; Great Moderations.

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1 Introduction

Empirical studies all agree that output growth rates in the United States have become significantly moderate around the mid-1980s, compared with those during the 1960s and 1970s, and remained the same in the subsequent decades. This important change in the macroeconomic environment is observed in other major countries as well and it is often referred to as Great Moderation (GM). GM has attracted attention of a good number of researchers and policy makers. In particular, intensive debates have been made regarding why GM has happened. For instance, one view has attributed GM to an improved of monetary policy implementation and the other view has argued that simply adverse shocks, such as oil shocks that have stricken most of the developed countries during the 1970s, have not occurred during the period of GM.

In this paper, we revisit the debate by extending the literature in two dimensions. The first dimension is about the coverage of time series that serves for our analysis. Our study covers the period during and after the current global financial crisis, the one that has started since the summer of 2007 and brought about deep recessions in many of developed countries, as well as the period before the financial crisis. As most existing studies in the literature focus their analysis on a period before the global financial crisis, there is no consensus on whether GM has ended or it still continues until now. In addition, there is a growing concern among both scholars and policy makers that GM may have played a certain role in the outbreak of the financial crisis. For instance, Bean (2009) discusses that benign economic environment under GM has fostered financial imbalances by encouraging economic agents to take excessive risks, and making financial system less resilient to adverse shocks. Along this line, the analysis using the post-crisis data provides us answers on the nature of relationship between the global financial crisis and GM.

The second dimension is estimation strategy. We apply a novel econometric approach developed by Oka and Qu (2011) that combines a quantile regression with a structural break test to the analysis of GMs. The key feature of their approach is that it does not impose a specific functional form for the distribution of GDP growth rates, and allows us to estimate timing and size of structural changes in the mean of each quantile of the distribution of GDP growth rates. Under the framework of quantile regression, "moderation" can be defined as changes in specific quantiles that widen dispersion between the upper quantile and the lower quantile of GDP growth rates. Consequently, moderation due to a fall in

upper quantiles and moderation due to a rise in lower quantiles may be separately analyzed. In addition, any changes in distribution of GDP growth rates other than moderation may be addressed. By contrast, in most existing studies, distribution of GDP growth rates is assumed to be symmetric around the mean, and GM is defined as reduction in variance of the growth rates.

We first study nature of GM by applying the methodology of Oka and Qu (2011) to selected 24 OECD countries including all of G7 countries. We estimate time path of distribution of quarterly GDP growth in these countries from the 1960s to 2014Q1 and ask if there are structural breaks in the distribution of these GDP growth rates. We define that a country has witnessed GM if the size of dispersion between estimated mean of 80th quantile and 20th quantile of GDP growth rate in 2014Q1 is smaller than the size of dispersion between the two quantiles in 1960Q1 and hereafter call countries where this feature is observed as GM countries. The estimation results are summarized as follows. (1) GM has also occurred in the countries other than the United States. There are also countries that have not witnessed GM throughout the sample periods. Among G7 countries, all countries other than Germany have experienced GM and among all of our sample OECD countries, 10 countries have experienced GM. (2) In GM countries, GM occurs mostly during the 1970s and the 1980s. There are, however, certain degree of country-specific heterogeneities regarding when GM has taken place. For instance, in the United States, moderation has occurred in 1984Q1, whereas in Japan, moderation has occurred twice one in 1973Q1 and the other in 1990Q3. In the latter country, therefore, GM has emerged gradually. (3) There are also substantial size of cross-country heterogeneity in size of moderation. In the U.S., the size of moderation is about 0.8% whereas the size of moderation in France is smaller, 0.2%. (4) In GM countries, moderation is mostly accompanied by contractionary changes in distribution of GDP growth rates. That is, moderation is either driven by a relatively large decline in 80th quantile compared with changes in 20th quantile or accompanied by a decline in 50th quantile. In other words, GM comes at the cost of decline in average GDP growth rates. (5) In GM countries, moderation continues up until the current years. That is, GM has not ended even after the current financial crisis.

Based on our estimation results, we investigate why GM has occurred. Among candidate explanations so far proposed in the literature, we focus on the explanation by the better monetary policy. To this end, we apply the methodology of Oka and Qu (2011) again to inflation rate in our 24 sample countries from the 1960s to 2014 and see how distribution

of inflation rates have changed throughout the sample period. The estimation results on inflation rates suggest that adoption of effective monetary policy may have caused GM at least in some countries because of the similarities in dynamics of GDP growth rates and inflation rates. That is, for most of sample countries, median of inflation rates has increased and dispersion between upper and lower quantiles of inflation rates have widened during the 1970s compared with the 1960s, and the median has declined and the dispersion has shrunk in the subsequent decades. While timing of moderation in inflation rates differs from that in GDP growth rates in most of GM countries, for the U.S. and New Zealand, timings of changes in distribution of inflation rates coincide with timings of moderation of GDP growth rates. Developments of inflation rates differ across GM countries and non-GM countries. For GM countries, the increase in median of inflation rates and the widening of dispersion between the upper and lower quantiles during the 1970s have been mild. In addition, the decrease in the median and the shrink in the dispersion in the subsequent decades were rapid. In other words, other things being equal, in GM countries, level and dispersion of inflation rates have been more effectively controlled.

Our study stems from two strands of the literature. The first literature is studies about GM. Since the pioneering works by Kim and Nelson (1999), McConnell and Perez-Quiros (2000), and Blanchard and Simon (2001), a large number of research has been conducted to explore causes of GM. As discussed in Enders and Ma (2011), roughly speaking, there are three classes of explanations. The first class of explanation is changes in goods production sector. For instance, McConnell and Perez-Quiros (2000) estimate changes in volatility of the disaggregated components of GDP and report that the moderation of U.S. GDP has come from reduction in volatility in durable goods production. Davis and Kahn (2008), based on both macro and micro evidence, claim that GM in the U.S. is largely attributed to a better inventory control. The second class of explanation is a better monetary policy. Summers (2005) argues that GM is a consequence of central bank's success at maintaining low and stable inflation.[1] The second class of explanation is good luck. Blanchard and Simon (2001) discuss that lack of large adverse shocks since the late 1970s or early 1980s is the key determinant behind the great moderation. In their view, the great moderation is a consequence of a steady decline of volatility in output growth over several decades since

[1] There are related works that concentrate on countries other than the United States. See for Sakura *et al.* (2005), Kimura and Shiotani (2009) and Ko and Murase (2010) for Japanese economy. See also Fritsche and Kuzin (2004) for the case of Germany. Simon (2001) studies the case of Australia.

the 1950s, that is interrupted in the 1970s and early 1980s and returns to trend onwards.

The second literature is studies that make use of quantile regression. After the seminal work by Koenker and Bassett (1978), the quantile regression is studied in various field, which includes the quantile autoregression model developed by Koenker and Xiao (2006). Bai (1995, 1998) considers the least absolute deviation estimation of structural changes in linear regressions. Qu (2008) and Su and Xiao (2008) propose a testing method for structural change in quantile regressions. Oka and Qu (2011) provide the estimation method for multiple structural changes in quantile regression framework.

The remainder of our paper is organized as follows. Section 2 discusses our estimation methodology. Section 3 reports our estimation results on GDP growth rates. Section 4 discusses our estimation results in relation to with the role played by the monetary policy in GM. Section 5 concludes.

2 The Estimation Methodology

2.1 Quantile regression with structural break test

The method used in this paper is based on the quantile regression (QR), which is originally developed by Koenker and Bassett (1978) and has been received considerable attention in both theoretical and empirical literature (see Koenker, 2005). The QR method allows one to estimate the conditional quantile function by fitting a model to an arbitrary quantile of the conditional distribution. Using the collection of conditional quantile functions, one can characterize the entire conditional distribution without imposing any distributional assumptions on unobserved innovations. The quantile regression can be applied for the time-series model, such as the Quantile Autoregressive (hereafter, QAR) model proposed by Koenker and Xiao (2006).

Recent studies propose methods to incorporate structural changes in the quantile regression. Qu (2008) and Su and Xiao (2008) consider Wald and subgradient-based tests for the null hypothesis of no structural break. In terms of the estimation, Bai (1995) develops asymptotic theory for least absolute deviation estimation of a shift in linear regression, while Bai (1998) proposes a method to allow for multiple changes for least absolute deviation. Oka and Qu (2011) extend testing and estimation method to accommodate dynamic models including the QAR, incorporate multiple structural changes in not only single but also multiple conditional quantiles, and determine the number of structural changes.

