Just got lucky? Inflation Targeting and Macroeconomic Stability*

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Abstract

This paper asks whether inflation targeting (IT) "just got lucky" in the sense that its adoption in a number of countries in the 1990s just happened to coincide with a more tranquil macroeconomic environment or whether it can be credited with contributing to a more stable macroeconomic structure. There is wide disagreement about the macroeconomic effects of inflation targeting, both theoretically and empirically. I contribute to the debate by using an innovative approach that allows the generation of counterfactual variances of inflation and output that would have prevailed if IT were not introduced. In particular, I use the counterfactual Vector Autoregressive (VAR) method developed by Stock and Watson (2002) to determine whether the observed decline in the variability of inflation and output growth can be attributed to a more stable structure (the propagation mechanism) or less violent shocks (the impulses). I find that the observed moderation in inflation volatility may be attributed largely to a more stable structure associated with the introduction of IT and less to the consequence of milder shocks. I estimate the propagation mechanism to account for more than 50 percent of the decline in inflation volatility for the majority of countries in the sample. Meanwhile, the observed tranquility in the business cycle is driven solely by much less violent shocks which have offset what appears to be a less stable structure seemingly arising from the IT framework. Results provide indirect evidence that the achievement of low and stable inflation may have come at the expense of output stabilization, as predicted by theory.

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1 Introduction

There is a huge strand of literature which notes that the adoption of inflation targeting (IT) as the monetary policy framework in an increasing number of countries - both industrialized and developing - has coincided with a decline not only in the level of inflation, but also in its volatility. In addition, the economic environment in those countries seems to have become more tranquil with less business cycle variability after they introduced their inflation targets. Whether this observed macroeconomic stability can be causally attributed to the IT framework remains a major issue in the literature.

Under the IT framework, monetary authorities announce an explicit inflation target and promises to achieve it over a certain policy horizon using various monetary policy instruments. There is a wide disagreement on the theoretical predictions on how inflation targeting could affect the variability of inflation and output. While one school of thought argues that IT leads to low and stable inflation because it alleviates the dynamic inconsistency problem and helps "lock in" earlier disinflationary gains by providing a credible nominal anchor (Bernanke, Laubach, Mishkin, and Posen (1999), Svensson (1997a), and Mishkin (1998)), the other argues that IT could lead to unfavorable outcomes if institutions are weak and macroeconomic fundamentals are not solid (Mishkin (2000), Mishkin (2004), Sims (2005), Bernanke and Woodford (2005)). With respect to output variability, some economists take the view that "flexible" IT framework (FIT) could deliver optimal equilibrium, that is, low and stable inflation as well as output stability (Vega and Winkelried (2005), Svensson (2000)), while others prove theoretically that there is a trade-off between the variances of inflation and output (Taylor (1994), Fuhrer (1997)). Empirical research also generated mixed evidence, with differential results noted for emerging market and developing economies (EMDEs) and advanced economies (AEs). The empirical approaches adopted also vary from time-series techniques to country case studies and panel-based methodologies, some of which attempt to address the self-selection issue in the adoption of IT. However, at the background of all this empirical work is global moderation in macroeconomic volatility in the 1990s coinciding with the rise in the popularity of the IT framework.

Did IT just get lucky in the sense that its adoption was followed by a more tranquil environment or can the framework be causally linked to this macroeconomic phenomenon? As the debate on the stabilization effects of IT remains unsettled, I contribute to the debate by using an innovative approach that allows the generation of counterfactual variances of inflation and output if IT were not introduced. In particular, I use the “counterfactual” Vector Autoregressive (VAR) method developed by James (1993), extended by Simon (2001), and employed by Stock and Watson (2002), Karras, Lee, and Stokes (2005), and Karras, Lee, and Stokes (2006), to determine whether the observed decline in the variability of inflation and output growth can be attributed to a more stable structure (propagation mechanism) or less violent shocks (the impulses). The adoption of IT may be argued to have altered the structure by which monetary policy affects inflation and output as well as how shocks are propagated in the system. The effectiveness of IT in promoting macroeconomic stability is consistent with the finding that the propagation mechanism is statistically significant. However, if the decline in volatility can be traced solely to impulses, then this is evidence that IT really just got lucky.

This paper has three major contributions to the literature on the macroeconomic effects of inflation targeting. First, it provides new evidence on the causal effect of inflation targeting on the variability of both inflation and output. Second, it presents indirect evidence on the inflation-output variability trade-off, i.e., whether the achievement of low and stable inflation came at the expense of higher output volatility. Third, it introduces to the IT evaluation literature a novel method in the creation of counterfactual outcomes, one that has been used previously in examining business cycles and exchange rate variability. It must be stressed that because the introduction of IT is an endogenous choice, the identification of causality between the IT framework and better outcomes which are associated with it is not straightforward.[1] The country-by-country analysis in the counterfactual VAR method implies that the endogeneity issue, which can be traced to self-selection of IT countries into adopting IT will be limited.

Results of the study show that the observed decline in inflation variability can be attributed largely to a more stable structure that is associated with the adoption of inflation targeting and partly to milder shocks. That is, the IT framework appears to have played a significant role in bringing inflation to a low and stable level. However, inflation targeting seems to have generated a less stable structure which worsens output variability. Much less violent shocks in the period after IT was adopted offset what appears to be “destabilizing” effects of IT, thus resulting in the observed tranquility in the business cycle. These results

[1] A simple comparison of the outcomes in IT countries and non-inflation targeting countries leads to biased estimates.

provide indirect evidence to the predicted existence of a trade-off between inflation variability and output variability that policymakers have to consider very carefully.

The remainder of the paper is organized as follows. Section 2 presents a brief review of the literature on the macro-stabilization effects of inflation targeting. Section 3 sketches a theoretical model that helps guide the empirical analysis while Section 4 presents the empirical approach. Section 5 provides a description of the data used as well as the sources while Section 6 presents the empirical evidence. Section 7 presents some policy implications and concludes.

2 Review of Related Literature

Since New Zealand adopted the IT framework in 1989, an increasing number of central banks have decided to switch their respective monetary policy frameworks from monetary aggregate or exchange-rate targeting to directly targeting inflation. The literature on the evaluation of the macroeconomic impacts of the IT framework has grown since. In brief, there is a variation in the focus of research, from advanced economies or developing economies only, to a combination of both. The empirical techniques also vary, from cross-section ordinary least squares (OLS) and instrumental-variable (IV) panel regressions, to propensity score matching, fixed effects, and system generalized method of moments (GMM). In this section, I summarize the findings and approaches of major studies which contributed largely to the understanding of how the monetary policy framework affects price and output conditions.

Under the IT framework, monetary authorities announce an explicit inflation target and promises to achieve it over a certain policy horizon using various monetary policy instruments. Monetary authorities typically make adjustments to their key policy interest rates to bring inflation back to target. Other instruments such as rediscounting and reserve requirements are also used. Monetary authorities in IT countries provide regular reports explaining their policy decisions and the assessment of the inflation environment and outlook. They recognize the important features of IT as follows: (1) a simple framework which can be easily understood; (2) allows greater focus on price stability; (3) forward-looking and recognizes that monetary policy actions affect inflation with a lag; (4) reflects a comprehensive approach to policy by taking into consideration the widest set of available information about the economy; (5) increases the accountability of monetary authorities to the inflation objective since the announced inflation target serves as a yardstick for the performance of monetary authorities, and thus helps build their credibility; (6) promotes transparency in the conduct of monetary policy through the announcement of targets and the reporting of measures that monetary authorities will adopt to attain these targets, as well as the outcomes of its policy decisions; and (7) does not depend on the assumption of a stable relationship between money, output and prices, and can still be implemented even when there are shocks that could weaken the relationship. There are two types of IT frameworks — strict IT (SIT) and flexible IT (FIT). According to Svensson (1997b), under SIT, authorities are only concerned about keeping inflation as close to a given inflation target as possible, without regard to the stability of the real economy. Meanwhile, under FIT, monetary authorities are to some extent also concerned about macroeconomic outcomes, such the stability of interest rates, exchange rates, output and employment.

While the focus of this research is macroeconomic volatility, it is important to provide a background on the theory and empirical evidence on how IT affected inflation levels because as Berg (2005) emphasizes, inflation normally varies less when it is lower. Does IT help reduce average inflation? In theory, the following interrelated mechanisms can lead to lower inflation: (1) IT solves the dynamic inconsistency problem which leads to high inflation; (2) IT "locks in" earlier disinflationary gains as the announcement of targets helps anchor inflation expectations; (3) Well-anchored expectations reduce the inflationary impact of shocks; (4) IT potentially improves the credibility of monetary authorities in achieving their announced targets, also contributing to the anchoring of expectations; and (5) IT raises the predictability of inflation and reduces forecasting error of future inflation. What does the empirical evidence suggest? In their review of key studies on the macroeconomic effects of IT, Schmidt-Hebbel and Carrasco (2016) point out that there appears to a more systematic evidence that IT helped reduce average inflation among EMDEs, but the evidence is not conclusive when the comparison is made among AEs. This analysis is consistent with the observation that IT countries were able to bring down average inflation after they adopted the framework, but so have NIT countries during the great moderation. However, Schmidt-Hebbel and Carrasco (2016) note that the evidence is dependent on the empirical strategy and the country composition of treatment and control groups, where the adoption of IT is viewed as the treatment. Table (1) summarizes the findings of the most recent studies, including their econometric strategies and the sample countries used.

Does IT help stabilize inflation volatility? There is no conclusive evidence that IT is responsible for the decline in the variability of inflation among IT adopters. There are a number of studies that find evidence supportive of IT. Batini and Laxton (2007) estimate cross-section difference-in-difference (DID) models on a sample of EMDE countries and find that IT led to a 4.8-percentage-point reduction in average inflation and 3.6-percentage-point reduction in its standard deviation relative to other monetary policy frameworks. Using propensity score matching (PSM) for both AEs and EMDEs to predict the probability that countries switch to IT, Vega and Winkelried (2005) show that IT helped in reducing, not only the level, but also the variability of inflation among the IT adopters. Lin and Ye (2009) also employ PSM but only on a sample of EMDEs and yield favorable results for IT. In the UK, King (2001) notes that since IT was introduced, inflation has become lower, more stable, and less persistent as inflation shocks die more quickly. Meanwhile, Neumann and von Hagen (2002) estimate dynamic Taylor rules and DID models for six IT countries from the Organization for Economic Co-operation and Development (OECD) and show that inflation targeting helped bring down the mean and variability of inflation.

However, some studies find that the the estimated effects of IT on volatility are not statistically significant. Johnson (2002) compares IT and NIT AEs and finds that IT does not have significant effects on expected inflation or on the variance of inflation, after controlling for country and year fixed effects. Levin, Natalucci, and Piger (2004) examine inflation expectations, persistence, and volatility in five IT AE and 13 IT EMDEs, and find that in EMDEs, IT does not seem to be associated with instantaneous adjustment in inflation expectations, and that the variance of inflation remained high although the average inflation went down after IT was adopted. Using PSM, Lin and Ye (2007) do not find IT to be responsible for the moderation of inflation variability in seven industrial economies. Brito and Bystedt (2010) apply dynamic panel estimator and find no significant evidence to conclude that IT led to a stabilization of inflation as well as output growth.[2]

Does IT help smoothen the business cycle? Taylor (1994) is among the first to bring to the policy debate the possible existence of a trade-off between inflation variability and output

[2]Brito and Bystedt (2010) note that they prefer this approach over DID models or PSM for a variety of reason. The dynamic panel estimator controls for simultaneity and omitted variable biases. He argues that it is better suited for making inference on the causal effect of IT on macroeconomic performance. He adds that in his specification, he includes a common time effect variation which controls for worldwide trends, weakened the cross-country negative correlation between the IT regime and average inflation and volatility, and revealed a strong negative relation between IT disinflation and output growth.

variability in the context of inflation targeting.[3] While the consensus is that there is no long-run Phillips curve trade-off between inflation and unemployment, Taylor (1994) shows theoretically the existence of a trade-off between the variances of inflation and output (measured as deviation from potential). He traces out the trade-off curve as a function of the weights on inflation and output in a policy rule. When interest rates respond more (less) to inflation and less (more) to real GDP, the aggregate demand/inflation curve tends to be flatter (steeper) and the variance of real GDP rises (falls) while the variance of inflation falls (rises). He adds that this trade-off is consistent with rational expectations and sticky prices, and implies that there is no trade-off between the levels of inflation and output in the long-run. He laments that this kind of trade-off has not become part of the popular debate in the literature.

