Growth and Inflation Regimes in Greater Tumen Initiative Area

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Abstract

This paper tests for multiple structural breaks in the mean, seasonality, dynamics and conditional volatility of Greater Tumen Initiative Countries' (GTI) growth and inflation, while also accounting for outliers. It finds a drop in the level of Chinese growth rate in the third quarter of 2011 and of inflation rate in 1998. There are more volatility regimes than the growth regimes and most GTI countries are currently enjoying historically low volatility of their growth and inflation. Two exceptions are the increased growth volatility for Japan since 2006 and inflation volatility for Russia since 2012. There is an increased importance of seasonality in GTI and especially in Chinese inflation volatility, constituting at least a half of the total volatility.

Keywords: China slowdown, multiple structural breaks, seasonality, Greater Tumen Initiative, growth and volatility regimes, growth and inflation.

JEL classifications: E31, E32, C22, C18

1. Introduction

China, Mongolia, Russia and South Korea have agreed to transform the Greater Tumen Initiative (GTI) into an international organization of economic cooperation in Northeast Asia during the summit in Yanji, China on September. 17, 2014[1]. The Tumen River Area Development Programme (TRADP) was first formed by the United Nations Development Programme (UNDP) with the objectives of regional cooperation, economic development, and environmental management in 1995. In spite of its great potential GTI had been largely inactive due to several challenges, including disharmony of interest among member countries, weak infrastructure development, and lack of funding to activate the project. However, GTI has received new stimulus since China adopted it as part of its central economic development plan in 2009. This paper sheds light on the recent developments in the main macroeconomic variables of growth and inflation for these four countries and Japan, currently an observer nation to the initiative.

There are many earlier studies on growth and inflation regimes but none fully focuses on this important geographical region that produces about a quarter of the World GDP[2]. The moderation in volatility of output has been well documented for the US and other developed countries, see McConnell and Perez-Quiros (2000), and Gadea, Gomez-Loscos and Perez-Quiros (2018), among others. Coric (2012) studies 98 countries and finds that almost two thirds experienced GDP growth volatility decline between 1961 and 2007, implying that the so-called "Great Moderation" took place in economies at all income levels.

On the other hand, Easterly, Kremer, Pritchett and Summers (1993) find that medium term growth lacked persistence, and countries transitioned between high and low growth regimes. Ben-David and Papell (1998), Pritchett (2000), Hausmann, Pritchett and Rodrick (2005), Jones and Olken (2008), Berg, Ostry, Zettelmeyer (2012) show that the growth regimes are indeed more important phenomena than the long run average growth rate that masks them. Yet Kar, Pritchett, Raihan and Sen (2013) criticize that the structural break tests that are used to identify the growth regimes suffer from low power, due to the presence of high volatility in shorter annual samples, hence miss some of the “true” regimes.

Kar et al. (2013) suggest to refrain from using purely statistical test but to marry it with an ad hoc filter approach that has been used in earlier studies of Hausmann et al. (2005), and Aizenman and Spiegel (2010), among others. In particular, they propose evaluating the sample splits derived from Bai and Perron’s (1998, 2003) dynamic programming approach based on a priori defined filters and find more breaks. In contrast to the earlier works that often use a simple model with regime dependent intercept (e.g. Jones and Olken, 2008), Jerzmanowski (2006) and Kerekes (2012) use Markov-switching AR(1) model for the growth rates, whose intercept, AR coefficient and volatility depend on four different regimes: growth, stagnation, crisis and miracle growth. But the condition that the intercept, AR coefficient and volatility are required to change at the same time can be restrictive.

Although the Great moderation and growth regime literatures both address the economic development, which makes “hard to think about anything else” (Lucas, 1988) due to its implication for human well-being, the former often uses the growth rates of quarterly real GDP while the latter relies on that of the annual real GDP per capita. Therefore, the first contribution of the paper is to use the recently developed iterative structural break testing methodology of Bataa, Osborn, Sensier and Dijk (2014) and to identify growth regimes in the GTI using the longest and most up-to-date quarterly data, to increase power of the test.

Blanchard and Simon (2001) show that while the causes of the decline in US output volatility are complex, this decline can be linked to changes in the properties of inflation and particularly to a decline in inflation volatility over the period 1952-2001. Similarly, Eichengreen, Park and Shin (2012) find that policy instability, measured by high and variable inflation rates, are precursors to growth slowdowns. Therefore, my second contribution is to search for coincident changes in inflation and growth properties. This is in line with Jones and Olken (2008) who ask what the breaks actually entail without making statements about the direction of causality between the variables.