We apply the empirical methodology developed in Oka and Qu (2011) so as to analyze the great moderation. The vast amount of empirical literature of the great moderation has concentrated on change in the conditional mean or variance of the macroeconomic time series such as GDP. On the one hand, the mean and variance are useful to capture the central tendency and dispersion of the conditional distribution of the time series. On the other hand, these measures are estimated under assumptions regarding distribution of the macroeconomic time series. Related to this point, our methodology extracts changes in conditional distribution of the macroeconomic time series without the help of distributional assumptions.

We use the first-order autoregressive process to analyze the GDP growth rate $\{\Delta y_t : t = 1, \ldots, T\}$. Let $Q_{\Delta y_t}(\tau|x_{t-1})$ denote the τ-th conditional quantile function of x_t for some quantile $\tau \in (0, 1)$. Then, the conditional quantile function with m structural breaks is written as

$$Q_{\Delta y_t}(\tau|x_t) = \begin{cases} x_t'\beta_1^0(\tau), & t = 1, \ldots, T_1^0 \\ x_t'\beta_2^0(\tau), & t = T_1^0 + 1, \ldots, T_2^0 \\ \vdots & \\ x_t'\beta_{m+1}^0(\tau), & t = T_m^0 + 1, \ldots, T, \end{cases}$$

where $\beta_j^0(\tau)$ $(j = 1, \ldots, m + 1)$ are unknown parameters that are quantile dependent and T_j^0 $(j = 1, \ldots, m)$ are unknown break dates. Also, the number of structural changes, m, is unknown. In the current paper, we concentrate on the analysis where x_t is expressed as:

$$x_t = c + \Delta y_{t-1}.$$

We use three quantiles $\{0.2, 0.5, 0.8\}$, which are parsimonious yet enough to characterize asymmetric change in the conditional distribution.

Our estimation procedure consists of the two steps. First, we test the existence of structural break over the sample period and determine the number of breaks by using the test sequentially. Given the number of the breaks, we estimate coefficients and break dates simultaneously.

2.2 Data

We focus our analysis on 24 OECD countries for which a sufficiently long time series data for real GDP is available. The sample country includes Australia, Belgium, Canada,

Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Luxemburg, Mexico, Netherlands, New Zealand, Norway, Portugal, South Africa, South Korea, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The sample period runs from 1960Q1 to 2014Q1 and the data are all seasonally adjusted.[2]

3 Great Moderation in OECD countries

3.1 Estimation Results

We summarize our estimation results in Figure 1, Figure 2, and Table 1. Figure 1 displays time path of estimated mean growth rate of 80th quantile, median (50th quantile), and 20th quantile of GDP growth rates, in G7 countries. Shifts in the means of quantiles indicate that there are structural change in the distribution of GDP growth rate at the period. Figure 2 displays time path of our measure of moderation, which is a discrepancy between 80th quantile and 20th quantile of GDP growth rate, for G7 countries. Table 1 documents detailed estimation results for all of 24 sample countries. For each country, estimated timing of structural changes and estimated mean of three quantiles of GDP growth rates, 80th quantile, medium (50th quantile), and 20th quantile, as well as the dispersion between 80th quantile and 20th quantile, for each of the regimes are reported. Notice that some countries have witnessed two breaks in distribution of GDP growth rates. We report that a moderation has occurred when changes in distribution of GDP are significant at 10% level.

Five observations are made from the two figures and the table. Our first observation is that GM has occurred outside the U.S. as well but not all countries have witnessed GM. GM has occurred in all of G7 countries except for Germany. In non-G7 group, Australia, Ireland, Netherlands, New Zealand, South Africa, South Korea, Switzerland are GM countries. GM countries are thus 13 in total. Our second observation is that most of moderations have occurred during the 1970s and 1980s. There are, however, substantial cross-country heterogeneities in terms of timing when moderation has occured. In the U.S., GM has occurred in 1984Q2 whereas in the U.K. GM has occurred in 1980Q1. In Japan and Netherlands, GM has occurred gradually through two structual breaks in distribution during the sample period. In total of all GM countries, moderation occurs

[2]For Canada, Denmark, and South Korea, where early data sample is not available, we use the data from 1961Q1, 1966Q1, and 1970Q1, respectively.

five times during the early 1970s, twice during the late 1970s, three times during the early 1980s, twice during the late 1980s, and three times during the 1990s and beyond. Third observation is that there is also a large cross-country heterogeneity in terms of size of moderation. In the U.S., the moderation has reduced a dispersion between the 80th quantile and the 20th quantile from 1.56% to 0.76%, whereas in France, the moderation has reduced the dispersion only from 0.81% to 0.68%. Forth observation is that in GM countries, moderation occurs as a contractionary changes in distribution of GDP growth rates. That is, a moderation is accompanied by either a decline in median of GDP growth rate, or a disproportionately large decline in the upper quantile of GDP growth rate. While in our definition of moderation, a moderation may also occur due to an increase in lower quantile of GDP growth, in our sample countries, such a case is either absent or quantitatively small even when it exists. For instance, in the U.S., moderation was driven by a downward shift of upper quantile from 1.71% to 1.03% and accompanied by a downward shift of median from 0.86% to 0.74%. Though the lower quantile has increased slightly from 0.15% to 0.26%, its change is quantitatively small compared with the change in the upper quantile. Among GM countries, all countries other than New Zealand have witnessed a disproportionately large decline in the upper quantiles and all countries have witnessed a downward shift in the median. The last observation is that GM is continuing in all of GM countries. Though financial market turmoil and recession of economic activity brought about by the current financial crisis were prominent in some of GM countries, such as the U.S., the U.K., and Japan, distribution of GDP growth rate has not witnessed a significant change from the pre-crisis period, indicating that they are still in the regime of GM.

3.2 Discussion

It is useful to summarize implications of the estimation results. First, similarly to existing cross-country studies, our results show that both common and country-specific factors play a role. Among about half of our sampled countries that have experienced GM, there are several common features in the way that moderation has occurred. This implies economic factors that are commonly observed in these countries, such as lack of global oil price shocks, increasing compositional significance of service sector in the domestic economy, and disappearance of high inflation rates, may have contributed to GM. Second and more importantly, our results show that moderation comes with contractional changes in GDP

growth rates. This finding is novel in the literature and helps narrow down candidate explanations. For instance, disappearance of adverse global shocks may not be consistently reconciled with our findings as it would have favorable effects on GDP growth rates and would not have dampened median of GDP growth rates.

4 Monetary Policy and Great Moderation

Better monetary policy is considered one of the most promising candidates in GM in the preceding studies, including Clarida, Gali and Gertler (2000), Stock and Watson (2002), Boivin and Giannoni (2002), and Summers (2005). Summers (2005) states, for instance, that the appointment of Paul Volcker as chairman of the Board of Governors significantly changes the conduct of monetary policy from so-called the pre-Volcker period (from 1960 until mid-1979) where the response of monetary policy to anticipated inflation is accommodative.

We investigate causality from a monetary policy to GM using two distinct approaches. In the first approach, we examine narratively timing and feature of a monetary policy regime in each country, and see if narrative evidence is consistent with our findings for GM. One typical classification of monetary policy regimes is to classify them into inflation targeting regime and the rest. In fact, 12 of our sampled countries have adopted inflation targeting during the sample period. Table 2 reports adoption date and range of inflation target rates for each of the countries that have adopted inflation targeting.[3] It is seen from the table that relationship between GM and inflation targeting is weak. First, there are seven countries that have introduced inflation targeting but have never experienced GM. For instance, while Norway has introduced inflation targeting in 2001, it has experienced increased in dispersion between upper and lower quantiles. Second, in most of GM countries, introduction of inflation targeting has taken place several years before GM has taken place. These observations suggest that GM and inflation targeting are unrelated from each other.