The empirical evidence on how IT affects the variability of output remains inconclusive. Cecchetti and Ehrmann (2002) investigate the trade-off and develop a measure of central bankers' aversion to inflation variability in relation to output variability. They find that in a cross-section of 23 IT and NIT countries, aversion to inflation variability rose in the 1990s, thus adversely affecting output stability. This is found to be true for both IT and NIT countries though IT countries showed modestly higher increase in aversion to inflation variability than do NIT countries. They argue that the observed decline in output variability may be more likely due to a more stable external environment, and that increased focus on inflation target may, in fact, increase output-variability.

Results of other studies do not seem to support the trade-off between the variances of inflation and output. Using DID models, Ball and Sheridan (2004) compare the macroeconomic performance of 7 IT countries and 13 NIT countries, all from the OECD, and find no evidence that IT improved performance as measured by inflation, output, or interest rates. They note that while inflation and output growth became more stable in IT countries, those that did not adopt IT also experienced improvements around the same times as targeters. Goncalves and Salles (2008) reproduce the analysis of Ball and Sheridan (2004) and apply it to a sample of 36 EMDEs, of which 13 are IT countries, and find that IT countries have not only experienced greater reduction in average inflation but also larger drops in the variability of output growth. Levin and Piger (2004) suggest that less persistent inflation in the inflation-targeting countries has not been accompanied by more volatile output growth. Meanwhile, Corbo, Landerretche, and Schmidt-

[3]He first developed the idea in his earlier paper Taylor (1979).

Hebbel (2002) suggest that after the adoption of the inflation target, manufacturing output became less volatile while the output gap became less sensitive to disturbances in inflation. Pétursson (2004) analyzes the experience of IT countries in AEs and EMDEs with respect to a host of macroeconomic outcomes including, average inflation, variance of inflation, persistence, average growth, growth variability, interest rates and exchange rates. He notes that IT may have contributed to inflation stability as well as decreased variability in output growth, the latter being consistent with the flexible IT. Mishkin and Schmidt-Hebbel (2007) find that IT countries in EMDEs show large declines not only in inflation variability, but also in output volatility after adopting stationary inflation targeting. He argues that this could be traced to less violent supply shocks and improvements in monetary policy efficiency. He adds that in contrast to EMDE inflation targeters, AE targeters reported better macroeconomic performance only because they experienced smaller supply shocks. However, their monetary policy efficiency (which were already at high levels relative to EMDEs) actually deteriorated somewhat after they adopted IT. Batini and Laxton (2007) find no evidence that achievement of inflation objectives comes at the expense of real output stabilization.

Meanwhile, results of Clifton, Leon, and Wong (2001) suggest that IT tends to improve the unemployment-inflation trade-off by showing that in seven OECD countries, disinflations were associated with smaller increases in unemployment after IT was adopted. These results are consistent with Corbo et al. (2002) who find evidence that IT may have contributed to lowering the output costs of stabilization. Svensson (1997a) shows that the increased weight on output gap affects the pace at which inflation goes back to the target. He proves that if IT countries also has the objective of output stabilization, then inflation (forecast) will adjust rather gradually towards the long-run target, at a rate that is slower the greater weight placed on output stabilization is.

3 Theoretical Framework

To help frame the research question, I sketch below a very simple macroeconomic model following Alesina and Stella (2010) to derive the theoretical impact of inflation targeting on macroeconomic variability. Suppose aggregate supply can be written as:

$$y_t = \pi_t - \pi_t^e + u_t, \tag{1}$$

$$\text{var}(u_t) = \sigma_u^2 \tag{2}$$

where π_t is inflation, π_t^e is expected inflation, and u_t is assumed independent and identically distributed with mean 0 zero and variance σ_u^2. Suppose the country is an inflation targeter and the inflation target is set to be π_t^*. Monetary authorities minimize the deviation of output and inflation to their respective targets. Their loss function can then be written as $L = \frac{1}{2}[\alpha(y_t - k)^2 + (\pi_t - \pi_t^*)^2]$, where $k > 0$ refers to the output target, and α is the weight assigned to the cost of output deviations from the target. In this very simple model, there is incentive for government policymakers to inflate the economy due to nominal wage rigidity. Assuming rational expectations, then, only unexpected inflation can have effects on output. The public rationally expects policymakers to attempt to inflate the economy. Therefore, as Alesina and Stella (2010) note, in equilibrium, there is inflation above target and output at some "distorted" level. The adoption of the inflation targeting framework necessitates commitment by monetary authorities to a certain pre-announced inflation level or path. This commitment implies a decline in the weight assigned to output gap and a potentially substantial increase in the weight given to deviations of inflation from the target.

The central bank minimizes the loss function given the aggregate supply constraint:

$$L = \frac{1}{2}[\alpha(\pi_t - \pi_t^e + u_t - k)^2 + (\pi_t - \pi_t^*)^2] \tag{3}$$

The first-order condition yields an expression for π_t:

$$\pi_t = \frac{\alpha}{1+\alpha}(\pi_t^e - u_t + k + \pi_t^*) \tag{4}$$

Assuming rational expectations and noting that $\text{E}(\pi_t^e) = \pi_t^e$ and $\text{E}(u_t) = 0$, the Nash equilibrium inflation expectations can be written as:

$$\pi_t^e = \alpha(k + \pi_t^*) \tag{5}$$

Notice that what determines inflation expectations in this model are the level of the output target, the relative weight assigned to output deviations, and the inflation target. Plugging in the inflation expectations (Eq. 5) expression to the inflation expression from the first-order condition (Eq. 4) yields:

$$\pi_t = \alpha(k + \pi_t^*) - \frac{\alpha}{1+\alpha} u_t \tag{6}$$

Plugging in the expressions for inflation (Eq. 6) and inflation expectation (Eq. 5) to the AS equation (Eq. 1) leads to:

$$y_t = \left(\frac{1}{1+\alpha}\right) u_t \tag{7}$$

Taking the expectation of inflation and output in equations (6) and (7) results in:

$$\overline{\pi} = \alpha(k + \pi_t^*) \tag{8}$$

$$\overline{y} = 0 \tag{9}$$

This implies that average inflation is determined by the relative weight on output deviations as well as the output target level. In addition, average inflation is positively related to the inflation target — the lower the inflation target, the lower the resulting inflation, on average. The average (trend deviation) output is zero in this model. Hence, there is no trade-off between average inflation and average output with respect to the relative weights assigned to output and inflation gaps.

Taking the variances of equations (6) and (7) leads to:

$$\text{var}(\pi_t) = \left(\frac{\alpha}{1+\alpha}\right)^2 \sigma_u^2 \tag{10}$$

$$\text{var}(y_t) = \left(\frac{1}{1+\alpha}\right)^2 \sigma_u^2 \tag{11}$$

That is,

$$\frac{\partial \text{var}(\pi_t)}{\partial \alpha} = \frac{2\alpha\sigma_u^2}{(1+\alpha)^3} > 0 \tag{12}$$

$$\frac{\partial \text{var}(y_t)}{\partial \alpha} = \frac{-2\sigma_u^2}{(1+\alpha)^3} < 0 \tag{13}$$

Similar with the average inflation, the variance of inflation is a function of the weight assigned to the output gap. The lower the weight on output gap and the higher the weight assigned on the inflation gap, the lower the variance of inflation is. Meanwhile, with respect to output variability, the reduction in the weight assigned to the output gap increases the variance of output. As may be expected, the more stable shocks (σ_u^2) are, the less volatile the resulting inflation and output will be.

The adoption of inflation targeting implies that monetary authorities will directly pay attention to deviations of inflation to the target they set, instead of focusing on some intermediate target such as the monetary base. In terms of the loss function, this implies a reduction in the relative weight assigned to output gap α in favor of the inflation gap. This results in a trade-off between inflation and output variability. It may be noted that this model is broad enough to account for various forms of inflation targeting as practiced by central banks. On one extreme, strict IT implies that $\alpha = 0$ and monetary authorities only care about deviations of inflation from the target. The more flexible form of IT implies that $\alpha > 0$ as monetary authorities also pay attention to the variability of other macroeconomic variables such as output, employment, or exchange rates. The model is also broad enough to accommodate various levels of inflation targets π_t^* as determined and announced by monetary authorities.

4 Methodology

The key strategy employed to answer the research question is the "counterfactual VAR method" by James (1993), Simon (2001), and Stock and Watson (2002). In his seminal paper, James (1993) investigates the increased business cycle variability in the US during the postbellum period (1871-1909) relative to the antebellum period (1836-1857). First, he estimates a structural vector autoregressive model of output, prices, money supply, and interest rates. Measuring output variability as the standard error of forecast output, he shows that the forecast error variance rose from the ante- to the postbellum period. He introduces the calculation of "counterfactual variances" i.e., the change in forecast error due to the shift from ante- to postbellum structure (propagation mechanism) while holding the nature of disturbances constant as well as the shift from ante- to postbellum disturbances holding structure constant. He posits that the heightened output volatility cannot be explained by the decline in the variance of structural disturbances, leading him to argue that the economic structure may have become more vulnerable to disturbances, particularly monetary shocks.

In this paper, the starting point is an estimation of structural VAR models for the period prior to the adoption of IT and the period after for each country in the sample. Analysis is done on a sample of advanced economies and emerging market and developing economies which were some of the first countries to formally introduce the inflation targeting framework. The number of countries that can be analyzed using the empirical approach in this paper is constrained by the length of time-series data for the post-IT period, especially for those which have switched to inflation targeting fairly recently. Table (2) shows the approximate adoption dates of each country in the sample, which was based primarily on Roger (2009). Figure (1) shows that as of 2015, about 47 countries have formally shifted to IT, 15 of which are AEs and the majority are EMDEs (Schmidt-Hebbel & Carrasco, 2016).

The counterfactual VAR method is a test to distinguish between changes in the coefficients or the changes in the innovation variance of a VAR model. As Stokes (2013) notes, the basic idea of the test is that within a particular sample period, there may be changes in the coefficients of the model and or there may be changes in the innovation variance, or both may occur. Stock and Watson (2002) argue that the change in the variance of a series can be associated with changes in its spectral shape, changes in the level of its spectrum or both.

Following Karras et al. (2005), Karras et al. (2006), and Stokes (2013), I outline the basic idea behind the Stock and Watson methodology. Suppose we have VARs as

$$\mathbf{x}_t = \mathbf{A}_i(L)\mathbf{x}_{t-1} + \mathbf{u}_t \tag{14}$$

$$\text{Var}(\mathbf{u}) = \mathbf{\Sigma}_i \tag{15}$$

where $\mathbf{x}$ represents the vector of k variables in the VAR model ($k \geq 1$), t indexes time periods (i.e., $t = 1$ for the pre-IT adoption and $t = 2$ for the post-IT adoption period), the $\mathbf{A}'s$ represent the matrices of polynomials in the lag operator L, and $\mathbf{u}$ is the error term with variance $\mathbf{\Sigma}_i$ in period i. This model implies that if there has been no change in the coefficients, then $\mathbf{A}_1(L) = \mathbf{A}_2(L)$, while $\mathbf{\Sigma}_1 = \mathbf{\Sigma}_2$ if there has been no change in the variance.