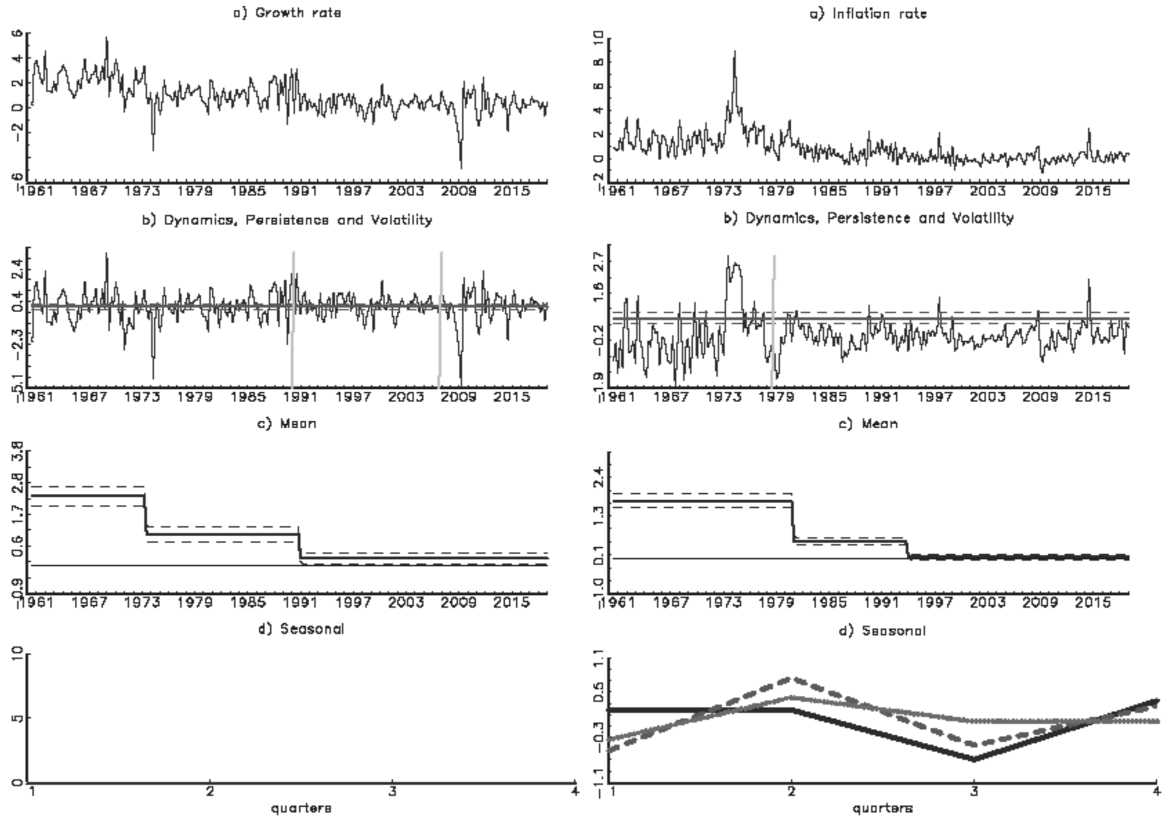
The paper is organized as follows. Section 2 explains the data and summarizes the iterative decomposition method of Bataa et al. (2014) to identify and distinguish between breaks in mean, seasonality (if any), persistence and (conditional) volatility of the growth and inflation series, while also accounting for the possible presence of outliers. Section 3 provides the results and compares with previous studies. Section 4 concludes.

2. Data and Methodology

I analyse quarterly real GDP growth and CPI inflation rates for each of the GTI countries. The sample for China, Russia and Mongolia starts later than the other two countries due to the lack of quality data. The start dates are therefore the second quarters of 1960 for Japan and South Korea, of 1993 for China and of 1995 for Mongolia and Russia. All end in the last quarter of 2018[3]. Russian and Mongolian growth rates and all the inflation rates are not seasonally adjusted.

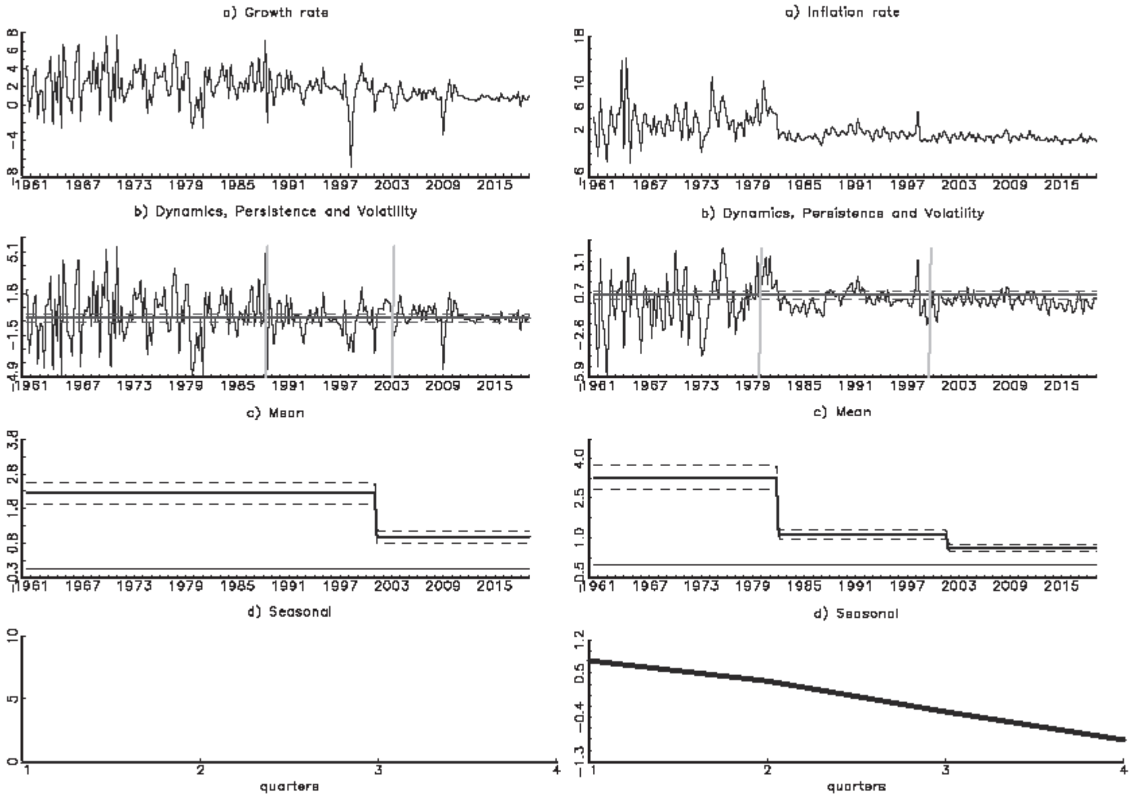
Panel a) in each of Figures 1 to 5 show the raw series analysed. One can easily eyeball the presence of outliers (see, for example, Japanese inflation after the first oil shock in Figure 1), changes in mean inflation (such as for Russia, Figure 4) and/or volatility (apparently present for Chinese, and South Korean growth and Mongolian inflation, Figures 3, 2 and 5). Seasonality is also evident in many of the series, with this perhaps being clearest for Russian and Mongolian growth as the peaks and troughs occur with 12-month intervals (Figures 4 and 5, respectively).