In the second approach, we focus on inflation rate, the objective of monetary policy in most of the central banks. We estimate quantiles of distribution of inflation rates and apply the same structural break test to the estimated time path of quantiles. The sample period

[3] In the table, we categorize Finland and Spain as countries that adopted inflation targeting though they have abandoned inflation targeting as they started to use Euro.

covers from 1960Q1 to 2014Q1 and the data for G7 countries are shown in Figure 3. We then examine if there are changes in the developments of inflation rates that are consistent with those of GDP growth rates in each of GM countries. Table 3 displays estimation results for inflation rate in the sample countries. In the table, estimated timing of structural changes in distribution of inflation rates, and estimated mean of three quantiles and the dispersion between 80th quantile and 20th quantile of inflation rates for each regime are documented for each country. The table shows that in most of the sample countries, there have been an increase in median of inflation rate and an increase in discrepancy between 80th and 20th quantile of distribution during the 1960s and the 1970s, and a decrease in these two series during the 1980s and beyond. For instance, in the U.S., median of inflation rate was 0.76% during the 1960, went up to 2.05% during the 1970, and fell to 0.71% during the 1980s. It is also notable that, similarly to developments in GDP growth rates, that the shrink in the dispersion was mainly brought about by a disproportionately large fall in the upper quantile rather than increase in the lower quantile of inflation rate distribution. To see the difference of developments of inflation between GM and non-GM countries, we compute average of median and dispersion between 80th quantile and 20th quantile of inflation rate across countries separately for two groups. Figure 4 displays time path of the average median and dispersion. It is seen from the figure that GM countries saw a smaller increase in both median inflation rate and dispersion of inflation rate during the 1970s compared with non-GM countries. In addition, GM countries saw a rapid decline in both median inflation rate and dispersion of inflation rate during the 1980s and beyond.

Our findings in this section are in line with previous studies that stress the role of monetary policy in GM, in particular, the work by Boivin and Giannoni (2002). Boivin and Giannoni (2002) estimate a dynamic general equilibrium model in the spirit of Smets and Wouters (2003, 2004) using two separate sample data periods for the U.S. economy. One spans from 1959Q1 to 1979Q2, and the other spans from 1979Q3 to 2001Q2. They first show that coefficient attached to inflation in the estimated Taylor rule is significantly higher when the latter period is used for estimation, indicating that the central bank has reacted to inflation more strongly during the period. They then simulate the estimated model to obtain implication of changes in Taylor rule to variances in output and inflation. They find that a monetary policy that strongly reacts to inflation delivers moderate output and inflation variations when demand shocks drive the economy, and that such a policy delivers volatile output and moderate inflation variations when supply shocks drive the

economy. Our results are consistent with the case when demand shocks are the main drivers of the economy in their model.

There are, however, two important differences in our study from the previous studies including Boivin and Giannoni (2002). The first difference is that our study implies that effective monetary policy has caused not only a moderation of GDP growth rates but also a decline in median of GDP growth rate. As shown in Table 1 and 3, changes in discrepancy in the distribution of GDP growth rates and inflation rates, are accompanied by changes in median of these two variables. The second difference is that our study implies that there is asymmetry in the way that the monetary policy affects macroeconomy. As shown in Table 1, in most of GM countries, moderations were driven by a disproportionately large decline in upper quantile rather than an increase in lower quantile. That implies, provided that adverse shocks and favorable shocks occur symmetrically, that the effective monetary policy dampens output and inflation greater when a positive demand shock occurs compared with the case when a negative demand shock occurs. In this sense, our result is related to studies the Keynesian Asymmetry, such as Bennett and Manna (2001).[4]

5 Conclusion

Quests for the causes of the Great Moderation has attracted attentions of a good number of researchers and policy makers in particular before the outbreak of current global financial crisis. In this paper, we revisit this issue using two distinct approaches from the previous studies. First, we analyze the time series that covers data after the global financial crisis as well as the data sample before the crisis so as to address the relationship between the financial crisis and the Great Moderation. Second, we make use of econometric methodology proposed by Oka and Qu (2011) that combines structural break tests with quantile regression for the analysis of Great Moderation. This methodology allows us to study how each quantile of distribution of GDP growth rates has evolved over the sample period in details.

We first estimate a distribution of quarterly GDP rate in 24 OECD countries from 1960Q1 to 2014Q1. We then analyze when and how the distribution has changed over

[4]See Cover (1992) and DeLong and Summers (1988) for the related empirical analysis on to how the monetary policy shock affects the economy. These studies report that positive monetary policy shocks have smaller real effects than negative monetary policy shocks.

time in each country. We find that about half of sample countries, including six of G7 countries, have experienced the Great Moderation. In most of these countries, the Great Moderation has occurred during the 1970s or the 1980s, and size of the Great Moderation, measured by changes in discrepancy between 80th quantile and 20th quantile of GDP growth rate over time, is about 1%. It is notable, however, that there is a substantial heterogeneity across countries in terms of timing and size of the Great Moderation. For all of the countries that have witnessed the Great Moderation, the Great Moderation has continued even after the current global financial crisis. Lastly and the most importantly, we find that the moderation has occurred as a contractionary changes in distribution of GDP growth rates. A moderation is accompanied by either a decline in median of GDP growth rate, or a disproportionately large decline in the upper quantile of GDP growth rates.

Based on our estimation results using GDP growth rates, we ask if the explanation by a better monetary policy suits with the data. To to this, we examine developments of inflation rate for our sampled 24 countries using the same methodology of Oka and Qu (2011). We find that median and dispersion of inflation rates have been better controlled in countries that have experienced Great Moderation compared with those that have not experienced Great Moderation. That is, we find that countries that have experienced the Great Moderation have achieved a lower inflation in terms of median of its distribution and lower dispersion of the inflation rate during the 1970s compared with the countries that have not experienced the Great Moderation. In addition, the decline in median and dispersion of inflation rates during the 1980s and beyond have been rapid for these countries.

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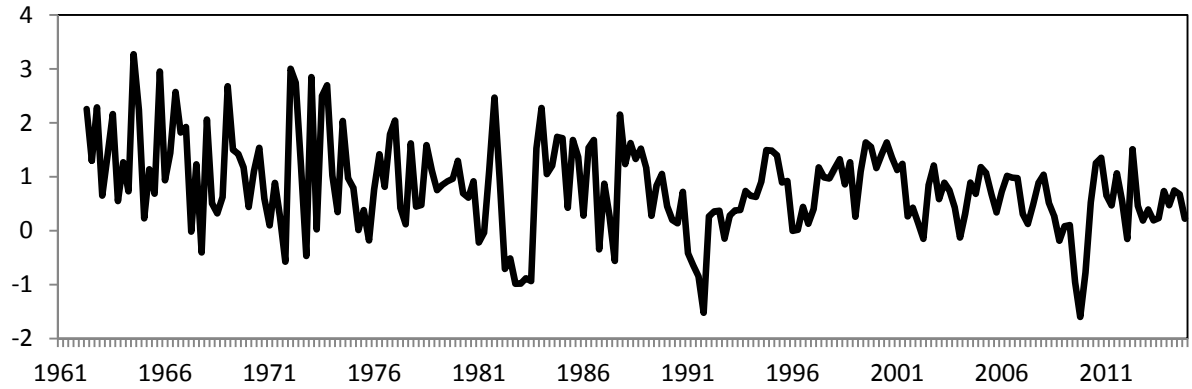
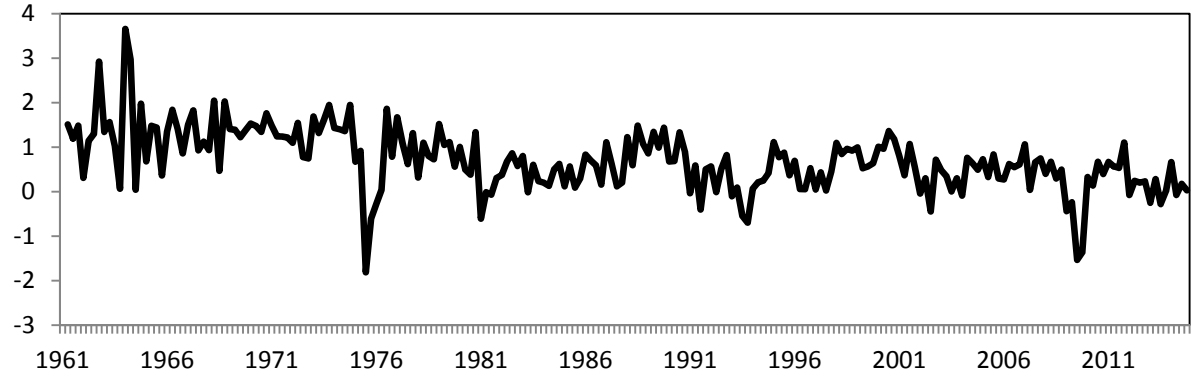
(Figure 1)