Let $\mathbf{B}_i(L) = [\mathbf{I} - \mathbf{A}_i(L)L]^{-1}$ be the moving average representation of the model and define B_{ij} as j^{th} lag of $\mathbf{B}_i$. The variance of the k^{th} series of $\mathbf{x}$ in the i^{th} period can be written as

$$\text{Var}(x_{kt}) = \left(\sum_{j=0}^{\infty} \mathbf{B}_{ij} \mathbf{\Sigma}_i \mathbf{B}_{ij}^{'} \right)_{kk} = \sigma_k(\mathbf{A}_i, \mathbf{\Sigma}_i)^2 \tag{16}$$

The above-given variance can be evaluated for various $\mathbf{A}_s$ and $\mathbf{\Sigma}s$, as Stock and Watson (2002) note. Define $\sigma_{kij} = \sigma_k(\mathbf{A}_i, \mathbf{\Sigma}_j)$ as the resulting variance if we combine the coefficients (structure) in period i ($\mathbf{A}_i$) and the variance (innovations) from period j ($\mathbf{\Sigma}_j$) for the k^{th} series. The "factual" variance or the variance that actually occurred if we were to estimate in the first and second period, respectively, can be written as $\sigma_{k11} = \sigma_k(\mathbf{A}_1, \mathbf{\Sigma}_1)$ and $\sigma_{k22} = \sigma_k(\mathbf{A}_2, \mathbf{\Sigma}_2)$ for the k^{th} series. However, Equation (16) also allows for the computation of "counterfactual" variances in the sense that the coefficients (structure) and variance (innovations) come from different sample periods. Then, $\sigma_{k12} = \sigma_k(\mathbf{A}_1, \mathbf{\Sigma}_2)$ refers to the variance of the k^{th} series in the first period had the error covariance matrix been from the second period or alternatively, the variance of the k^{th} series in the second period had the coefficients been from the first period. Similarly, $\sigma_{k21} = \sigma_k(\mathbf{A}_2, \mathbf{\Sigma}_1)$ represents the variance of the k^{th} series in the second period had the error covariance matrix been from the first period, or the variance of the k^{th} series in the first period had the coefficients been from the second period.

For illustration purposes, suppose the inflation rate is the first variable in the VAR ($k = 1$) model. The "factual" variance of inflation in the pre-IT and post-IT adoption periods can be written as $\sigma_{11} = \sigma_1(\mathbf{A}_1, \mathbf{\Sigma}_1)$ and $\sigma_{22} = \sigma_2(\mathbf{A}_2, \mathbf{\Sigma}_2)$. The counterfactual variance $\sigma_{12} = \sigma_1(\mathbf{A}_1, \mathbf{\Sigma}_2)$ represents the variance that would have been observed if the structure of the pre-IT period had been imposed with the shocks after the introduction of IT. Meanwhile, $\sigma_{21} = \sigma_2(\mathbf{A}_2, \mathbf{\Sigma}_1)$ represents the counterfactual variance when the pre-IT period shocks are imposed using the structure of the post-IT period.

Analyzing these variances leads us to various cases as outlined in Stokes (2013). If $\sigma_{k11} = \sigma_{k12}$, $\sigma_{k21} = \sigma_{k22}$, $\sigma_{k11} \neq \sigma_{k21}$, and $\sigma_{k22} \neq \sigma_{k12}$, then for the k^{th} variable, the coefficients after IT was adopted changed relative to prior-IT adoption but the variances are stable. Meanwhile, if $\sigma_{k11} \neq \sigma_{k12}$, $\sigma_{k21} \neq \sigma_{k22}$, $\sigma_{k11} = \sigma_{k21}$, and $\sigma_{k22} = \sigma_{k12}$, then it can be said that the variances between the pre-IT and post-IT adoption periods changed but the coefficients have not. If all the estimated factual and counterfactual variances are the same, then it can be concluded that there is stability in both the coefficients and the variance.

The main idea of the counterfactual VAR test is to compare the factual and counterfactual variances and assess whether the difference in estimated variances can be attributed to a change with the structure or change with the shocks or both. Thus, the statistic of interest can be defined as

$$T_{i,j}\_T_{k,l} = |\sigma_{i,j} - \sigma_{k,l}|. \tag{17}$$

The statistics $T_{i,i}\_T_{j,i}$ tests the existence of a counterfactual structural change. That is, whether the change in the structure that took place after IT was adopted had a statistically significant effect on the volatility of inflation or GDP growth. Meanwhile, $T_{i,j}\_T_{i,i}$ tests for a counterfactual shock change, i.e., whether the change in the shocks that occurred after IT was adopted had a statistically significant impact on inflation or output growth variability.

The next step is to formally test whether differences in estimated variances are significantly different from zero. However, the problem is that the distribution of these statistics are not known. Critical values can only be obtained using bootstrapping and Monte Carlo methods. Karras et al. (2005) propose a parametric method of bootstrapping, building on the work of Stine (1987), Runkle (1987), and Inoue and Kilian (2002). Their proposed methodology implements bootstrapping that is able to preserve the heteroskedasticity or serial correlation properties of the data, if these exist, in the process of resampling the data. Consequently, the resulting estimators become consistent unlike those from the traditional bootstrapping algorithm of time-dependent data which as Efron (1979) notes, assume that errors are independent and identically distributed.

This paper follows the bootstrapping algorithm proposed in Karras et al. (2005) and Karras et al. (2006) to generate consistent estimators. The algorithm has the following steps. First, I use Least Squares (LS) to estimate an AR or a VAR process of order p

$$x_t = \beta_0 + \beta_1 x_{t-1} + ... + \beta_p x_{t-p} + \varepsilon_{p,t} \tag{18}$$

which yields LS estimates $\hat{\beta}(p) = (\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_p)$. I use the Schwarz Bayesian Information Criterion (SBIC) in selecting the appropriate order of p that removes the autocorrelation and cross-correlation of the residuals. For quarterly VAR models, Ventzislav and Lutz (2005) recommends the use of SBIC especially for small sample sizes (i.e., less than 120) and Hannan-Quinn Criterion (HQC) for larger sample sizes.[4] Hacker and Hatemi-J (2008) also show that SBIC

[4]As basis for comparison of the various information criteria, they use the mean-squared error (MSE) of the

is the optimal criterion for choosing lag length in many situations due to better lag-choice accuracy, least sensitivity to ARCH regardless of stability or instability of the VAR model, and best forecasting abilities. Second, including k initial observations, I generate by random sampling with replacement from the regression residuals $T+k+p$ bootstrap innovations ε_t^*, where $T = p+1, ..., t$. Third, I use the vector of initial observations $x_0^* = (x_1^*, ..., x_p^*)$ as starting values to preserve the scale of x_t, then I generate a sequence of pseudo-data of length $T+k+p$ from the recursion $x_t^* = \hat{\beta}_0 + \hat{\beta}_1^* x_{t-1} + ... + \hat{\beta}_p^* x_{t-p} + \varepsilon_{tt}^*$. Fourth, I remove k initial observations then I compute the factual and counterfactual variances of x_t^*. In order to build the empirical distribution of the test statistics, I repeat steps two, three, and four for the desired number of iterations. The results shown in this paper are all based on 1000 iterations, consistent with those reported in Karras et al. (2005) and Karras et al. (2006).

The Monte Carlo algorithm to compute for critical values follows similar steps, except for the second step where the residual is replaced by $T+k+p$ independent and identically distributed random innovations μ_{t+k+p}. These are adjusted to the same variances of the estimated residuals from step one. Karras et al. (2005) and Karras et al. (2006) note that the Monte Carlo method has the advantage of having the disturbance free of heteroskedasticity and serial correlation. The statistical software B34S is used to estimate the models and generate the standard errors.

5 Data Description and Sources

To analyze macroeconomic stability, I focus on the volatility of inflation rate and real GDP growth. I consider the transmission mechanism through which monetary policy affects inflation and output in the estimation of the VAR models. Figure (3) shows the typical channels which allow monetary authorities in inflation targeting countries to achieve their inflation objectives. In my VAR models, policy rate adjustments are represented by changes in the short-term market interest rate, such as bond yields. This implies that I am capturing mainly the interest rate channel in my models. However, in some EMDEs, some studies have shown that the interest rate

implied pointwise impulse response estimates normalized relative to their MSE based on knowing the true lag order.

channel appears to have weakened while the credit channel remains an important transmission.[5] Hence, I use the the bank lending rate instead of bond yields for these countries.

I use quarterly observations up to Q4 2017 mainly from two sources. The first dataset is comprised of countries where inflation, short-term interest rates, and real GDP growth data are from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). The second set is comprised of OECD data for countries that happen to have missing information in the IMF dataset. The combined dataset is augmented or supplanted with data sourced from the government websites of each country if there are missing observations or if the latter represent longer series. The goal is to construct a time-series dataset that is sufficiently long to allow the estimation of VAR models before and after the targeting framework was adopted. Table (3) describes the data sources for each country in the sample for easier replication or extension of this paper. Quarterly inflation is computed as the year-on-year percent change in the consumer price index (CPI) while quarterly GDP growth is the year-on-year percent change in real GDP.

One important issue that could lead to problematic estimates is the observed decline in global inflation and business cycle volatility in the 1990s and for the most part of 2000s when the countries in the sample switched to IT. As evident in Figure (2), this global moderation in macroeconomic volatility is seen in both IT and NIT countries.[6] If the model is not able to account for the effect of this global disinflation trend and economic tranquility to domestic price and output conditions, the test may attribute the observed change to the inflation and output growth dynamics to the change in structure associated with the adoption of the IT framework. I use the inflation rate and GDP growth of the US to represent global inflation and output developments, respectively, in the VARs. It may be noted that while the US has announced an inflation target in 2012, it has not formally adopted the IT framework as its monetary policy regime.

In addition to domestic variables, it is important to account for other global shocks that have significant impacts on domestic macroeconomic stability. The idea is to account

[5]See, for instance, Charoenseang and Manakit (2007) for Thailand, and Guinigundo (2008) and Bayangos (2010) for the Philippines.

[6]Svensson (2010) notes that while all groups of countries enjoyed lower and more stable inflation, the experience of OECD counties and EMDEs are quite different. In particular, for OECD countries, the overall trends between inflation targeters and non-inflation targeters are broadly similar. This can be explained in part by the fact among the advanced economies, many non-IT countries have adopted monetary policies that are similar in practice to IT (Gertler (2005)) which makes the interpretation of empirical results quite a challenge. For EMDEs, Svensson (2010) notes that inflation in IT countries has gone down from a higher level relative to the non-IT countries.

for sufficient relevant variables in the VAR model, to the extent that the limited data sample allows, to prevent the counterfactual VAR test from putting too much weight on the role of shocks in changing the inflation or output dynamics. To represent global commodity shocks, I use the world price of crude oil, which is a simple average of Brent, Dubai, and West Texas Intermediate (WTI) oil prices collected by the IMF. I convert the nominal world price of oil to 2010 US dollars.[7]

There are several issues in determing the effective date when countries shifted to inflation targeting.[8] Pétursson (2004) notes that the discrepancy reflects largely the gradual adoption of the IT framework as central banks took time to adjust their structure to the new policy framework although its adoption was announced in advance. He adds that the adoption of all the features of IT also took some time for some countries. Other countries started with an initial phase of disinflation and when inflation has been sufficiently brought down, the central bank formally adopts an inflation target.

I rely on Roger (2009) in the identification of the effective adoption date of the targeting framework (Table 2). He conducts a comprehensive examination of each country and uses the following criteria in determining the effective IT adoption date: (1) formal announcement of IT regime; (2) adoption of explicit forward-looking target; (3) publication of an Inflation Report; and (4) evidence of subordination of exchange rate objective to inflation objective. In an email exchange, he clarified that his primary consideration in dating is the formal announcement of the adoption of the IT framework. Among those who have announced the shift to inflation targeting, Roger (2009) looks at whether they have specified an explicit, forward-looking target. The announcement of the target is then set as the IT adoption date. In his sample of 29 countries, Roger (2009) notes that about a third adopted stable inflation targets at the outset.