Figure 1: Japan Decomposition



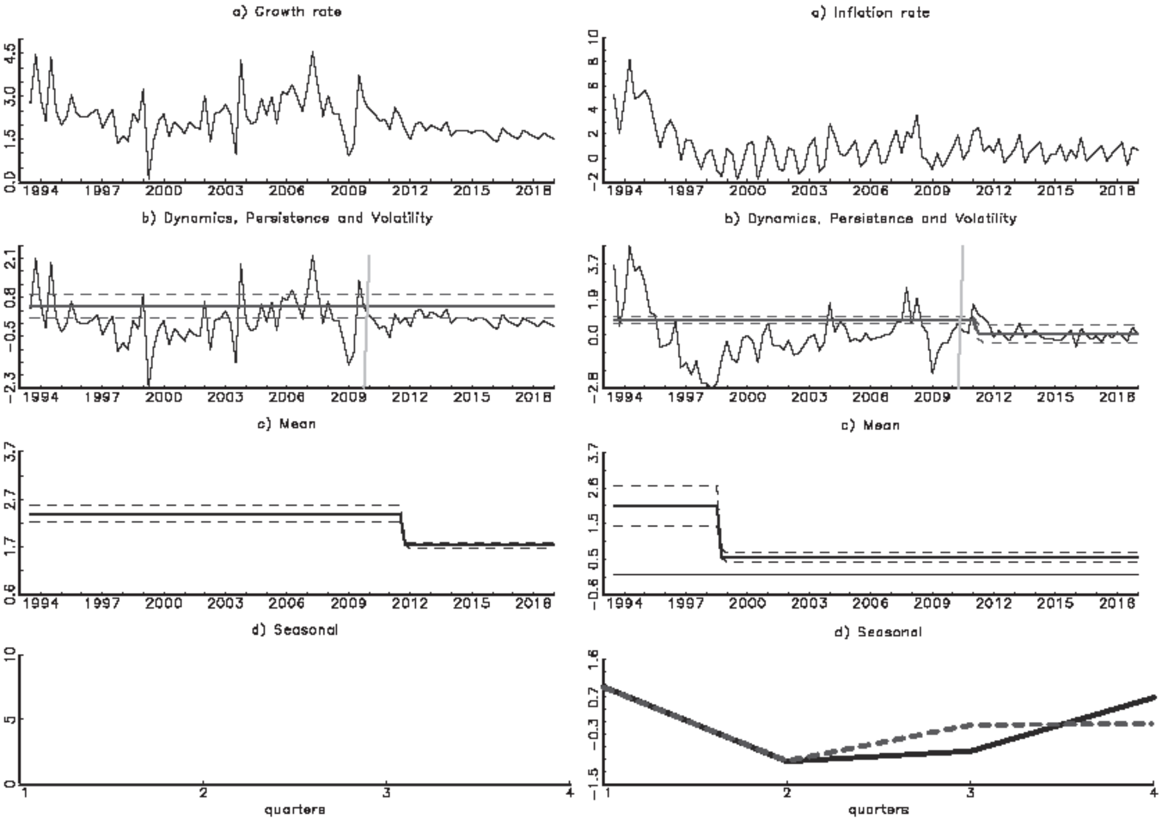
Notes: Panels show: a) observed growth and inflation, b) dynamic component, persistence (straight line) and volatility break dates (vertical lines); c) regime means and d) deterministic seasonal component for regime 1 in solid, regime 2 in dashed and regime 3 in dotted lines respectively.

Figure 2: South Korea Decomposition



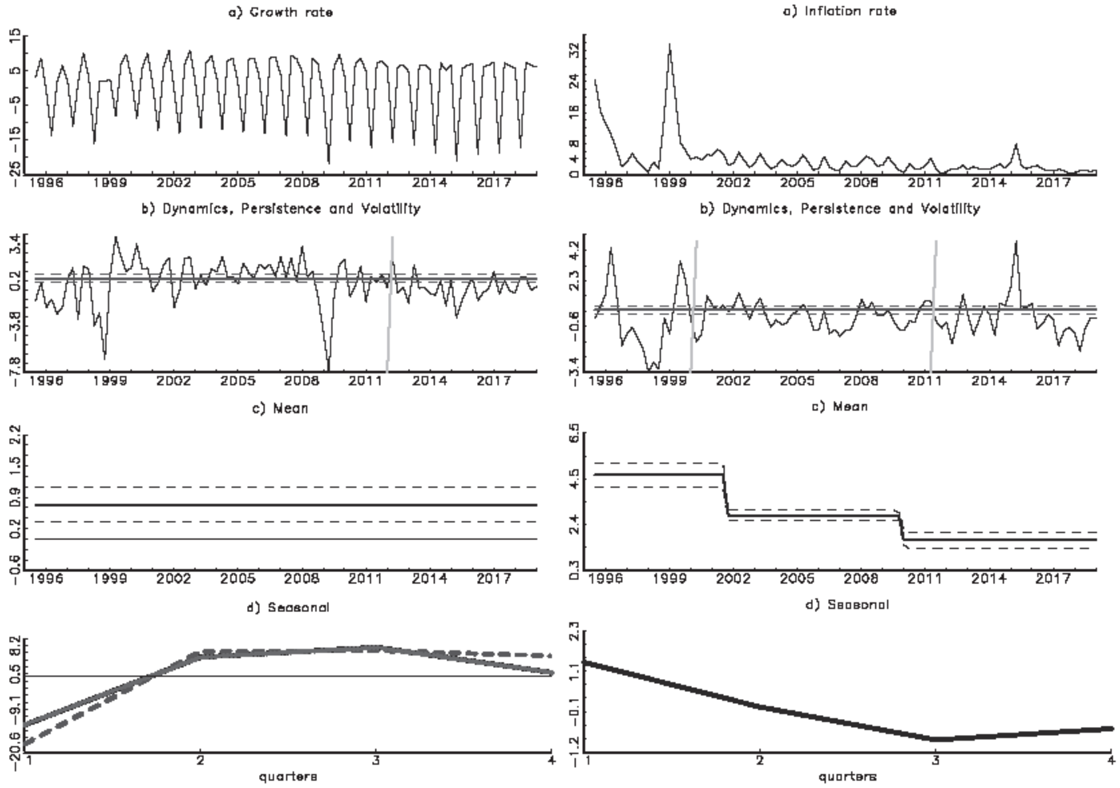
Notes: See Figure 1.