Growth Rates of GDP

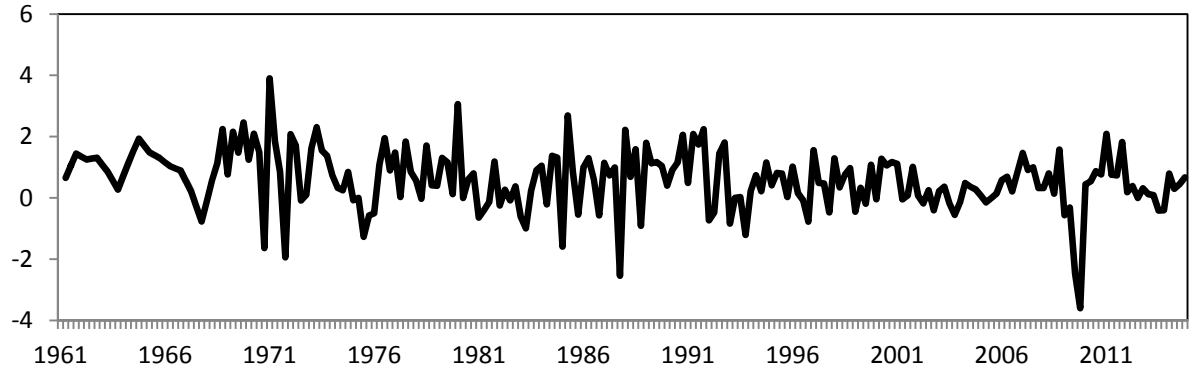
(1) Canada



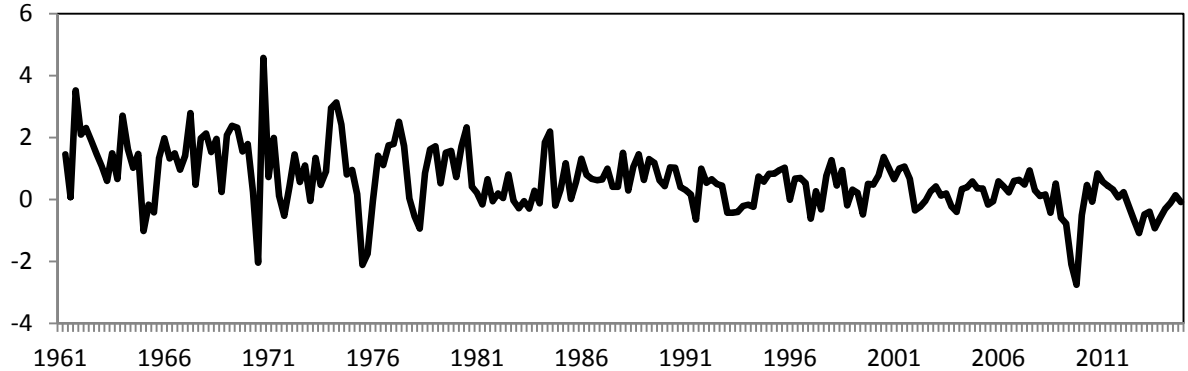
(2) France



(3) Germany



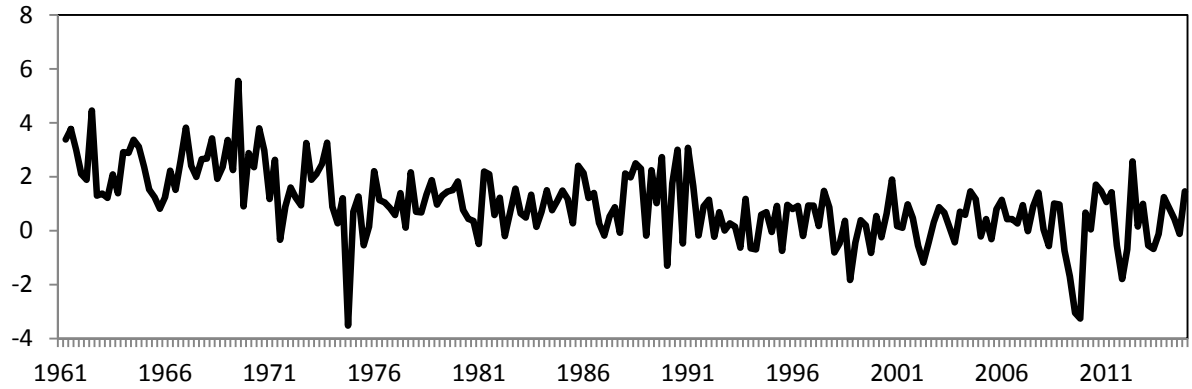
(4) Italy



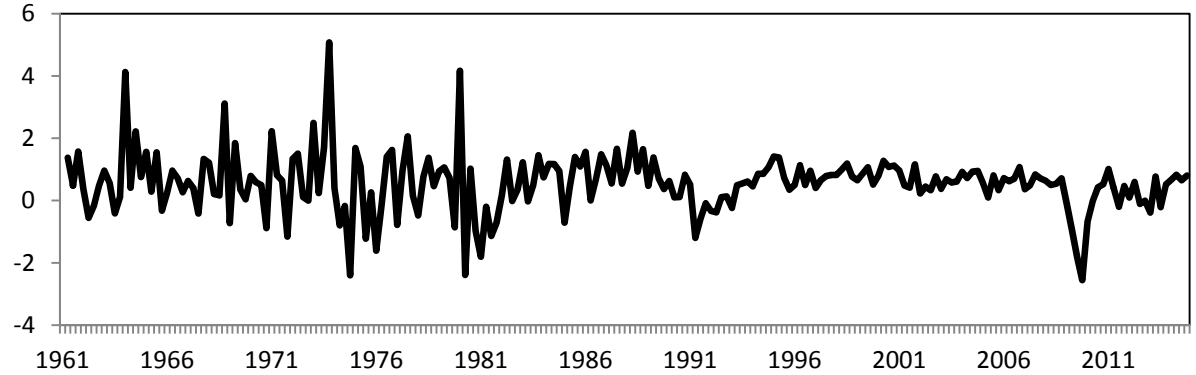
(Figure 1)