Figures (4) and (5) show the trends in inflation, output growth, and interest rates in the sample. The broken line indicates the effective adoption date of inflation targeting in each country. The most glaring observation from the figures is the dramatic decline in the variability of inflation and output growth after the targeting framework was adopted in each country.

[7]To adjust the nominal prices, I use the US CPI data from the IMF, which are indexed to 2010. The real price for time t is obtained by multiplying the nominal price with the adjustment factor, which is 100/CPI for time t. The result are real prices in 2010 US dollars.

[8]See, for instance, Corbo et al. (2002), Fracasso, Genberg, and Wyplosz (2003), Fraga, Goldfajn, and Minella (2004), Levin et al. (2004), Pétursson (2004), Ball and Sheridan (2004), and Vega and Winkelried (2005).

For countries with longer available time series, the figures highlight the well-known uptrend in inflation in the 1970s, slight moderation in the 1980s and the overall dip in inflation starting the 1990s. From the adoption dates, one can note that the frontrunners in IT adoption were AEs, led by New Zealand in 1990. Since the late 1990s, an increasing number of EMDEs have directly targeted inflation.

The summary statistics for inflation and output growth are presented in Tables (4) and (5), respectively. The statistics depict a substantial drop in the variability of inflation and output growth after IT was introduced in the countries in the sample. The standard deviation of inflation fell by a range of 1 in the case of Thailand to as high as 38 in the case of Mexico. There was also a sharp reduction in average inflation when the countries shifted to IT. Average inflation dipped by a range of 3 percentage points (for Thailand) to 39 percentage points (for Mexico). With respect to output growth, only Sweden seems to have exhibited a slight increase in volatility. For the rest of the countries in the sample, the business cycle has become smoother with the standard deviation of output growth declining by a range of 0.6 (for Canada) to 5 (for Indonesia). However, the trend in the average output growth is mixed. Some countries register higher average GDP growth after IT was adopted (Indonesia, New Zealand, Philippines, Sweden, Thailand, United Kingdom) while others show a decline (Australia, Canada, Korea, Mexico).

6 Empirical Evidence

As starting point, I estimate a simple univariate model for inflation and output growth for each country in the sample. I then expand the system to include interest rates, my measure of the monetary policy stance. This can be considered a simple model of monetary policy transmission. However, this model fails to account for the role of the global inflation trends in influencing domestic inflation. Hence, my baseline specification includes world inflation as the most exogenous variable in a four-variable VAR model for each country. I use the lags suggested by the SBIC and are indicated in Table (6). I begin by analyzing in detail the results for inflation, specifically, New Zealand, the front runner in IT adoption. Then, I compare my findings to the key results for rest of the countries in the sample. The idea is that the lengthy analysis for New Zealand's inflation results also serves as a guide in reading the results tables for the other countries.

6.1 Variability of Inflation

New Zealand

Results for New Zealand in Table (13) highlights the significant decline in the variability and mean of inflation after IT was introduced in 1989. The actual variance of inflation after the shift to IT is about nine times lower than that prior to the adoption. Focusing on the estimated variances, the univariate model appears to have estimated the dynamics quite well as the factual variances ($\sigma_{11} = 19.67$ and $\sigma_{22} = 1.29$) are close to the actual variances ($\sigma_1^2 = 19.29$ and $\sigma_2^2 = 2.07$) in the periods before and after the IT adoption. The factual variances estimated by the multivariate model ($\sigma_{11} = 15.75$ and $\sigma_{22} = 1.24$) are likewise close to the actual variances, though noticeably smaller in magnitude than the estimates from the univariate model. The estimated variances from both models capture the significant reduction in the variability of inflation after IT was adopted in New Zealand.

In assessing whether the counterfactual variances are significantly different from the factual variances, the analysis focuses on the results of the multivariate model. The reason is that the univariate model, as Karras et al. (2006) notes, assigns excessively significant role to the variation coming from the omission of key variables and thus, tends to reduce the importance of structural stability. Panel B of Table (13) indicates that the counterfactual estimate $\sigma_{12} = 3.24$, the variance of inflation that would have occurred if the structure of the pre-IT period had coincided with the post-IT shocks, is closer in magnitude with the actual and factual variances post-IT (σ_2^2 and σ_{22}, respectively). Meanwhile, the counterfactual variance that would have been observed when the post-IT structure is combined with pre-IT shocks, $\sigma_{21} = 8.10$, seems closer in magnitude to the actual and factual variances prior to IT adoption (σ_1^1 and σ_{11}, respectively). This seems to suggest that in the case of New Zealand, the lower variability of inflation after IT was institutionalized can be attributed to calmer shocks, rather than to a more stable structure theoretically offered by the IT framework. In the language of time-series analysis, the moderation in the volatility of inflation can be attributed mainly to impulses, and not to the propagation mechanism.

However, a mere comparison of the factual and counterfactual variances is not sufficient to allow us to conclude decisively if the IT framework had a role to play in bringing down the variance of inflation. Whether or not the differences between pairs of variances are statistically significant can be determined if these are greater than the computed critical values using bootstrapping and Monte Carlo techniques as reported in Panel B of Table (13). Keep in mind that $|\sigma_{ii} - \sigma_{ji}|$ yields the difference in the counterfactual variances while holding the shocks constant, while $|\sigma_{ii} - \sigma_{ij}|$ holds the structure constant. This implies that if we want to find out whether there is a meaningful structural change, we should look at $|\sigma_{11} - \sigma_{21}|$ or $|\sigma_{12} - \sigma_{22}|$ and check if they are statistically significant. But if we would like to see whether there is a sizable change in the innovation variance, then the focus should be on $|\sigma_{11} - \sigma_{12}|$ or $|\sigma_{21} - \sigma_{22}|$.

It is also crucial to compare the magnitude of the factual and counterfactual variances when making the comparison of the variances. Table (7) summarizes what the different pairwise comparisons imply with respect to the change in structure or shocks in the post-IT period. For example, if $|\sigma_{11} - \sigma_{21}|$ is statistically significant and the counterfactual variance σ_{21} is lower than the factual variance σ_{11}, then this is evidence suggesting that the more stable structure in the post-IT period helps reduce the variability of inflation. The same can be concluded if $|\sigma_{12} - \sigma_{22}|$ is significant and the counterfactual variance σ_{12} is higher than the factual variance σ_{22}. The other two cases lead us to the opposite conclusion. Meanwhile, if $|\sigma_{11} - \sigma_{21}|$ is statistically significant, but the counterfactual variance σ_{21} is higher than the factual variance σ_{11}, then the evidence points to a less stable structure after IT was adopted. The same can be said if $|\sigma_{12} - \sigma_{22}|$ is significant but the counterfactual variance σ_{12} is lower than the factual variance σ_{11}. The latter two cases do not explain the decline in the variability of inflation. In this case, we look at the role of impulses. It is likely that shocks are generally calmer after IT was adopted relative to those in the pre-IT period. This can be concluded if $|\sigma_{11} - \sigma_{12}|$ is statistically significant and the counterfactual variance σ_{12} is lower than the factual variance σ_{11}; or if $|\sigma_{21} - \sigma_{22}|$ is statistically significant and the counterfactual variance σ_{21} is higher than the factual variance σ_{11}.

In this section, I generally highlight the Monte Carlo critical values at the 5 percent significance level in determining the statistical significance of the differences in variances. Results in Panel B of Table (13) show that both $|\sigma_{11} - \sigma_{21}| = 7.65$ and $|\sigma_{12} - \sigma_{22}| = 2.00$ are not statistically significant as these are too small to exceed the Monte Carlo critical values of 14.78 and 16.03, respectively. However, directionally, the evidence points to a more stable structure in the post-IT period. The counterfactual variance $\sigma_{21} = 8.10$ is smaller than the factual variance $\sigma_{11} = 15.75$, while $\sigma_{12} = 3.24$ is slightly bigger than $\sigma_{22} = 1.24$. That is, in the pre-IT period, modifying the structure of the model while maintaining the shocks reduces the variance of inflation, while in the post-IT period, the same increases inflation variability. Meanwhile, $|\sigma_{11} - \sigma_{12}| = 12.51$ is large and decisively significant (greater than the Monte Carlo critical value of 6.87). In addition, $\sigma_{11} = 15.75$ is much larger than the counterfactual variance $\sigma_{12} = 3.24$. This implies that combining the pre-IT structure with post-IT shocks raises significantly the pre-IT variance of inflation. Furthermore, the difference $|\sigma_{21} - \sigma_{22}| = 6.86$ is bordering significant (Monte Carlo critical value=7.36), with the counterfactual variance $\sigma_{21} = 8.10$ turning out to be substantially higher than the factual variance $\sigma_{22} = 1.24$. This suggests that in the post-IT period, changing the shocks while keeping the post-IT structure increases the volatility substantially. All these results seem to suggest that the main reason behind the reduction in volatility after IT was adopted in New Zealand are calmer shocks (the impulses) and not a more stable structure (the propagation mechanism.)

Nine other IT countries

Analysis of the results for the other countries reveals that UK exhibits the same result as New Zealand Table (17). The estimated factual variances from both the univariate and multivariate models are not only quite close to the actual variances pre- and post-IT, but also capture the substantial moderation in the volatility of inflation. After IT was adopted in the UK, shocks became less violent and the differences $|\sigma_{11} - \sigma_{12}|$ and $|\sigma_{21} - \sigma_{22}|$ are statistically significant, thus helping explain the considerable decline in the inflation variability. However, the statistics ($|\sigma_{11} - \sigma_{12}|$, $|\sigma_{12} - \sigma_{22}|$), which show whether the change in structure helped reduced the variance of inflation, are not statistically significant. Nonetheless, direction-wise, the results point to a more stable structure after the adoption of IT.

Canada, the second country to directly target inflation, exhibits a totally different story Table (9). Analysis of the differences in the factual and counterfactual variances reveals that the sizable decline in inflation variability can be explained solely by a more stable structure. The counterfactual variance $\sigma_{21} = 0.99$ is smaller than the factual variance $\sigma_{11} = 4.93$ and the difference is statistically significant. In addition, the counterfactual variance $\sigma_{12} = 5.53$ is statistically significantly much larger than the factual variance $\sigma_{22} = 0.79$. That is, combining the post-IT structure with the pre-IT shocks would substantially lessen inflation variability in the pre-IT period, while accompanying the post-IT shocks with the pre-IT structure would increase the volatility in the post-IT period. Meanwhile, the statistics which test the impact of a counterfactual shock are both not statistically significant. That is, combining the pre-IT structure with the post-IT shocks or post-IT structure with the pre-IT shocks would not significantly change the variance of inflation.

Meanwnile, the results for the other AEs (Australia (Table 8) and Sweden (Table 15)) as well as all the EMDEs - Indonesia (Table 10), Korea (Table 11), Mexico (Table 12), Philippines (Table 14) and Thailand (Table 16) all suggest that the substantial reduction in inflation variability after the IT framework was adopted in these countries can be explained by a combination of a more stable structure and milder shocks. The differences in the pairs of variances are statistically significant, with the estimated variances declining when the post-IT structure is maintained while changing the shocks, or when the post-IT shocks are kept but the structure is altered. The models also yield factual variances that are close in magnitude to the actual variances in the periods before and after IT was adopted.

6.2 Variability of Output Growth

Is inflation targeting output stabilizing or does it lead to more volatility? Did inflation targeting contribute to the seeming calmness in the business cycle after the adoption of the framework? Results for each country shown in Tables (18) to (27) show that in an overwhelming majority of the IT countries in the sample, shocks are much calmer than the pre-IT period, offsetting what appears to be a less stable structure after IT was introduced. This implies that IT may have had "destabilizing" effects as earlier predicted in Taylor (1994).