Figure 3: China Decomposition



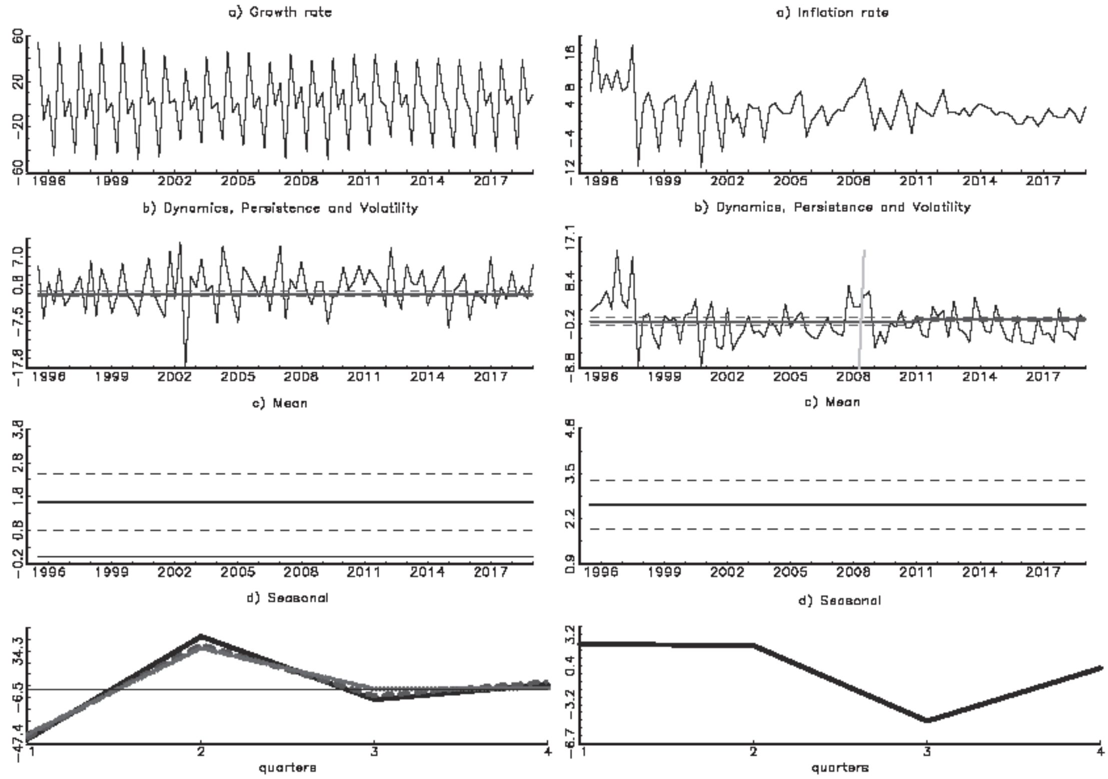
Notes: See Figure 1.

Figure 4: Russia Decomposition



Notes: See Figure 1.

Figure 5: Mongolia Decomposition



Notes: See Figure 1.

Bataa et al. (2014) consider decomposing a stationary time series Y_t into components capturing level (L_t), seasonality (S_t), outliers (O_t) and dynamics (y_t), where level and seasonality are deterministic and only the last component is stochastic and represented by means of an autoregressive (AR) process (although this could include stationary stochastic seasonality, if appropriate).

The model they consider allows for structural change in each of the level, seasonal and dynamic components, where breaks in the latter may occur in the AR coefficients or in the conditional volatility. A crucial feature of the model is that the numbers of structural breaks in these components do not have to be the same and nor do their temporal locations, hence might prove more flexible than the Markov-switching framework used in Jerzmanowski (2006) and Kerekes (2012). The general model specification is given by

$$Y_t = L_t + S_t + O_t + y_t \tag{1}$$

$$L_t = \mu_{k_1} \qquad t = T^1_{k_1-1} + 1, \ldots, T^1_{k_1}, \quad k_1 = 1, \ldots, m_1 + 1 \tag{2}$$

$$S_t = \sum_{l=1}^{s} \delta_{k_2 l} D_{lt} \qquad t = T^2_{k_2-1} + 1, \ldots, T^2_{k_2}; \quad k_2 = 1, \ldots, m_2 + 1 \tag{3}$$