Growth Rates of GDP

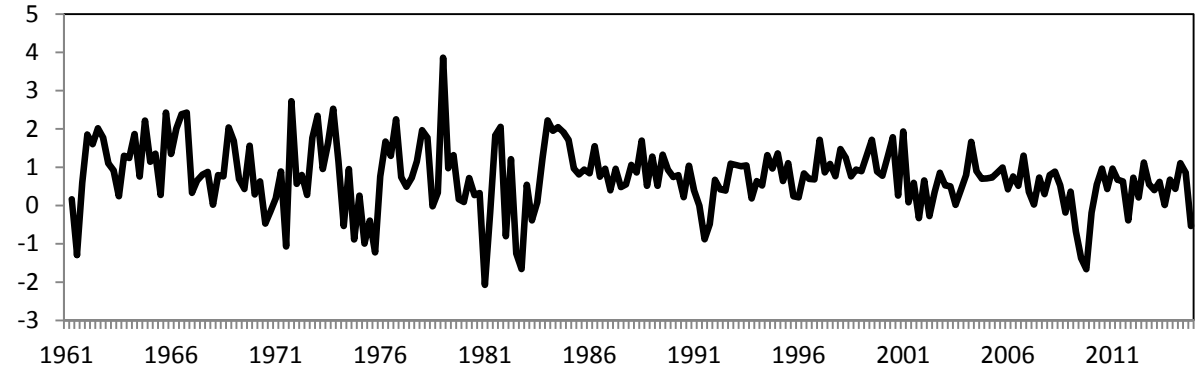
(5) Japan



(6) United Kingdom



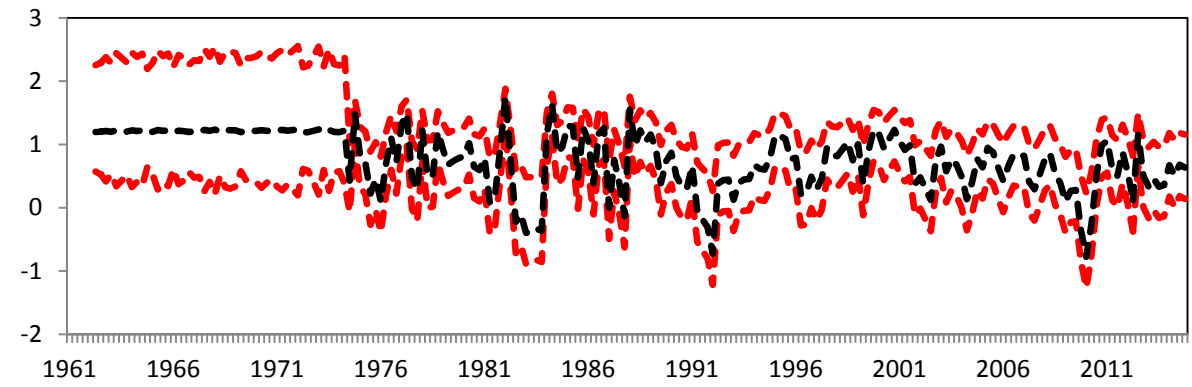
(7) United States



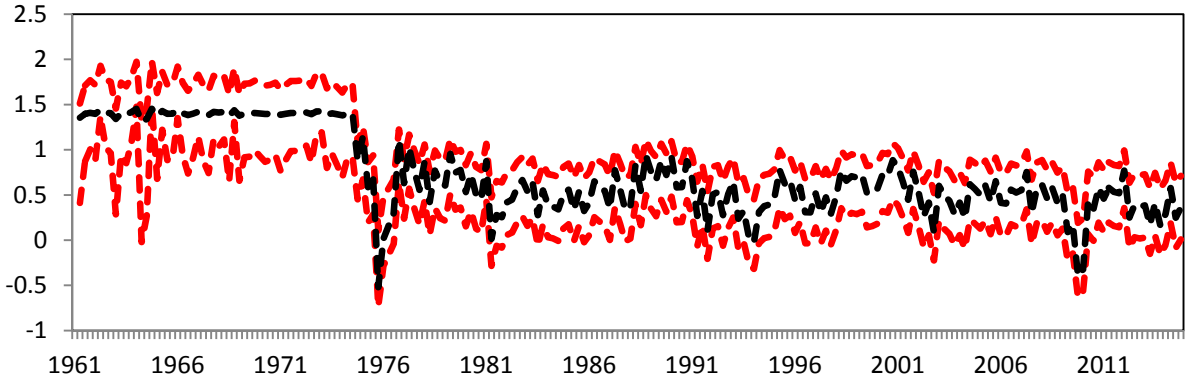
(Figure 2)

Distribution of GDP Growth Rates

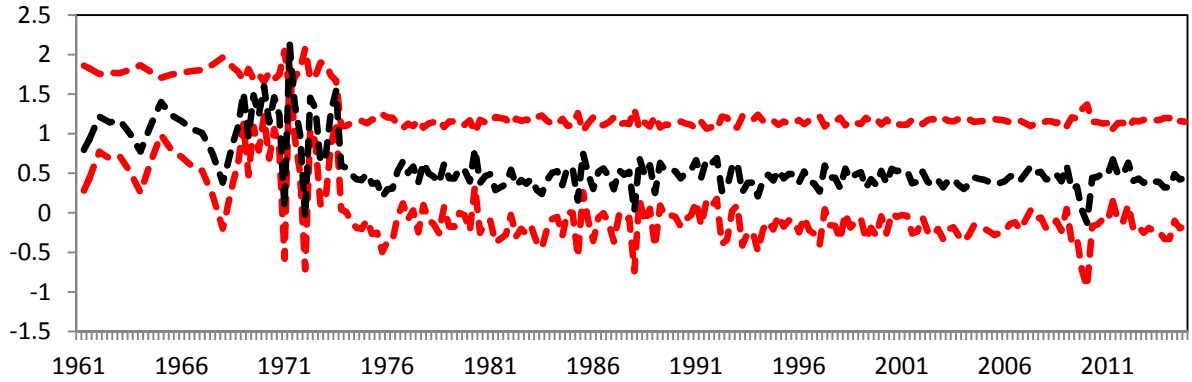
(1) Canada



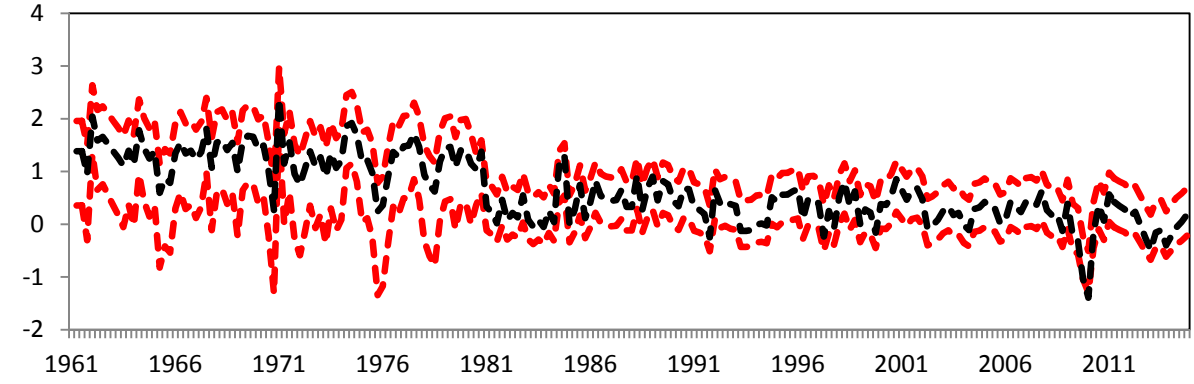
(2) France



(3) Germany



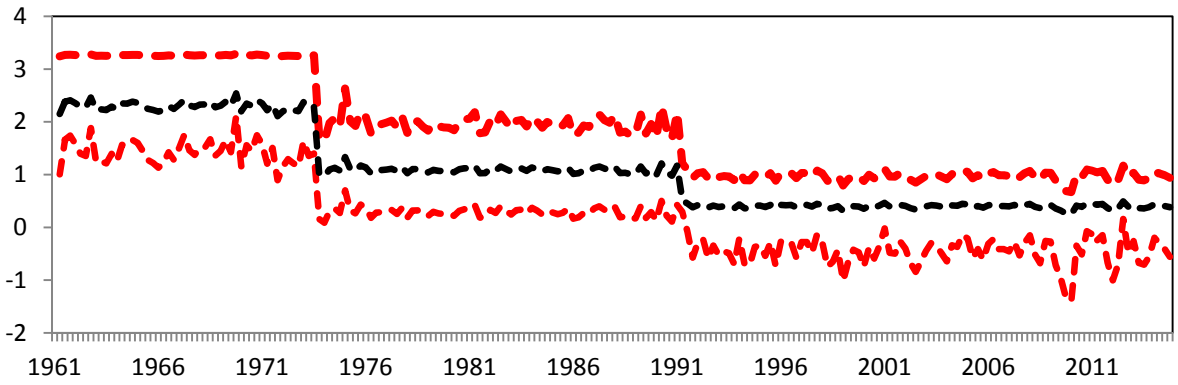
(4) Italy



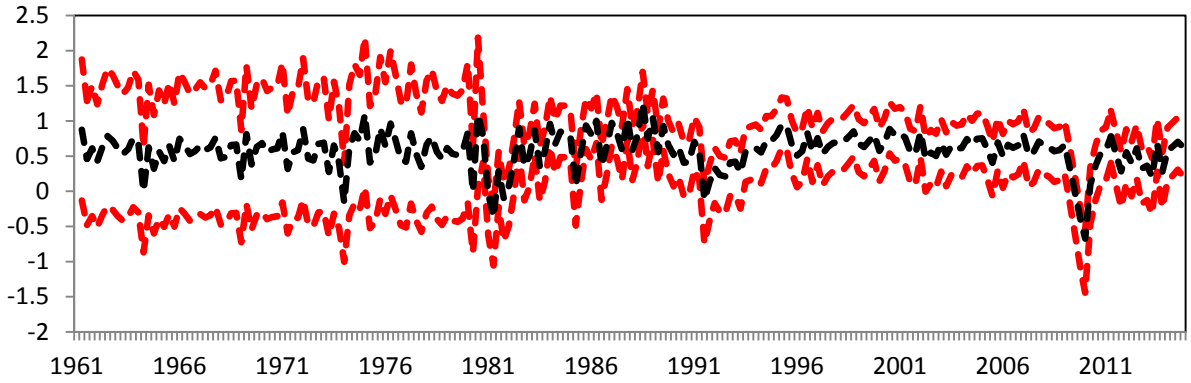
(Figure 2)