Evidence for "destabilizing" effects of IT

Results from the counterfactual VAR analysis show that in all AEs (Canada (Table 19), New Zealand (Table 23), Sweden (Table 25), and the United Kingdom (Table 27)) as well as in some EMDEs (Korea (Table 21), Mexico (Table 22), Philippines (Table 24)), the counterfactual variance σ_{21} is statistically significantly larger than the factual variance σ_{11} in the pre-IT period. That is, in the pre-IT period, volatility of output growth would have risen substantially if we apply the post-IT structure. Looking at $|\sigma_{12} - \sigma_{22}|$, results show that the counterfactual variance σ_{12} is lower than the factual variance σ_{22} for most of these countries. While this difference is not statistically significant, the implication is qualitatively meaningful. In the post-IT period, the variability of output growth would have fallen when we combine the shocks with the pre-IT structure. Did the shocks contribute to the relative stability in the business cycle? The answer appears to be in the affirmative as the statistics $|\sigma_{11} - \sigma_{12}|$ and $|\sigma_{21} - \sigma_{22}|$ are statistically significant in these countries. In addition, the counterfactual variance σ_{12} is much smaller than the factual variance σ_{11} while σ_{21} is much larger than σ_{22}. These results imply that in the pre-IT period, holding the structure fixed but applying the post-IT shocks would have reduced the variability of output growth considerably. Meanwhile, in the post-IT period, combining the pre-IT shocks with the post-IT structure would have made output growth significantly more volatile.

Overall, after IT was adopted, shocks have become sufficiently less volatile to counter the destabilizing effects IT may have had on output growth volatility. It may be noted that Sweden is a special case because it is the only country which exhibited increased output variability. Since shocks appear to be much calmer in the post-IT period, similar with other countries, the observed volatility in output growth can be traced primarily to the less stable structure associated with the IT framework.

Evidence for stabilizing effects of IT

Results for Indonesia (Table 20) and Thailand (Table 26) seem to suggest that IT has led to more stable structure in stark contrast to the findings for other countries. In both countries, the counterfactual variance σ_{21} (σ_{12}) is statistically significantly smaller (larger) than the factual variance σ_{11} (σ_{22}). That is, holding the shocks fixed, applying the post-IT structure reduces the volatility in the pre-IT period, while combining the pre-IT structure with post-IT shocks raises the variability in the post-IT period significantly. Calmer shocks in the post-IT period also helped reduce the variance of output. Thus, the observed decline in output growth variability for these two countries can be traced to a combination of more stable structure and calmer shocks. In the case of Australia (Table 18), the decline in the variance of output growth can be traced solely to less volatile shocks. The statistics which test the effect of a counterfactual structure are not statistically significant. That is, there is no conclusive evidence suggesting that IT has either a stabilizing or destabilizing effect on output growth in Australia.

6.3 Summary of Results

The main VAR specification comprised of world inflation, interest rates, GDP growth, and inflation yields results that are both favorable and not-so-favorable to inflation targeting. In Table (38), I summarize my findings on what drives the relative benign inflation and output after IT was adopted in the sample countries.

In sum, it appears that the remarkable decline in inflation variability can be traced to a combination of more stable structure after IT was adopted and generally less violent shocks. As implemented in Karras et al. (2006), the counterfactual VAR approach allows the decomposition of the proportion of variability that is attributable to either the change in structure or the change in innovation variance. The estimated difference in the variances between the two periods can be decomposed as follows:

$$\frac{\sigma_{22} - \sigma_{11}}{\sigma_{22} - \sigma_{11}} = \frac{\sigma_{22} - \sigma_{21}}{\sigma_{22} - \sigma_{11}} + \frac{\sigma_{21} - \sigma_{11}}{\sigma_{22} - \sigma_{11}} \tag{19}$$

The change in the variance that can be attributed to the structure is given by $\frac{\sigma_{21}-\sigma_{11}}{\sigma_{22}-\sigma_{11}}$, which yields what would have been the variance during the pre-IT period if the structure during the post-IT period is adopted much earlier. Meanwhile, the contribution of the shocks given by $\frac{\sigma_{22}-\sigma_{21}}{\sigma_{22}-\sigma_{11}}$ looks at what would have been the variance during the post-IT period if we instead experience the pre-IT period shocks. Alternatively, the change in the variance can be decomposed as $\frac{(\sigma_{22}-\sigma_{12})+(\sigma_{12}-\sigma_{11})}{\sigma_{22}-\sigma_{11}}$, where the relative importance of the structure is given by $\frac{\sigma_{22}-\sigma_{12}}{\sigma_{22}-\sigma_{11}}$ while that of shocks is $\frac{\sigma_{12}-\sigma_{11}}{\sigma_{22}-\sigma_{11}}$. While this is a reasonable decomposition, it answers a slightly different question. For instance, it asks what would have been the variance during the post-IT period if the structure during the pre-IT period is maintained. As this does not exactly identify whether inflation targeting has significantly affected macroeconomic volatility, the other kind of decomposition is analyzed instead.[9]

Results show that for most of the countries in the sample, the propagation mechanism or the change in structure accounts for a larger proportion of the reduction in inflation volatility after the IT adoption (Table 43). To get a sense of the magnitudes of the variances, let us take Canada, the country where the role of the change in structure is quite glaring. The difference

[9]Based on the alternative decomposition, the resulting level of shares will be different but the qualitative results are not very different for most countries (Tables 47 and 48).

in the estimated inflation variances between the two periods is $\sigma_{22} - \sigma_{11} = 0.79 - 4.93 = -4.14$. Given that $\sigma_{21} = 0.99$, my computation suggests that the structure accounts for about 95 percent $\left[\frac{\sigma_{21}-\sigma_{11}}{\sigma_{22}-\sigma_{11}} = \frac{-3.94}{-4.14} = .95\right]$ of the volatility decline, while shocks are responsible for the remaining 5 percent $\left[\frac{\sigma_{22}-\sigma_{21}}{\sigma_{22}-\sigma_{11}} = \frac{-0.20}{-4.14} = .05\right]$. In terms of the relative importance of the propagation mechanism, countries following Canada include Indonesia (91 percent), Sweden (81 percent), Mexico (80 percent), Philippines (55 percent), New Zealand (53 percent), and Australia (53 percent). In the case of Thailand, the contribution of the propagation mechanism is more than 100 percent. The reason for this can be attributed to the finding that shocks appear to be slightly more violent in the post-IT period. Numerically, this is reflected in the negative sign in the contribution of the impulses. This "negative" effect is offset by the more than 100 percent contribution of the change in structure.

Meanwhile, in other countries, shocks seem to have played a bigger role. In Korea and the UK, calmer shocks are responsible for about 87 percent and 58 percent of the respective reduction in inflation volatility, respectively. More stable structure accounted for the remaining 13 percent for Korea and 42 percent for the UK. While there could be some variation in their relative importance, it must be stressed that both the propagation mechanism and the impulses have a role to play in explaining the relative tranquility in inflation after the adoption of the IT framework.

With respect to output volatility, evidence from the sample countries suggest that the relative stability of output growth can be attributed largely to milder shocks (impulses) after IT was adopted. In fact, these shocks are relatively much less violent than the pre-IT period to offset what appears to be output-destabilizing effects of inflation targeting. As can be seen in Table (44), the contribution of the structure is negative in the majority of the countries which implies that shocks account for more than 100 percent of the decline in output variability. Consistent with the earlier findings of increased stability in structure for Indonesia and Thailand, the computed contribution of structure in the decomposition is positive. In particular, the structure is responsible for about 78 percent and 72 percent of the output volatility decline in Indonesia and Thailand, respectively, while shocks account for the remaining 22 percent and 28 percent.

6.4 Does accounting for the global inflation trends really matter?

The analysis above takes into account the influence that the global tranquility in inflation may have had on domestic inflation and output. If global developments are in fact crucial in explaining domestic macroeconomic stability, failure to account for these in the model would tend to minimize the relative importance of structural stability and practically puts excessive weight on the importance of impulses. This section investigates whether the results would change dramatically if the model excludes global inflation in the VAR models.

Inflation

The implied inflation volatility results shown in Table (29) show that in a number of countries, some of the statistics testing the impact of a change in the structure has ceased to be significant. At the same time, the variance differences that test the effects of a shock change remain statistically significant. Looking at the summary of implications in Table (39), the qualitative conclusion of a more stable structure in the post-IT period is maintained but this result is no longer statistically significant for some countries. This implies that if the 3-variable model is instead used as the main specification, the conclusion would have been that with respect to inflation, the contribution of the propagation mechanism would seem minimal. This finding provides support to the concern that the variation due to global inflation would be relegated to the shock change if it were not included in the VAR system.

Output

The impact of removing world inflation in the VAR model appears to be broadly the same when looking at output volatility. However, the decomposition of the source of volatility change reveal much more dramatic results. The contribution of the change in shocks has increased tremendously compared to the results when world inflation is included in the system. Nonetheless, the qualitative conclusions remain the same.

6.5 Robustness Check

Three other specifications are estimated to check the robustness of the estimates and implications of the counterfactual VAR approach. First, I estimate a 4-variable VAR model, replacing world inflation with world oil price inflation as the most exogenous variable in the system. The results shown in Table (40) show that the qualitative results are generally the same as the results of the main model. That is, the more stable inflation after IT was adopted can be traced to a combination of more stable structure and calmer shocks. However, there are a few changes in the significance of the variance-difference statistics (Table 30). In particular, the statistics testing the role of impulses turned out to be insignificant in a few countries, but the impact was not sufficiently substantial to alter the implications of the model. At the same time, the results for the decomposition of the sources of volatility changes (Table 45) are generally the same for most countries. That is, the decline in inflation volatility can be attributed largely to the propagation, and partly to the impulses.

With respect to output variability, the results are likewise similar with those of the main specification. The statistics testing structural stability and shock change in Table (35) are qualitatively the same as in the results of the baseline model. In addition, the model implications in Table (40), as well as the decomposition of volatility sources in Table (46) lead to practically unchanged conclusions. The reduction in the variability of output after IT was adopted can be traced much less violent shocks which outweigh the destabilizing effects of IT on output growth.

As another robustness check, I estimate a 4-variable VAR model where I replace world inflation with US output growth as an indicator of global output performance. The idea is to capture the impact of calmer global output developments on domestic output and inflation. The weakness of this model, however, is that it fails to sufficiently capture the disinflation trend and less volatile inflation environment that characterized the periods when IT adoption gained momentum. Results shown in Tables (31) and (36) are broadly similar with those from the baseline model. The introduction of IT appears to have made the structure more stable for inflation but less stable for output growth in most countries (Table 41). Interestingly, the decomposition results provide stronger evidence that the adoption of IT played a significant role in stabilizing inflation than what was suggested by the results from the baseline model (Table 45). For output growth, the results of the decomposition are qualitatively the same as the main results (Table 46).

Finally, I simultaneously account for the impact of world inflation and of world output on domestic monetary transmission. I estimate a 5-variable VAR model comprised of US inflation, US output growth, domestic interest rates, domestic output growth, and domestic inflation. This model has the advantage of capturing not only the global disinflation trend, but also the generally smoother global business cycle in a single model. The results corroborate the findings from the baseline model. As can be noted in Tables 32, 37 and 42, the results point to practically the same conclusions. Similar with previous findings, the computation of the respective contributions of the propagation mechanism and impulses suggest that a more stable structure after IT was introduced is mainly responsible for the decline in the volatility of inflation (Table 45). Calmer shocks also helped though at a lesser extent. Meanwhile, much less violent shocks were able to bring down output variability despite the less stable structure noted after countries switched to inflation targeting, consistent with the main results (Table 46). Overall, this suggests that the main specification, though only accounts for the impact of global inflation, is sufficient to provide convincing evidence on how the IT framework affected macroeconomic variability.