$$y_t = \sum_{i=1}^{p} \phi_{k_3,i} y_{t-i} + u_t \qquad t = T^3_{k_3-1} + 1, \ldots, T^3_{k_3}; \quad k_3 = 1, \ldots, m_3 + 1 \tag{4}$$

$$\sigma^2_{u,t} = var(u_t) \qquad t = T^4_{k_4-1} + 1, \ldots, T^4_{k_4} \ ; \quad k_4 = 1, \ldots, m_4 + 1 \tag{5}$$

where m_j denotes the number of breaks of type j that occur at observations T^j_{kj} (k_j = 1, ..., m_j), with $T^j_0 = 0$ and $T^j_{m_j} = T$ (where T denotes the total sample size), and for s seasons per year (s = 4 for quarterly data), D_{lt} (l = 1, …, s) are seasonal dummies equal to unity if the observation at time t falls in season l and zero otherwise. Note that the coefficient $\delta_{k_2 l}$ represents the deviation of the unconditional mean of Y_t in the l-th season (month) from the overall mean level μ_j and, for identification purposes, we impose the restriction $\sum_{l=1}^{s} \delta_{k_2 l} = 0$ for all seasonality regimes k_2 = 1, …, m_2+1.

I can then define the seasonal share in the total volatility as in (6), where $\sigma^2_{S,t}$ and $\sigma^2_{y_t}$ are simply standard deviations of the fitted values of (2) and (4) respectively:

$$Ss_{k_5} = \frac{\sigma^2_{S_t}}{\sigma^2_{S_t} + \sigma^2_{y_t}} \qquad t = T^5_{k_5-1} + 1, \ldots, T^5_{k_5}; \quad k_5 = 1, \ldots, m_2 + m_3 + m_4 + 1 \tag{6}$$

Although our principal interest is the possibility of breaks in the components (2) to (5), outliers are corrected to prevent these distorting inferences concerning other components. Outliers, O_t in (1), are observations that are abnormally distant from the overall level, defined as 5 times interquartile range from the median and, when detected, are replaced with the median of the six neighbouring non-outlier observation. The null hypothesis of no break is tested against an unknown number of breaks up to M using WDMax test and if rejected the exact number of breaks are identified using sequential tests Seq(i+1|i), starting with i=1 as in Bai and Perron (1998, 2003). Bataa et al. (2014) employ an iterative approach using Qu and Perron (2007) test to examine breaks in each of the components of (2)-(5) and the details of their methodology are relegated to the original study to conserve space.

There is a well-known trade-off between size and power when choosing the maximum number of breaks (M) and trimming parameter, that is the minimum fraction of the sample between any two breaks (see Bai and Perron, 1998, 2003). My choice is to allow for a maximum of three breaks (20% trimming) except for the autoregressive and seasonal parameters for China, Russia and Mongolia. For these I consider up to two breaks (30% trimming). The results are quite robust to other sensible parameterization.

3. Empirical Results

Figures 1 to 5 show the empirical results of the iterative decomposition in graphical form. These charts provide: a) the original unadjusted GDP growth and CPI inflation series; b) the estimated dynamic component y_t (constructed by removing outliers, mean and seasonal components) together with its estimated persistence, defined as the sum of the autoregressive coefficients in (4) and corresponding ± 2 standard error bands (in dashed lines), and volatility break dates (vertical lines); c) the level component L_t with ± 2 standard error bands; and d) the estimated seasonal component for each seasonal regime[4]. Standard errors are obtained using the HC covariance matrix in the corresponding regression over the regime defined by the appropriate estimated break dates. Where relevant, the graphs showing the seasonal components are line-type-coded with the first regime (that is, the sub-sample to the first break date) in solid line, the second in dashes and the third in dots.

Table 1 provides structural break test results for the mean, seasonality (if not already seasonally adjusted), autoregressive parameters and volatility in its first four panels. The last panel reports the convergence statistics of the Bataa et al. (2014); the number of iterations for outer (and inner) loop. Table 2 shows the break dates and the respective component's regime-specific estimates based on the breaks and also the estimates ignoring those breaks. 95% confidence interval for the break dates and heteroskedasticity robust standard errors are also reported in brackets. There are five country-columns, each split into further growth and inflation sub-columns. I discuss the results for seasonality first, then dynamics and finally level and volatility.

The null hypothesis of no structural break in the seasonal pattern of Japanese inflation against an alternative of unknown number of breaks is rejected soundly as WDmax statistic of 22.34 is significantly higher than the critical value of 14.55 (panel B of table 1). The sequential test indicates that there are two seasonal breaks, which occur in the first quarter of 1978 and the last quarter of 1999 (panel B of table 2)[5]. As the right-hand side of panel d) in Figure 1 reveals, the first quarter decline in prices started in 1978. Since then although the overall pattern of seasonality is largely intact, the magnitude of the seasonal oscillations has reduced in the new millennia. Bataa et al.'s (2014) study monthly of G7 inflation found that there are also two seasonality breaks in Japanese inflation; in September 1984 and May 1999, the latter of which is very close to the one in this study.

I find no statistically significant structural change in South Korean, Russian and Mongolian inflation seasonality; prices peak in the first quarter and drop subsequently throughout the year for the former two countries (figures 2 and 4) while inflation is highest in the first half of the year and declines only in the autumn in Mongolia. As for China, there is a marginally significant structural break in inflation seasonality; after 2009 prices neither drop in the third quarter, nor increase in the last quarter, as much as they used to before that (figure 3). In terms of the size of seasonality, measured by their standard deviations, the countries rank from low to high order as Japan, South Korea, China, Russia and then Mongolia.