Distribution of GDP Growth Rates

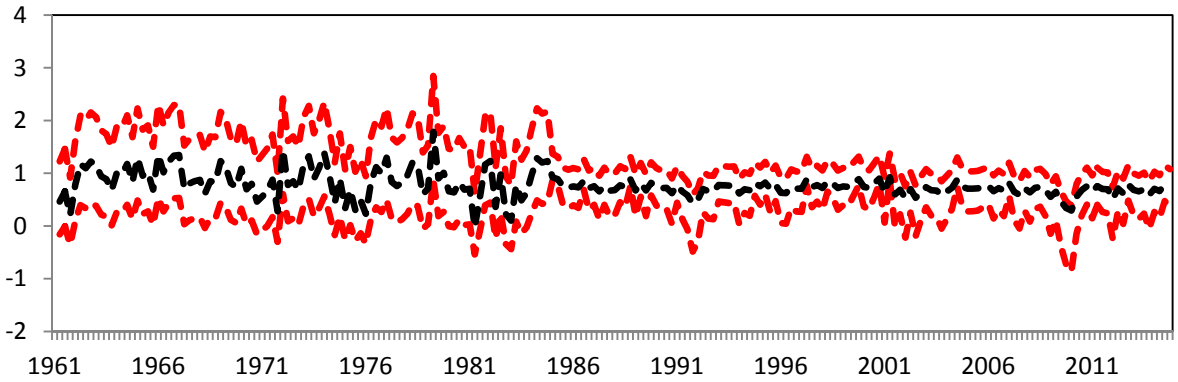
(5) Japan



(6) United Kingdom



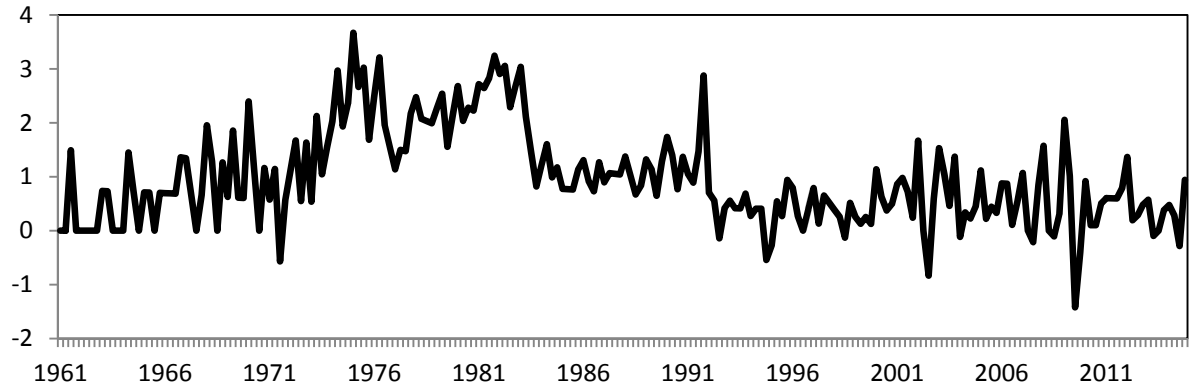
(7) United States



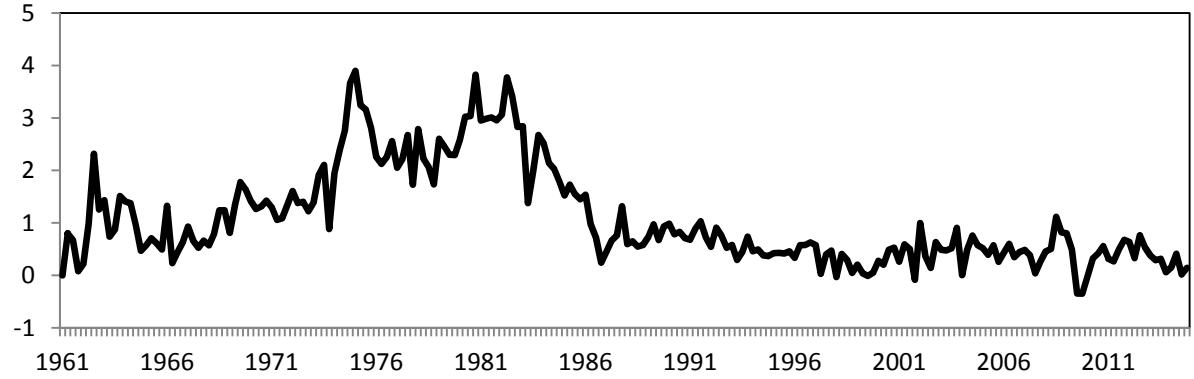
(Figure 3)