6.6 Pseudo-placebo Test: Pre-IT period

An alternative approach to do some sort of a placebo test is to apply the counterfactual VAR method to the pre-IT sample period and use the midpoint of the sample as the arbitrary breakpoint. However, this approach is not a foolproof placebo test because the counterfactual VAR approach tests whether there has been significant changes in the coefficients or the changes in the innovation variance of a VAR model at some meaningful break point.[10] When the counterfactual VAR method is used on the pre-IT period, even using an arbitrary breakpoint, there could be country-specific shocks that could influence the results. A straightforward placebo test would have not detected any statistically significant result on the pre-IT period. But this pseudo-placebo test on the pre-IT period could potentially detect one for reasons unrelated to the monetary policy framework. Hence, the results should be interpreted with caution.

On inflation variability, results in Table (49) and Table (51) reveal that for the majority

[10]Hence, the dating of the shift to inflation targeting is crucial in obtaining meaningful results.

of the countries in the sample, the statistic which test the structural change are either not statistically significant or imply less stable structure, inconsistent with the earlier result on the effect of inflation targeting. A number of countries also yield insignificant results on the test for structural change looking at the volatility of output growth (Table 50). With respect to the statistics testing whether shocks were calmer or more violent after the arbitrary breakpoint, results are mixed. Overall, this placebo-like test shows that during the sample period prior to the shift to inflation targeting, the counterfactual VAR method either does not detect significant structural change for a number of countries or yields inconsistent results.

6.7 Pseudo-placebo Test: Japan and the US

Another pseudo-placebo test is to apply the counterfactual VAR approach to countries which either have not shifted to or do not recognize their monetary policy frameworks to be inflation targeting. Japan shifted to inflation targeting in January 2013 when it announced its price stability target of 2 percent. Meanwhile, the US Federal Reserve does not recognize itself as an inflation targeter. Although it set in January 2012 an inflation target of 2 percent, argued to be the level best aligned with its congressionally mandated goals of price stability and full employment, the US is not formally an inflation-targeting country. Both countries provide interesting cases where the counterfactual VAR method can be used on the period prior to their announcement of their inflation targets. However, the caveats noted on the pseudo-placebo test in the previous section also apply in these cases.[11] In addition, it may be noted that US inflation and output growth are used as proxies for world inflation and world output growth, respectively. Any significant structural or shock change for the US would thus be a relevant result.

For Japan, the counterfactual VAR method yield mixed results with respect to both the structural change and shock change (Tables 52 and 57). That is, the test cannot distinguish whether the observed decline in inflation volatility can be attributed to either a structural change or shock change. Meanwhile, the result is more conclusive with respect to output growth. The observed moderation in output volatility can be attributed solely to much calmer shocks (Table 54). Overall, these results provide support to the use of the counterfactual VAR approach in

[11] In determining a reasonable breakpoint for both Japan and the US, I look at inflation trends in the US. Given the sizeable moderation in the variability of inflation starting in the early 1990s, I choose Q1 1995 as a sensible breakpoint.

determining whether IT has significant effects on inflation and output volatility in the countries in the sample.

In the case of the US, the results suggest that the sizeable moderation in inflation variability can be traced largely to a more stable structure in the late 1990s. Clearly, this result can be attributed to things other than inflation targeting. However, the estimated VARs for the countries in this study account for the variation attributed to the US. Hence, it can be argued that any sort of confounding variation or change in the US is controlled for. Furthermore, it is not quite plausible that a structural change in the US at some point would confound results for the other countries whose break points varied from as early as Q1 1990 to Q3 2005.

7 Discussion and Conclusion

This paper investigates the dramatic decline in inflation variability as well as the smoother business cycle that have been observed in many countries since the 1990s. Focusing on countries which adopted inflation targeting in various years from 1989 to 2005, it asks "Did IT just get lucky or can the framework be causally linked to this macroeconomic phenomenon?" To answer this question, this paper utilizes an innovative technique that has not been previously utilized in analyzing the impact of a policy regime to key macroeconomic variables, particularly inflation and output growth. Under this approach, there are three possible reasons that can explain the more tranquil inflation and output environment. First, after inflation targeting was adopted, the economic structure could have undergone a meaningful transformation, associated with the change in the monetary policy framework, that made it sufficiently more stable to lead to less macroeconomic volatility. Second, while the economic structure is practically unchanged, the economic environment has become less volatile and economic shocks have become calmer, resulting in lower macroeconomic variability. Third, the observed tranquility in macroeconomic variables is the result of a combination of the first two reasons, more stable structure (the propagation mechanism) and calmer shocks (the impulses).

This paper employs the technique developed by James (1993), enhanced by Simon (2001), and applied to business cycle volatility by Stock and Watson (2002), Stock and Watson (2003), Karras et al. (2006), and to exchange rate variability by Karras et al. (2005). James (1993) estimates a structural vector autoregressive model and introduces the computation of "factual" and "counterfactual" variances to investigate whether the heightened cyclical variability in the postbellum era is driven by more volatile shocks (impulses) or a more sensitive structure (propagation). I estimate univariate and multivariate VAR models in the period before inflation targeting was adopted and after its adoption using quarterly data for five advanced economies and five emerging market and developing economies. The "counterfactual" VAR approach provides a way to estimate the counterfactual variability in inflation and output among the inflation targeting countries without the need to examine non-inflation targeting countries. As such, the selection concern for the IT adopters typically present in panel econometric approaches are somehow limited. The approach in this paper estimates "factual variances," the variability in the pre-IT period and in the post-IT period, as well as "counterfactual variances," the hypothetical variances that would have been observed if one period's structure is accompanied by the other period's shocks. A comparison of these estimated variances with each other and to the actual variances, with the aid of critical values generated from bootstrapping and Monte Carlo techniques, provides evidence as to what factor/s could have been responsible for the more stable inflation and output growth after countries introduced the inflation targeting framework.

The baseline model augments a simple monetary policy transmission model (interest rates, GDP growth, inflation) with the global inflation (proxied by US inflation) to account for the impact of a more tepid global inflation environment. Results show that the reduced inflation variability among the inflation targeting countries in my sample can be attributed to a combination of more stable structure (propagation mechanism) and milder shocks (impulses), but the former appears to account for a more significant stabilization role. The implication of this is quite interesting. If inflation targeting were adopted much earlier, we could have seen a more tranquil inflation environment earlier as well. At the same time, results suggest that if shocks in the period after IT was adopted were combined with the structure of the pre-IT period, the inflation volatility would also have been lower. The approach allows the computation of the relative contribution of the propagation mechanism and the impulses in bringing down inflation volatility. There is a variation in the computed shares, with the propagation mechanism explaining at least half of the volatility decline in Thailand, Canada, Indonesia, Sweden, Mexico, Philippines, New Zealand, and Australia; while the impulses seem to be much more important in Korea and the United Kingdom. Nonetheless, the results imply that IT has a significant role to play in bringing about a more stable inflation environment, even after accounting for the moderation in global inflation. The mechanisms through which IT could have achieved this include increased credibility and transparency of monetary authorities as well as the promotion of well-anchored inflation expectations which, in turn, potentially reduces inflation persistence and increases the predictability of future inflation.

The evidence on business cycle volatility is not as friendly to inflation targeting. Results show that the observed moderation in the business cycle after the adoption of inflation targeting can be attributed mainly to calmer shocks (impulses) and not at all to the change in structure. In fact, the evidence from the propagation mechanism points to the IT framework's (unintended) effect of putting in place a less stable structure that would have resulted in increased output volatility, assuming we keep the volatility of shocks unchanged. The shocks appear to be much calmer than the pre-IT period offsetting what appears to be "destabilizing" effects of inflation targeting. Results from the main model are robust to various specifications, including one which jointly accounts for the impact of global inflation and output developments.

How do I reconcile my findings to the evidence in the literature? First, my results using the counterfactual VAR approach provide new evidence that IT has stabilizing effects on inflation, consistent with what has been found in a number of studies which utilize panel-based methodologies such as difference-in-difference models and propensity score matching.[12] Second, my findings on the role of shocks in the post-IT period provide some support to the view that the inflation and output environment in the 1990s and for the most part of 2000s has been generally much more tranquil. However, while this view mainly credits less volatile shocks for bringing down inflation variability, my results suggest that the impact of milder shocks is not as large as the inflation stabilizing effects of IT. The implication is that if IT were not introduced, the inflation environment may not have been as tranquil as it turned out to be. Third, I find evidence which does not support the view that IT is output stabilizing. Instead, my results provide empirical evidence to the prediction of Taylor (1994) and Fuhrer (1997) of the existence of a trade-off between inflation variability and output volatility. These results are also consistent with Cecchetti and Ehrmann (2002) who note that increased aversion to inflation variability may adversely affect output volatility.

[12]These include Batini and Laxton (2007), Vega and Winkelried (2005), Lin and Ye (2009), King (2001), and Neumann and von Hagen (2002).

What is the relevance of these findings to policymakers? These results point to the crucial role of monetary authorities in assigning weights to their price and output objectives. This is especially true among targeters which adopt the flexible form of inflation targeting. Putting too much weight on inflation may come at the sacrifice of smoother business cycle. At the same time though, they have to be careful in trying to achieve too many goals at the same time. This is because as Orphanides (2013) notes, overburdening monetary policy could eventually undermine the credibility of the central bank, which then compromises its effectiveness in achieving its price stability goals and contributing to crisis management. Furthermore, the number of instruments at the disposal of monetary authorities may be less than the number of goals they wanted to pursue. As pointed out by several economists, including Mundell (1968), should the number of targets of monetary authorities exceed the number of instruments at their disposal, at least one target may not be fully attained.

A Appendix

A.1 Data Sources and Sample Countries

Table 1: Impact of IT on average inflation

Authors	Sample: Treatment Group; Control Group	Empirical Strategy	Diifference in inflation rate
Ball and Sheridan (2004)	AEs: 17 IT; 13 NIT	Cross-section OLS	Zero
Vega and Winkelried (2005)	World; 23 IT; 86 NIT	PSM	-2.6% to -4.8%
Mishkin and	AEs: 21 IT; 13 NIT	Cross-section OLS	Zero
Schmidt-Hobbel (2007)	AEs: 21 IT; 13 NIT	IV Panel	-5.0%
	21 post-T; 21 pre-IT	IV Panel	Zero
Batini and Laxton (2007)	21 IT; 29 NIT	Cross-section OLS	4.8 %
Lin and Ye (2007)	AEs: 7 IT	PSM	Zero
Lin and Ye (2009)	EMDEs: 13 IT	PSM	-3.0%
Born, Jahan	EMDEs: 10 IT; 29 NIT	Cross-section OLS	-3%
and Gemayel (2011)		Various panels	-2.0% to -3.0%
Calderón and Hebbel (2008)	World: 24 IT; 73 NIT	Various models*	-3.0% to -6.0%
Samarina and	World: 5 AEs	PSM	Zero for AEs,
De Haan (2014)	and 59 EMDEs		negative for EMDEs

*Multivariate structural inflation model; panel models; fixed effects, random effects, and system GMM
Source: Schmidt-Hebbel and Carrasco (2016)

Table 2: IT countries and approximate adoption dates

Advanced Economies		**Emerging Market Economies**	
New Zealand	1990M1	Thailand	2000M5
Canada	1991M2	Mexico	2001M1
UK	1991M10	South Korea	2001M1
Sweden	1993M1	Philippines	2002M1
Australia	1993M4	Indonesia	2005M7

Table 3: Data Sources

Country	Inflation	GDP Growth	Short-term market interest rate	Lending Rate
Australia	IMF	OECD	OECD	IMF
Canada	IMF	OECD	OECD	IMF
Indonesia	IMF	OECD	FRED	IMF
Korea	IMF	IMF	FRED	IMF
Mexico	IMF	OECD	CB website	IMF
New Zealand	IMF	OECD	OECD	IMF
Philippines	IMF	IMF	CB website	IMF
Sweden	IMF	OECD	OECD	IMF
Thailand	IMF	IMF	CB website	IMF
United Kingdom	IMF	OECD	CB website	IMF

Notes:
1. IMF refers to International Monetary Fund, particularly to the International Financial Statistics.
2. OECD refers to the Organisation for Economic Co-operation and Development.
3. FRED refers to the Federal Reserve Bank of St. Louis economic data.
4. CB website refers to the central bank website of the relevant country.
5. Metadata from OECD defines short-term interest rates to be “usually either the three month interbank offer rate attaching to loans given and taken amongst banks for any excess or shortage of liquidity over several months or the rate associated with Treasury bills, Certificates of Deposit or comparable instruments, each of three month maturity.”
6. Indonesia’s short-term interest rate refers to the 3-month bank deposit rates.
7. The short-term interest rates for Mexico, Philippines, and United Kingdom refer to the rates on three-month government securities.
8. Thailand’s short-term interest rate refers to the rate on three-month time deposit rates.
9. FRED reports Korea’s interest rate on government securities.