Remarkably large seasonal fluctuations for Russian and Mongolian growth in figures 4 and 5 contain two structural breaks each with similar timing, perhaps both reflecting their dependence on fuel and energy products as their main economic growth. In both countries, growth drops in the first quarter and recovers in the second quarter (and also third quarter for Russia's case). The magnitude of the drop in the first quarter has intensified in Russia, first in the second quarter of 2003 and again in the third quarter of 2011 while the seasonality is overall declining for Mongolia, although starting from an extremely high level. The magnitude of the Russian seasonal fluctuations is a drop of 12.92% in the first quarter, and seasonal recoveries of 3.92%, 8.04% and 0.96% respectively in the remaining quarters of the year before 2003. Then the pattern changes into a drop of 15.04% in the first quarter and recoveries of 6.66%, 7.47% and 0.91% in the following quarters. After 2010, the drop is 18.55% and the recoveries are 6.31%, 6.45% and 5.79%. The comparative seasonal drop and recoveries are -43.56%, 47.34%, -8.49%, 4.71% over the quarters before 2003, -42.02%, 40.21%, -5.31%, 7.13% afterwards and -39.26%, 36.98%, 0.82% and 1.47% after 2011 in Mongolia.

It is also interesting to find no growth persistence break for all the countries (panel C of Table 1). This is line with the earlier literature that finds low growth persistence (see e.g. Easterly et al.). The growth persistence is statistically insignificant for Japan and South Korea, but significant for the other countries (panel C of Table 2). Inflation persistence, measured by the sum of autoregressive coefficients declines in China in the third quarter of 2011 and is now the lowest in the GTI area, while that of Mongolia increased after a quarter[6].

The null hypothesis of a constant mean is rejected for all series except in Russian growth and Mongolian growth and inflation. The sequential tests indicate that there are two breaks for Japan and one break for China in their levels of growth and inflation. The number of breaks in growth and inflation does not match for South Korea and Russia; 1 and 2 for the former and 0 and 2 for Russia. The 95% confidence intervals for the break dates much tighter than the seaonality breaks.

Japanese growth declines in the second quarter of 1973, after the first oil shock, from 2.31% per quarter to 1.03%, and again in the last quarter of 1990, after the burst of its asset price bubble. The growth is mere 0.24% after this break, which is at least 3 times lower than the post-60 average growth of 0.94%, obtained by ignoring the breaks. Interestingly, South Korea maintained its miracle growth rate of 2.21% up until 2001. This is in contrast to Ben-David and Papell (1998) who found, using annual real per capita GDP, growth slowdowns, in 1967 for Japan and in 1979 for South Korea using data from 1950 to 1990. However their methodology allows for only one break. Bai and Perron (1998, 2003) show that when there are more than one breaks such a procedure can be misleading. Jones and Olken (2008) and Kar et al. (2012) found two down-breaks in 1970 and 1991 for Japan, which are very close to what I find. For South Korea, Jones and Olken (2008) found an up-break in 1962 using a sample that ends in mid 2000s. Kar et al. (2012) reported two up-breaks in 1962 and 1982 and two down-breaks, in 1991 and 2002 for South Korea. But as explained in the Introduction they do not consider the statistical significance of their breaks.

There is some evidence that the growth regimes precede those of inflation for Japan and South Korea, in contrast to Eichengreen et al.'s (2012) claim. The second Japanese growth decline occurs less than 3 years before the inflation decline, while 2001 growth slowdown of 1.28 percentage point in South Korea is followed within a quarter by 0.52 percentage drop in its level of inflation. Interestingly, Bataa et al. (2014) also found two down-breaks in Japanese inflation; the first one is in January 1981 and the second one in 1990s. The level of inflation is breaking down in both China and Russia but remains at stubbornly high level in Mongolia.

Eichengreen et al. (2012) note that a special anxiety is attached to the question of how and when Chinese growth might slow. This study finds evidence that the slowdown might have already occurred and is dated in the third quarter of 2011. If this break is ignored one would wrongly calculate the average annual growth is 8.8% per annum since 1995, but as Table 2 indicates the growth has declined from 9.56% before the break to 6.9% afterwards. This could indeed be associated with the increased power of Bataa et al.'s (2014) testing strategy.

Panel Ds of Tables 1 and 2 indicate that volatility regimes are most common. There are 6 and 7 of them in growth and inflation, respectively. While most other countries' growth volatilities are entering more stable regimes, Japanese one is substantially higher in the latest regime that started in the last quarter of 2006, influenced by the GFC, yet the inflation volatility is still subdued since 1979. Inflation volatilities are also mostly subdued except in Russia, where the inflation has become more volatile after the first quarter of 2012, perhaps reflecting the Western sanctions.

The volatility for inflation first declines in 1981 for South Korea followed by a decline for its growth in 1989 (panel D, Table 2). The inflation volatility further declines in 2000, which is again followed by a growth volatility decline after 3 years. Such close relationship applies for China and to a lesser extent for Russia. Given that inflation volatility is often used as policy instability (see e.g. Eichengreen, Park and Shin, 2012) it could be that inflation volatility precedes growth volatility. This hypothesis should be an interesting topic for future research, perhaps using the multivariate approach as in Bataa et al. (2013).

The share in the total volatility of seasonal origin has increased for all inflation series. While around a quarter of the total volatility used to be attributed to the seasonality in Japan and South Korea before the 1980s, more than a half is due to such forces in the new millennia. It is particularly high in otherwise tranquil Chinese inflation where it accounts for 82% of the total volatility after the third quarter of 2011. As for the Russian and Mongolian growth rates, more than 80% their volatility is driven by seasonal fluctuations. As the business cycle component of Russian quarterly growth volatility declines, the seasonal cycle's share has increased; 92% of its total volatility is being driven by seasonality since the second quarter of 2013.