Inflation Rate

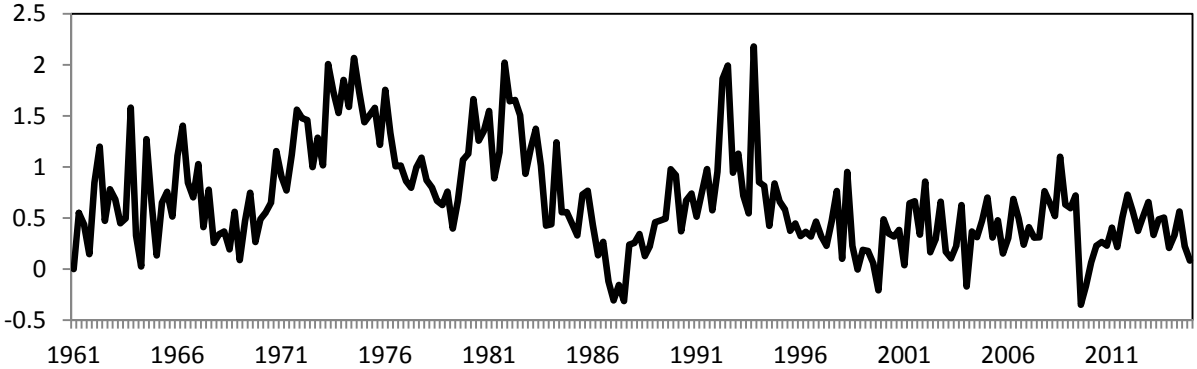
(1) Canada



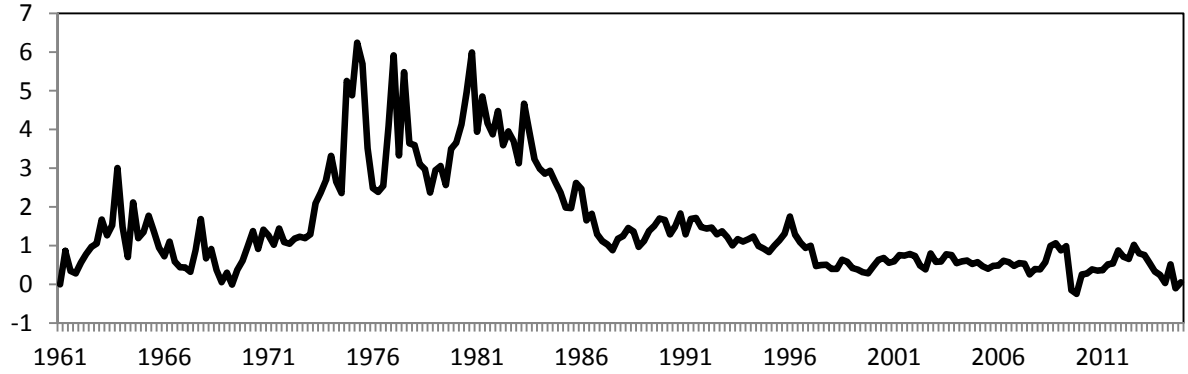
(2) France



(3) Germany



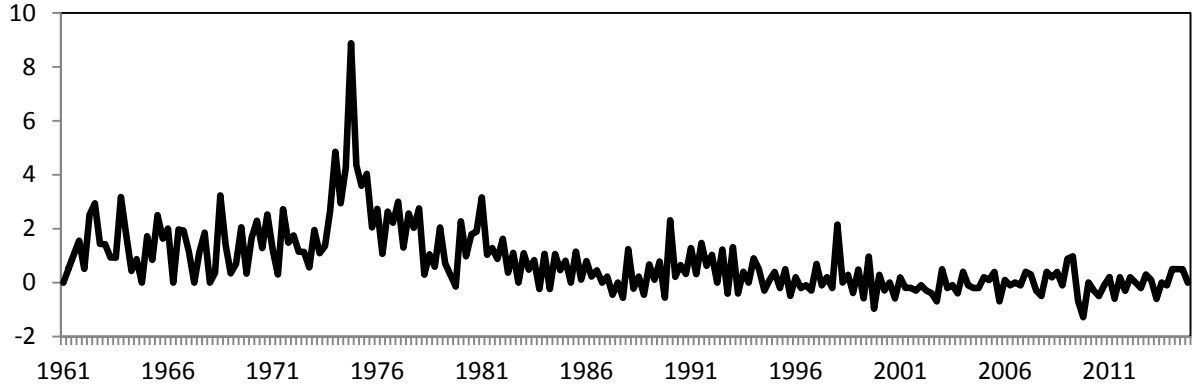
(4) Italy



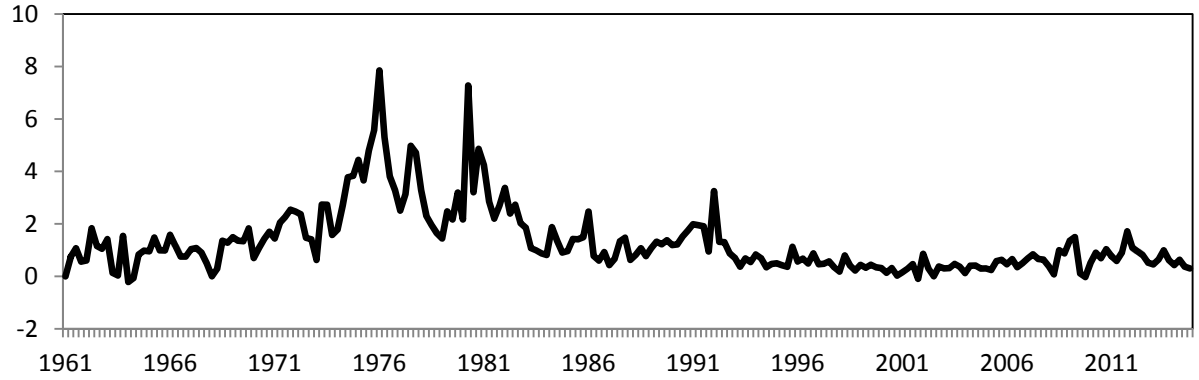
(Figure 3)

Inflation Rate

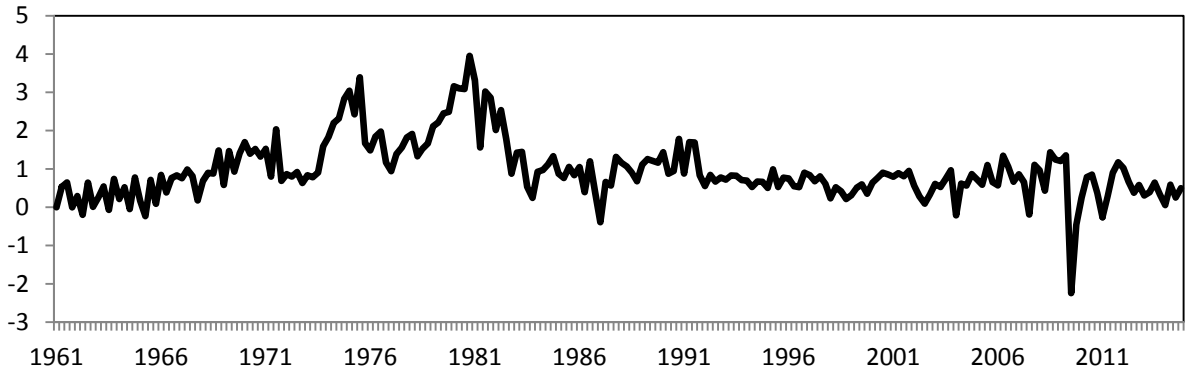
(5) Japan



(6) United Kingdom



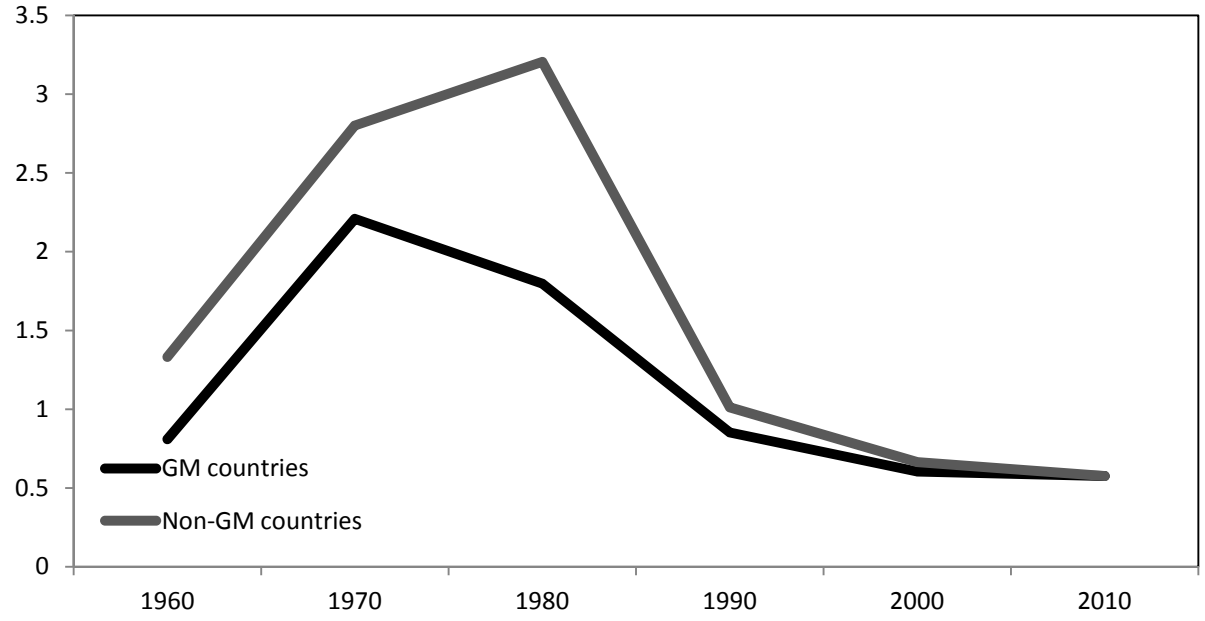
(7) United States



(Figure 4)