Table 4: Descriptive Statistics for Inflation: Full Sample, Pre-IT and Post-IT Subsamples

Country	Period	Variance	Mean	CV	St. Dev.	Min	Max	N
Australia	1968Q1-2017Q4	16.02	5.25	0.76	4.00	-0.45	17.69	200
	1968Q1-1993Q1	15.77	7.91	0.50	3.97	0.33	17.69	101
	1993Q2-2017Q4	1.63	2.53	0.51	1.28	-0.45	6.13	99
Canada	1962Q1-2017Q4	9.58	3.90	0.79	3.10	-0.86	12.70	224
	1962Q1-1990Q4	10.26	5.75	0.56	3.20	0.00	12.70	116
	1991Q1-2017Q4	1.24	1.91	0.58	1.11	-0.86	6.44	108
Indonesia	1991Q1-2017Q4	143.00	9.88	1.21	11.96	-0.59	78.40	108
	1991Q1-2005Q2	239.86	12.72	1.22	15.49	-0.59	78.40	58
	2005Q3-2017Q4	12.57	6.58	0.54	3.54	2.59	17.78	50
Korea	1980Q1-2017Q4	28.81	4.95	1.08	5.37	0.56	31.99	152
	1980Q1-2000Q4	43.10	6.85	0.96	6.56	0.59	31.99	84
	2001Q1-2017Q4	1.42	2.60	0.46	1.19	0.56	5.54	68
Mexico	1980Q1-2017Q4	1216.77	25.96	1.34	34.88	2.27	177.44	152
	1980Q1-2000Q4	1519.47	43.47	0.90	38.98	6.75	177.44	84
	2001Q1-2017Q4	1.23	4.34	0.26	1.11	2.27	7.46	68
New Zealand	1974Q1-2017Q4	33.63	5.96	0.97	5.80	-0.51	18.94	176
	1974Q1-1989Q4	19.29	12.61	0.35	4.39	3.47	18.94	64
	1990Q1-2017Q4	2.07	2.16	0.67	1.44	-0.51	7.62	112
Philippines	1982Q1-2017Q4	84.89	7.99	1.15	9.21	-0.89	60.92	144
	1982Q1-2001Q4	123.91	11.39	0.98	11.13	-0.89	60.92	80
	2002Q1-2017Q4	4.22	3.73	0.55	2.05	-0.06	10.28	64
Sweden	1982Q1-2017Q4	9.79	3.02	1.04	3.13	-1.42	11.30	144
	1982Q1-1992Q4	6.35	6.89	0.37	2.52	1.83	11.30	44
	1993Q1-2017Q4	1.81	1.32	1.02	1.34	-1.42	4.97	100
Thailand	1994Q1-2017Q4	6.35	2.89	0.87	2.52	-2.78	10.29	96
	1994Q1-2000Q1	7.73	4.94	0.56	2.78	-0.93	10.29	25
	2000Q2-2017Q4	3.95	2.17	0.92	1.99	-2.78	7.50	71
UK	1979Q1-2017Q4	14.05	3.91	0.96	3.75	0.30	21.55	156
	1979Q1-1992Q3	19.25	7.45	0.59	4.39	2.62	21.55	55
	1992Q4-2017Q4	0.72	1.98	0.43	0.85	0.30	4.56	101
AE	Full sample	16.62	4.41	0.90	3.96	-0.59	16.44	900
	Pre-IT	14.19	8.12	0.47	3.70	1.65	16.44	380
	Post-IT	1.50	1.98	0.64	1.21	-0.59	5.94	520
EMDE	Full sample	295.96	10.33	1.13	12.79	-0.29	71.81	652
	Pre-IT	386.81	15.87	0.92	14.99	0.99	71.81	331
	Post-IT	4.68	3.88	0.54	1.98	0.52	9.71	321

Notes:
CV is coefficient of variation
AE and EMDE refer to the averages of AE countries (Australia, Canada, New Zealand, Sweden and United Kingdom) and EMDE countries (Indonesia, Korea, Mexico, Philippines, and Thailand)

Table 5: Descriptive Statistics for GDP Growth: Full Sample, Pre-IT and Post-IT Subsamples

Country	Period	Variance	Mean	CV	St. Dev.	Min	Max	N
Australia	1968Q1-2017Q4	3.88	3.29	0.60	1.97	-3.41	8.39	200
	1968Q1-1993Q1	6.53	3.31	0.77	2.56	-3.41	8.39	101
	1993Q2-2017Q4	1.20	3.26	0.34	1.10	1.13	5.63	99
Canada	1962Q1-2017Q4	5.65	3.18	0.75	2.38	-4.08	9.28	224
	1962Q1-1990Q4	6.25	3.96	0.63	2.50	-4.08	9.28	116
	1991Q1-2017Q4	3.68	2.34	0.82	1.92	-4.05	5.89	108
Indonesia	1991Q1-2017Q4	17.81	5.00	0.84	4.22	-17.93	10.74	108
	1991Q1-2005Q2	32.57	4.53	1.26	5.71	-17.93	10.74	58
	2005Q3-2017Q4	0.43	5.55	0.12	0.66	4.21	6.66	50
Korea	1980Q1-2017Q4	18.40	6.16	0.70	4.29	-7.34	16.40	152
	1980Q1-2000Q4	22.38	8.04	0.59	4.73	-7.34	16.40	84
	2001Q1-2017Q4	3.91	3.85	0.51	1.98	-1.93	7.78	68
Mexico	1980Q1-2017Q4	11.88	2.56	1.34	3.45	-8.62	10.25	152
	1980Q1-2000Q4	16.41	2.97	1.36	4.05	-8.62	10.25	84
	2001Q1-2017Q4	5.98	2.06	1.19	2.45	-7.72	7.27	68
New Zealand	1974Q1-2017Q4	8.24	2.45	1.17	2.87	-5.85	14.87	176
	1974Q1-1989Q4	13.04	1.72	2.10	3.61	-5.85	14.87	64
	1990Q1-2017Q4	5.09	2.88	0.78	2.26	-3.16	8.75	112
Philippines	1982Q1-2017Q4	13.72	3.74	0.99	3.70	-11.09	12.37	144
	1982Q1-2001Q4	17.77	2.33	1.81	4.22	-11.09	12.37	80
	2002Q1-2017Q4	3.19	5.50	0.32	1.79	0.52	8.91	64
Sweden	1982Q1-2017Q4	5.88	2.28	1.07	2.42	-6.31	7.87	144
	1982Q1-1992Q4	3.70	1.82	1.06	1.92	-2.41	6.32	44
	1993Q1-2017Q4	6.75	2.48	1.05	2.60	-6.31	7.87	100
Thailand	1994Q1-2017Q4	17.61	3.71	1.13	4.20	-12.53	15.47	96
	1994Q1-2000Q1	41.02	2.86	2.24	6.40	-12.53	10.51	25
	2000Q2-2017Q4	9.49	4.01	0.77	3.08	-4.28	15.47	71
UK	1979Q1-2017Q4	4.56	2.22	0.96	2.14	-6.08	6.97	156
	1979Q1-1992Q3	7.05	2.20	1.21	2.66	-4.08	6.97	55
	1992Q4-2017Q4	3.26	2.23	0.81	1.81	-6.08	4.81	101
AE	Full sample	5.64	2.68	0.91	2.36	-5.15	9.48	900
	Pre-IT	7.32	2.60	1.15	2.65	-3.97	9.17	380
	Post-IT	4.00	2.64	0.76	1.94	-3.69	6.59	520
EMDE	Full sample	15.89	4.24	1.00	3.97	-11.50	13.05	652
	Pre-IT	26.03	4.15	1.45	5.02	-11.50	12.05	331
	Post-IT	4.60	4.19	0.58	1.99	-1.84	9.22	321

Notes:
CV is coefficient of variation
AE and EMDE refer to the averages of AE countries (Australia, Canada, New Zealand, Sweden and United Kingdom) and EMDE countries (Indonesia, Korea, Mexico, Philippines, and Thailand)

Table 6: Lag Length of VAR models based on SIC

	Model 1 (Main Specification)	Model 2	Model 3	Model 4	Model 5
Australia	1	1	2	1	1
Canada	2	2	2	2	1
Indonesia	3	3	3	3	2
Korea	1	2	2	2	1
Mexico	2	2	2	2	2
New Zealand	2	3	2	2	2
Philippines	2	2	2	2	2
Sweden	1	3	1	1	1
Thailand	1	2	2	2	1
United Kingdom	2	2	2	2	2
Japan	2	2	2	2	2
United States	x	2	2	x	x
Variables:					
World Inflation	Yes	No	No	No	Yes
World GDP Growth	No	No	No	Yes	Yes
World Oil Price	No	No	Yes	No	No
Interest Rate	Yes	Yes	Yes	Yes	Yes
GDP Growth	Yes	Yes	Yes	Yes	Yes
Inflation	Yes	Yes	Yes	Yes	Yes

A.2 Implied Inflation Volatility Tables: Baseline Model

Table 7: Analysis of Test Statistics

Test Statistics	Condition	Conclusion for post-IT period
$(\sigma_{11} - \sigma_{21})*$	$\sigma_{11} > \sigma_{21}$	More stable structure
$(\sigma_{12} - \sigma_{22})*$	$\sigma_{12} > \sigma_{22}$	More stable structure
$(\sigma_{11} - \sigma_{12})*$	$\sigma_{11} > \sigma_{12}$	Calmer shocks
$(\sigma_{21} - \sigma_{22})*$	$\sigma_{21} > \sigma_{22}$	Calmer shocks

Table 8: Implied inflation volatility: Australia
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
	Period 1			Period 2	
Variance (σ^2)	15.77			1.63	
Mean	7.91			2.53	
CV	0.50			0.51	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	10.72	1.59		3.49	4.87
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	5.85*	1.90	7.23*	3.29*	1.38
BT-95%	4.75	4.55	3.98	4.02	5.98
BT-99%	6.47	6.99	5.77	5.66	7.64
MC-95%	4.60	4.55	2.47	2.43	4.93
MC-99%	5.79	5.91	3.97	3.58	6.60
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	10.29	1.40		3.54	5.59
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	4.70*	2.14	6.75*	4.19*	2.05
BT-95%	5.00	4.97	3.42	3.49	5.59
BT-99%	7.24	7.14	5.29	5.57	7.88
MC-95%	3.97	4.03	1.99	1.95	4.25
MC-99%	5.28	5.19	2.85	2.62	5.69