4. Conclusions

This paper uses a newly developed iterative procedure for the decomposition of GTI growth and inflation into level, seasonality and dynamic components, together with conditional volatility, when these components are permitted to exhibit distinct multiple structural breaks over the sample period and outliers are taken into account. To my knowledge, such a flexible procedure has not been used previously in the.

The paper delivers evidence that important structural changes occurred not only in the level (mean) of growth and inflation, but also in their seasonal pattern, and volatility. These results highlight the importance of considering different types of structural breaks in the current debate of implications of Chinese growth slowdowns (see, for example, Pritchett and Summers, 2014) for Northeast Asian economies. More specifically, just as did the growth slow down in the second quarter of 1973 and in the last quarter of 1990 in Japan and also in the first quarter of 2001 in South Korea, I find a statistically significant growth slowdown in the third quarter of 2011 for China.

The paper also sheds light on the sources of inflation volatility and documents that seasonality is emerging as the dominant source of volatility in an era of reduced business cycle volatility. This highlights the importance of rethinking the current practice of relying too much on seasonal adjustment techniques such as X-13 or DEMETRA before analysing the growth and inflation behaviour as these seasonal filters are removing too much of the real life or relevant fluctuations.

Acknowledgements

The author gratefully acknowledges financial assistance from the Economic Research Institute for Northeast Asia's Visiting Researcher program, under which this work was initiated. However, the Institute bears no responsibility for the contents of this paper. I would like to acknowledge the constructive comments received at the Institute's seminar and at University of Niigata Prefecture workshop "International Trade and Innovation in Global Economization".

Table 1. Structural Break Tests in Components of GDP Growth and CPI Inflation

	Japan 1960q2-2018q3		South Korea 1960q2-2018q3		China 1993q2-2018q3		Russia 1995q2-2018q3		Mongolia 1995q2-2018q3	
	growth	inflation	growth	inflation	growth	inflation	growth	inflation	growth	inflation
A. Mean										
WDmax	102.52*	202.16*	48.19*	110.37*	51.73*	33.60*	8.93	64.31*	7.18	1.50
Seq(2|1)	26.44*	38.04*	2.68	24.84*	0.20	0.19		24.96*		
Seq(3|2)	0.45	0.02		0.0				0.0		
B. Seasonality										
WDmax	N.A.	22.34*	N.A.	7.04	N.A.	13.29*	87.06*	4.40	41.31*	3.18
Seq(2|1)		19.84*				7.67	18.32*		50.30*	
Seq(3|2)		0.0								
C. AR lags	0	3	3	4	4	2, 0	1	1	3	0, 4
WDmax	1.83 (9.4)	9.63 (14.6)	13.07 (14.6)	14.04 (16.9)	5.32 (15.5)	14.34*(10.8)	4.4 (8.24)	1.42 (10.8)	10.72(13.3)	19.8*(13.3)
Seq(2|1)						2.17 (11.70)				4.35 (16.70)
D. Volatility										
WDmax	15.68*	64.22*	70.42*	140.29*	58.63*	45.55*	11.44*	23.74*	3.62	24.47*
Seq(2|1)	15.73*	5.98	55.53*	23.40*	2.63	6.78	6.63	21.49*		6.74
Seq(3|2)	4.27		4.65	0.0				1.30		
E. # iteration	2 (2)	6 (2)	3 (2)	5 (2)	3 (2)	19 (2)	19 (2)	8 (2)	3 (2)	5 (3)

Notes: Decomposition using the iterative method of Bataa *et al*. (2014), with breaks detected using Qu and Perron's (2007) test. * indicates a rejection of the null hypothesis with 95% confidence. The null hypothesis of *WDmax* test is no structural break while the alternative is up to *M* breaks. If the null is rejected then *Seq(i+1|i)* test is sequentially applied to determine the exact number of breaks, starting with a null of 1 break against an alternative of 2, until the null is not rejected. Asymptotic 5% critical values of *WDmax, Seq*(2|1) and *Seq*(3|2) tests for the mean and volatility are 9.42, 9.82 and 10.72, respectively with trimming 20% and *M* = 3. The corresponding values for the seasonality are 14.55, 15.46 and 16.34 respectively, with 20% trimming and *M* = 3 (13.26 and 14.34 with 30% trimming and *M* = 2). Those for the autoregressive parameters (trimming parameter and *M* are the same with seasonality) are reported next to the test statistics in brackets in panel C as the lag orders differ across variables. The autoregressive order of the dynamic component is selected by the AIC criterion and is reported in panel C. Finally, the numbers required to achieve convergence on the main and (sub) loops are shown. If the iteration converges to a two cycle (when 19) it reports results based on Bataa *et al*. (2016)'s information criteria.