Inflation Rate and Great Moderation

(1) Median of inflation rates



(2) Dispersion between upper and lower quantile of inflation rates

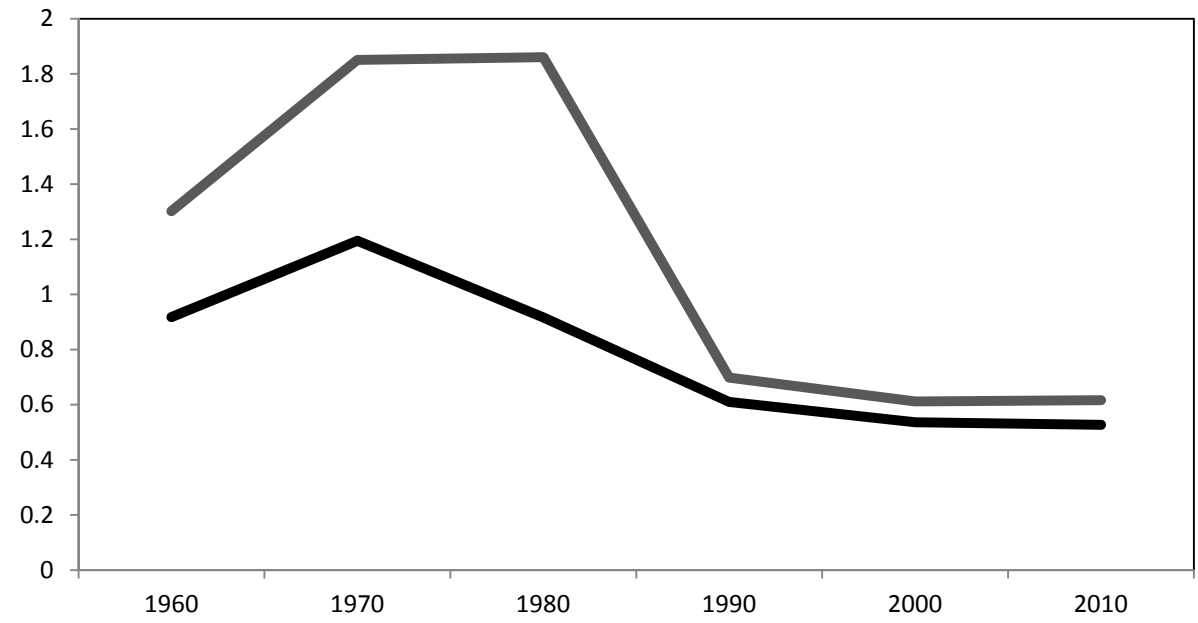


Table 1: Structual Breaks in Distribution of GDP

	Regime I				Regime II					Regime III				
Country	median	80th	20th	80-20th	Start	median	80th	20th	80-20th	Start	median	80th	20th	80-20th
Australia	0.89	2.51	-0.29	2.8	1981.4	0.84	1.23	0.25	0.98	NA	NA	NA	NA	NA
Belgium	1.2	1.34	1.04	0.3	1974.1	0.47	0.78	0.17	0.61	NA	NA	NA	NA	NA
Canada	1.21	2.38	0.42	1.96	1973.4	0.63	1.15	0.13	1.02	NA	NA	NA	NA	NA
Denmark	0.6	0.88	0.29	0.59	1991.3	0.21	1.21	-0.66	1.87	NA	NA	NA	NA	NA
Finland	0.91	1.73	0.19	1.54	1989.2	0.41	1.3	-0.44	1.74	NA	NA	NA	NA	NA
France	1.4	1.73	0.92	0.81	1974.1	0.5	0.81	0.13	0.68	NA	NA	NA	NA	NA
Germany	1.07	1.79	0.6	1.19	1973.1	0.44	1.15	-0.16	1.31	NA	NA	NA	NA	NA
Iceland	0.98	1.37	0.49	0.88	1997.4	0.73	3.59	-2.45	6.04	NA	NA	NA	NA	NA
Ireland	1.13	1.53	0.88	0.65	1999.4	0.65	2.32	-0.36	2.68	NA	NA	NA	NA	NA
Italy	1.28	1.86	0.2	1.66	1979.4	0.28	0.76	-0.15	0.91	NA	NA	NA	NA	NA
Japan	2.3	3.26	1.43	1.83	1973.1	1.09	1.96	0.29	1.67	1990.3	0.4	0.97	-0.45	1.42
Luxemburg	0.89	1.32	0.5	0.82	1995.2	0.98	2.09	-0.26	2.35	NA	NA	NA	NA	NA
Mexico	1.6	1.89	1.38	0.51	1981.2	0.74	1.46	-0.19	1.65	NA	NA	NA	NA	NA
Netherland	1.24	2.34	-0.01	2.35	1971.1	0.72	1.82	-0.47	2.29	1986.3	0.61	0.92	0.01	0.91
New Zealand	0.94	3.07	-2.19	5.26	1986.2	0.68	1.36	-0.02	1.38	NA	NA	NA	NA	NA
Norway	1.1	1.28	0.95	0.33	1977.4	0.51	1.75	-0.36	2.11	NA	NA	NA	NA	NA
Portugal	1.09	1.38	0.71	0.67	2000.1	0.14	0.54	-0.65	1.19	NA	NA	NA	NA	NA
South Africa	1.19	2.21	0.08	2.13	1976.4	0.61	1.21	0.17	1.04	NA	NA	NA	NA	NA
South Korea	1.87	2.8	0.93	1.87	2000.1	0.95	1.6	0.53	1.07	NA	NA	NA	NA	NA
Spain	1.24	1.44	0.82	0.62	1984.1	0.63	1.47	0.05	1.42	1995.2	0.54	0.73	0.28	0.45
Sweden	0.83	1.05	0.67	0.38	1979.3	0.56	1.53	-0.31	1.84	1990.2	0.6	1.18	-0.11	1.29
Switzerland	0.79	2.34	-1.14	3.48	1970.1	0.39	0.71	0.01	0.7	NA	NA	NA	NA	NA
United Kingdom	0.59	1.46	-0.37	1.83	1980.1	0.57	0.9	0.14	0.76	NA	NA	NA	NA	NA
United States	0.86	1.72	0.16	1.56	1984.2	0.7	1.03	0.27	0.76	NA	NA	NA	NA	NA

Note: Countries that have witnessed Great Moderations are shadowed.

Table 2: Monetary Policy Regime

	Inflation Targeting		Great Moderation	
Country	Adopting Date	Target Range	Break Period I	Break Period II
Australia	1993	2--3	1981.4	NA
Belgium	NA	NA	1974.1	NA
Canada	1991	2 +/- 1	1973.4	NA
Denmark	NA	NA	1991.3	NA
Finland	1994	2	1989.2	NA
France	NA	NA	1974.1	NA
Germany	NA	NA	1973.1	NA
Iceland	2001	2.5 +/- 1.5	1997.4	NA
Ireland	NA	NA	1999.4	NA
Italy	NA	NA	1979.4	NA
Japan	NA	NA	1973.1	1990.3
Luxemburg	NA	NA	1995.2	NA
Mexico	2001	3 +/- 1	1981.2	NA
Netherland	NA	NA	1971.1	1986.3
New Zealand	1990	1--3	1986.2	NA
Norway	2001	2.5 +/- 1	1977.4	NA
Portugal	NA	NA	2000.1	NA
South Africa	2000	3--6	1976.4	NA
South Korea	2001	3 +/- 1	2000.1	NA
Spain	1995	3.5--4	1984.1	1995.2
Sweden	1993	2 +/- 1	1979.3	1990.2
Switzerland	NA	NA	1970.1	NA
United Kingdom	1992	2 +/- 1	1980.1	NA
United States	NA	NA	1984.2	NA

Note 1: Countries that have witnessed Great Moderations are shadowed.
Note 2: Table is constructed from Roger (2010).
Note 3: Finland and Spain have abandoned Inflation Targeting as they started to use Euro.

Table 3: Structual Breaks in Distribution of Inflation

	Regime I				Regime II					Regime III					Regime IV				
Country	median	80th	20th	80-20th	Start	median	80th	20th	80-20th	Start	median	80th	20th	80-20th	Start	median	80th	20th	80-20th
Australia	0.6	1.24	0.1	1.14	1971.1	2.12	2.76	1.73	1.03	1990.4	0.57	0.92	0.25	0.67	NA	NA	NA	NA	NA
Belgium	1.31	1.71	1.06	0.65	1985.2	0.53	0.77	0.26	0.51	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Canada	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Denmark	2.2	2.99	1.55	1.44	1991.3	1.01	1.35	0.72	0.63	1992.1	0.53	0.65	0.41	0.24	2002.4	0.46	0.69	0.23	0.46
Finland	1.8	1.77	2.27	-0.5	1991.1	0.41	0.74	0.17	0.57	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
France	1.74	2.14	1.48	0.66	1985.2	0.49	0.65	0.32	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Germany	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iceland	5.78	7.72	3.27	4.45	1989.4	1.05	1.58	0.58	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ireland	1.15	1.58	0.58	1	1969.3	3.27	4.9	2.23	2.67	1983.3	0.7	1.02	0.38	0.64	NA	NA	NA	NA	NA
Italy	0.9	1.36	0.55	0.81	1971.1	1.58	1.95	1.33	0.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Luxemburg	1.07	1.51	0.7	0.81	1989.2	0.57	0.8	0.34	0.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mexico	7.13	9.45	5.95	3.5	1988.1	4.46	5.9	3.78	2.12	1999.1	1.24	1.55	0.87	0.68	NA	NA	NA	NA	NA
Netherland	0.99	1.91	0.34	1.57	1971.2	1.68	2.19	1.39	0.8	1982.1	0.51	0.74	0.32	0.42	NA	NA	NA	NA	NA
New Zealand	2.18	2.57	1.63	0.94	1986.4	0.63	0.99	0.31	0.68	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Norway	0.99	1.52	0.56	0.96	1971.2	1.96	2.76	1.56	1.2	1988.1	0.67	0.88	0.5	0.38	2003.1	0.37	0.81	0.01	0.8
Portugal	0.82	1.94	0.41	1.53	1971.1	4.53	6.24	2.93	3.31	1985.2	1.18	1.6	0.83	0.77	NA	NA	NA	NA	NA
South Africa	0.21	0.87	-0.34	1.21	1976.4	2.8	3.84	1.91	1.93	1981.4	3.31	0.72	0.78	-0.06	1992.3	1.48	2.01	1	1.01
South Korea	3.06	4.52	0.99	3.53	1972.1	2.12	2.8	1.28	1.52	1998.1	0.61	1.08	0.31	0.77	NA	NA	NA	NA	NA
Spain	2.32	2.89	1.62	1.27	1992.1	0.78	1.01	0.43	0.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sweden	0.96	1.34	0.58	0.76	1971.2	1.96	2.65	1.36	1.29	1991.1	0.36	0.6	0.09	0.51	NA	NA	NA	NA	NA
Switzerland	0.96	1.29	0.57	0.72	1993.2	0.15	0.39	-0.03	0.42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
United Kingdom	1.74	2.41	1.34	1.07	1991.1	0.54	0.77	0.36	0.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
United States	0.76	1.15	0.21	0.94	1972.4	2.05	2.32	1.48	0.84	1984.1	0.71	0.96	0.51	0.45	NA	NA	NA	NA	NA

Note: Countries that have witnessed Great Moderations are shadowed.