Table 2. Regimes in Components of GDP Growth and CPI Inflation and Seasonality Share in the Total Volatility

	Japan		South Korea		China		Russia		Mongolia	
	growth	inflation	growth	inflation	growth	inflation	growth	inflation	growth	inflation
A. Mean break dates	**73q2**	**80q4**	**01q1**	**81q4**	**11q3**	**98q3**		**01q3**		
	(72q1-74q3)	(80q1-81q3)	(97q3-04q3)	(81q1-82q3)	(09q4-13q2)	(98q1-99q1)		(00q4-02q2)		
	90q4	**93q4**		**01q2**				**09q4**		
	(87q3-94q1)	(90q1-97q3)		(88q3-14q3)				(08q1-11q3)		
Regime means (s.e.)	2.31 (0.16)	1.70 (0.10)	2.21 (0.16)	3.29 (0.22)	2.39 (0.09)	2.37 (0.31)		4.62 (0.27)		
	1.03 (0.13)	0.51 (0.05)	0.93 (0.10)	1.13 (0.09)	1.71 (0.03)	0.51 (0.07)		2.81 (0.10)		
	0.24 (0.09)	0.06 (0.04)		0.61 (0.05)				1.68 (0.18)		
	[0.94 (0.08)]	[0.73 (0.06)]	[1.82 (0.12)]	[1.77 (0.12)]	[2.20 (0.07)]	[0.89 (0.11)]	[0.69 (0.18)]	[2.84 (0.16)]	[1.64 (0.42)]	[2.55 (0.35)]
B. Seasonality break dates	N.A.	**78q1**	N.A.		N.A.	**09q1**	**03q2**		**03q1**	
		(74q1-82q1)				(03q3-14q3)	(01q2-05q2)		(01q1-05q1)	
		99q4					**10q3**		**11q3**	
		(91q4-07q4)					(09q3-11q3)		(10q1-13q1)	
Seasonal St.Dev.	N.A.	0.41	N.A.		N.A.	0.90	8.42		34.38	
		0.52				0.64	9.66		32.19	
		0.26					11.17		28.00	
		[0.33]		[0.61]		[0.76]	[9.23]	[0.86]	[30.10]	[2.91]
C. Dynamic break dates						**11q3**				**11q4**
						(09q3-13q3)				(09q4-13q4)
Persistence (s.e.)						0.80 (0.07)				0.46 (0.33)
						0.15 (0.24)				0.69 (0.21)
	[0.02 (0.09)]	[0.63 (0.11)]	[-0.15 (0.14)]	[0.46 (0.14)]	[0.49 (0.19)]	[0.78 (0.07)]	[0.37 (0.17)]	[0.47 (0.13)]	[-1.24 (0.25)]	[0.46 (0.32)]

Table 2. Continued

	Japan		*South Korea*		*China*		*Russia*		*Mongolia*	
	growth	*inflation*	*growth*	*inflation*	*growth*	*inflation*	*growth*	*inflation*	*growth*	*inflation*
D. Volatility break dates	**90q3**	**79q3**	**89q2**	**81q1**	**11q1**	**11q1**	**13q2**	**00q4**		**09q3**
	(84q1-93q3)	(65q4-79q4)	(80q2-89q4)	(67q2-81q2)	(07q3-11q2)	(07q1-11q2)	(01q4-14q1)	(96q4-01q1)		(05q1-10q1)
	07q2		**04q1**	**00q4**				**12q1**		
	(04q3-11q2)		(04q1-05q1)	(95q3-03q1)				(11q3-16q2)		
Regime shock St. Dev	1.09	0.92	2.27	2.06	0.76	0.94	2.01	1.81		4.25
	0.66	0.42	1.21	0.80	0.18	0.28	1.07	0.58		1.92
	1.24		0.79	0.45				1.31		
	[1.01]	[0.62]	[1.73]	[1.29]	[0.62]	[0.78]	[1.81]	[1.10]	[4.09]	[3.41]
E. Seasonality share	N.A.	0.27	N.A.	0.22	N.A.	0.31	0.80	0.29	0.85	0.40
in total volatility		0.32		0.42		0.38	0.82	0.39	0.87	0.52
		0.37		0.55		0.70	0.84	0.56	0.88	0.59
		0.54				0.82	0.92			
		[0.44]		[0.56]		[0.45]	[0.82]	[0.51]	[0.88]	[0.63]

Notes: Estimates of the break dates and of the components of (1) in the resulting regimes. 95% confidence intervals for the break dates and heteroscedasticity robust standard errors are reported in brackets. The quantities that are estimated ignoring the breaks are in square parentheses.

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[1] See http://www.tumenprogramme.org for details. Such development is extremely important for Mongolia as imports from China, Russia, Japan and South Korea constitute 41.8%, 36.8%, 11.9% and 5.6% of the total respectively, while 96% and 1.3% of the total exports go to China and Russia as of 2018.

[2] According to the IMF World Economic Outlook-2018, the World, Chinese, Japanese, South Korean, Russian and Mongolian GDP were 84835462, 13457267, 5070626, 1655608, 1576488, 12724 million USD respectively.

[3] Data for China, Japan, South Korea and Russia are obtained from the OECD (www.oecd.org). Chinese growth rate prior to the first quarter of 2011 is not available there, hence obtained from Bataa *et al.* (2018). Russian growth rate is also not available from the OECD prior to the second quarter of 2003, hence seasonally unadjusted series is obtained from the Federal State Statistical Office of the Russian Federation (www.gks.ru) and both Mongolian series are from the National Statistical Office of Mongolia (www.1212.mn). The lack of high quality seasonally unadjusted raw growth rate data that goes back to 1960 was unavailable for Japan and Korea; hence I used OECD's seasonally adjusted data.

[4] The procedure detected the following outliers: 74q2 in Japanese inflation, 98q2 in growth, and 63q4, 64q2, 64q4, 74q2 and 80q2 in inflation for Korea, 95q3-96q1 and 98q4-99q2 in inflation for Russia and 95q4 in inflation for Mongolia. These outliers are associated with well-known historical events such as the first oil shock, the transition related shock therapy consequences and Russian debt crisis of 1998.

[5] Note that the growth rates are seasonally adjusted for Japan, Korea and China, thus indicated with N.A. in the tables; see OECD and Bataa *et al.* (2018).

[6] When the autoregressive lag in panel C of Table 1 is 1, the AR (1) coefficient itself is the persistence.

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