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1968Q1 - 1993Q1
Period 2: 1993Q2 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 9: Implied inflation volatility: Canada
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	10.26			1.24	
Mean	5.75			1.91	
CV	0.56			0.58	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	5.50	0.79		4.17	1.04
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	4.46*	3.39	1.33	0.25	3.14
BT-95%	3.56	3.74	1.90	2.02	4.12
BT-99%	5.02	5.09	2.71	2.87	5.43
MC-95%	3.70	3.93	1.87	1.91	4.11
MC-99%	5.51	5.77	2.54	2.61	6.25
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	4.93	0.79		5.53	0.99
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	3.94*	4.74*	0.61	0.20	4.54*
BT-95%	4.10	4.05	2.74	2.66	4.66
BT-99%	5.98	5.48	4.68	4.49	7.19
MC-95%	2.79	2.66	1.23	1.20	2.83
MC-99%	3.75	3.77	1.81	1.68	

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1962Q1 - 1990Q4
Period 2: 1991Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 10: Implied inflation volatility: Indonesia
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
		Period 1		Period 2	
Variance (σ^2)		239.86		12.57	
Mean		12.72		6.58	
CV		1.22		0.54	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	244.90	5.33		27.46	47.57
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	197.40*	22.13	217.50*	42.23	20.11
BT-95%	146.80	140.50	195.00	194.50	249.60
BT-99%	239.90	240.20	319.20	291.60	410.50
MC-95%	125.90	123.70	82.35	81.35	152.80
MC-99%	178.00	179.50	121.90	116.30	204.10
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	221.50	4.85*		115.70	24.42
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	197.10*	110.90*	105.80*	19.57	91.28
BT-95%	136.40	130.90	104.60	127.60	173.80
BT-99%	257.30	209.80	161.20	197.50	272.10
MC-95%	97.63	87.11	54.73	58.71	111.60
MC-99%	148.80	130.90	78.16	91.34	

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1991Q1 - 2005Q2
Period 2: 2005Q3 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 11: Implied inflation volatility: Korea
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

		Actual			
	Period 1			Period 2	
Variance (σ^2)	43.10			1.42	
Mean	6.85			2.60	
CV	0.96			0.46	
		(A) Univariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	12.86	1.28		1.49	11.01
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	1.85	0.21	11.37*	9.73*	9.52*
BT-95%	6.33	6.17	6.24	6.12	8.07
BT-99%	9.11	9.04	8.57	9.09	12.48
MC-95%	5.63	5.65	3.09	3.21	6.22
MC-99%	7.30	7.45	4.31	4.74	8.99
		(B) Multivariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	9.07	0.97		2.73	8.02
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	1.05	1.76	6.34*	7.05*	5.29*
BT-95%	4.90	4.37	4.20	4.08	5.89
BT-99%	7.03	7.32	5.84	6.34	8.71
MC-95%	4.12	3.81	2.08	2.09	4.05
MC-99%	5.57	5.53	2.92	3.14	5.71

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1980Q1 -2000Q4
Period 2: 2001Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 12: Implied inflation volatility: Mexico
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
		Period 1		Period 2	
Variance (σ^2)		1519.47		1.23	
Mean		43.47		4.34	
CV		0.90		0.26	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	1522.00	0.99		7.30	205.80
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	1316.00*	6.31	1515.00*	204.90	198.50
BT-95%	1232.00	1292.00	1652.00	1571.00	1841.00
BT-99%	1873.00	2254.00	2351.00	2703.00	3020.00
MC-95%	1145.00	1100.00	582.80	562.30	1210.00
MC-99%	1678.00	1654.00	782.50	898.50	1860.00
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	1391.00	1.02		20.65	273.90
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	1118.00*	19.63	1371.00*	272.90	253.20
BT-95%	763.40	735.10	1007.00	1000.00	1079.00
BT-99%	1165.00	1170.00	1607.00	1567.00	1615.00
MC-95%	647.30	573.70	297.90	294.60	640.40
MC-99%	942.60	862.60	422.10	430.40	961.50

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1980Q1 - 2000Q4
Period 2: 2001Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 13: Implied inflation volatility: New Zealand
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	19.29			2.07	
Mean	12.61			2.16	
CV	0.35			0.67	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	19.67	1.29		2.83	8.98
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	10.69	1.54	16.84*	7.69	6.15
BT-95%	23.14	24.15	20.67	21.82	29.89
BT-99%	36.58	36.54	34.70	33.01	51.06
MC-95%	22.29	22.10	9.01	10.74	23.84
MC-99%	33.54	29.47	12.98	15.19	36.08
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	15.75	1.24		3.24	8.10
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	7.65	2.00	12.51*	6.86	4.86
BT-95%	15.80	17.12	12.15	11.50	19.08
BT-99%	22.58	22.62	19.78	18.66	28.95
MC-95%	14.78	16.03	6.87	7.36	16.62
MC-99%	20.86	23.39	10.78	11.31	22.51

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1974Q1 - 1989Q4
Period 2: 1990Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 14: Implied inflation volatility: Philippines
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	123.91			4.22	
Mean	11.39			3.73	
CV	0.98			0.55	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	124.10	4.22		5.68	92.27
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	31.86	1.46	118.50*	88.05*	86.60*
BT-95%	75.88	73.61	106.90	122.50	134.20
BT-99%	121.50	154.20	174.70	175.90	204.40
MC-95%	74.63	71.80	44.27	43.54	83.04
MC-99%	100.90	101.70	66.32	66.75	109.00
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	122.90	3.43		27.45	57.32
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	65.62*	24.02	95.49*	53.89*	29.88
BT-95%	73.25	67.05	79.16	82.75	98.19
BT-99%	98.42	123.40	112.90	122.30	157.80
MC-95%	55.31	55.98	30.71	28.92	61.19
MC-99%	82.70	74.93	42.83	42.69	90.97

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1982Q1 - 2001Q4
Period 2: 2002Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 15: Implied inflation volatility: Sweden
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

		Actual			
	Period 1			Period 2	
Variance (σ^2)	6.35			1.81	
Mean	6.89			1.32	
CV	0.37			1.02	
		(A) Univariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	7.03	1.28		2.39	3.77
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	3.26*	1.11	4.64*	2.49*	1.38
BT-95%	3.35	3.42	3.08	3.63	4.63
BT-99%	5.32	4.81	4.56	5.03	6.51
MC-95%	2.79	3.09	1.54	1.94	3.07
MC-99%	4.07	3.97	2.76	2.49	4.58
		(B) Multivariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	9.67	1.50		7.70	3.02
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	6.64*	6.21*	1.96*	1.53	4.68*
BT-95%	4.24	5.17	3.16	3.40	5.31
BT-99%	6.60	8.30	5.28	4.60	8.54
MC-95%	3.36	3.79	1.73	1.89	3.62
MC-99%	5.94	5.60	2.54	2.71	5.70

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1982Q1 - 1993Q1
Period 2: 1993Q2 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 16: Implied inflation volatility: Thailand
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	7.73			3.95	
Mean	4.94			2.17	
CV	0.56			0.92	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	9.39	3.91		6.77	5.43
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	3.96	2.86	2.62	1.52	1.34
BT-95%	5.19	5.48	3.98	4.91	6.97
BT-99%	9.00	8.43	7.92	7.14	12.16
MC-95%	5.43	5.67	3.16	3.71	6.41
MC-99%	7.82	8.56	6.26	5.47	9.61
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	7.12	3.74		29.88	3.56
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	3.56	26.14*	22.76*	0.18	26.32*
BT-95%	4.87	7.15	5.88	3.93	8.20
BT-99%	9.03	14.40	11.81	5.76	14.37
MC-95%	5.55	7.23	4.24	3.88	7.97
MC-99%	10.43	13.69	8.58	4.94	15.13

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1994Q1 - 2000Q1
Period 2: 2000Q2 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 17: Implied inflation volatility: United Kingdom
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

		Actual			
	Period 1			Period 2	
Variance (σ^2)	19.25			0.72	
Mean	7.45			1.98	
CV	0.59			0.43	
		(A) Univariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	17.38	0.73		1.15	11.00
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	6.38	0.42	16.23*	10.27*	9.85*
BT-95%	7.38	7.09	8.56	9.37	10.63
BT-99%	11.86	11.60	12.45	14.97	16.56
MC-95%	7.43	7.51	3.41	3.81	7.74
MC-99%	11.26	10.42	5.14	5.09	12.01
		(B) Multivariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	10.15	0.71		6.04	6.20
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	3.95	5.33	4.11*	5.49*	0.16
BT-95%	5.25	5.90	4.27	3.96	6.86
BT-99%	8.59	9.42	7.36	5.99	11.16
MC-95%	5.06	5.35	2.69	2.73	5.70
MC-99%	7.54	8.14	4.06	4.03	8.65

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1979Q1 - 1992Q3
Period 2: 1992Q4 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

A.3 Implied Output Growth Volatility Tables: Baseline Model

Table 18: Implied output growth volatility: Australia
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
	Period 1			Period 2	
Variance (σ^2)	6.53			1.20	
Mean	3.31			3.26	
CV	0.77			0.34	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	6.49	1.18		1.20	6.41
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	0.08	0.01	5.29*	5.23*	5.21*
BT-95%	2.07	2.15	1.65	1.75	2.66
BT-99%	2.90	2.98	2.41	2.33	3.81
MC-95%	2.12	2.12	1.44	1.54	2.55
MC-99%	2.98	2.99	1.95	2.16	3.42
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	5.74	1.16		1.22	5.79
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	0.05	0.06	4.52*	4.63*	4.57*
BT-95%	1.63	1.70	1.54	1.54	2.16
BT-99%	2.19	2.30	2.07	2.05	2.76
MC-95%	1.69	1.63	1.20	1.22	2.03
MC-99%	2.41	2.45	1.72	1.58	2.77

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1968Q1 - 1993Q1
Period 2: 1993Q2 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 19: Implied output growth volatility: Canada
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
	Period 1			Period 2	
Variance (σ^2)	6.25			3.68	
Mean	3.96			2.34	
CV	0.63			0.82	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	6.19	2.95		1.79	10.20
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	4.00*	1.16	4.40*	7.25*	8.41*
BT-95%	3.16	3.22	2.03	1.96	3.70
BT-99%	4.39	4.27	2.81	2.69	5.72
MC-95%	3.28	3.42	1.87	1.86	3.63
MC-99%	4.16	4.21	2.55	2.88	5.45
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	4.61	2.65		1.34	7.32
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	2.70*	1.31	3.27*	4.66*	5.97*
BT-95%	2.80	2.68	1.68	1.72	3.06
BT-99%	3.95	3.75	2.31	2.51	4.48
MC-95%	2.66	2.67	1.52	1.41	3.15
MC-99%	3.63	3.55	2.16	1.97	4.03

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1962Q1 - 1990Q4
Period 2: 1991Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 20: Implied output growth volatility: Indonesia
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
	Period 1			Period 2	
Variance (σ^2)	32.57			0.43	
Mean	4.53			5.55	
CV	1.26			0.12	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	32.15	0.41		0.38	35.41
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	3.26	0.04	31.78*	35.00*	35.04*
BT-95%	15.63	16.01	18.05	18.01	22.89
BT-99%	26.87	23.77	28.11	25.87	37.66
MC-95%	14.87	14.60	10.59	10.65	17.82
MC-99%	20.31	20.89	14.39	13.77	24.32
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	30.82	0.25		15.96	8.81
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	22.00*	15.71*	14.85*	8.56*	7.15
BT-95%	18.86	17.34	14.56	16.86	23.09
BT-99%	35.29	30.90	22.21	26.25	36.81
MC-95%	15.62	13.95	8.28	8.53	17.15
MC-99%	23.09	19.40	10.80	13.50	25.84

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1991Q1 - 2005Q2
Period 2: 2005Q3 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 21: Implied output growth volatility: Korea
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1		Period 2		
Variance (σ^2)	22.38		3.91		
Mean	8.04		3.85		
CV	0.59		0.51		
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	20.63	3.89		3.60	22.27
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	1.65	0.29	17.03*	18.38*	18.67*
BT-95%	13.12	13.54	11.72	11.22	17.86
BT-99%	19.44	20.47	18.33	18.29	26.55
MC-95%	12.89	12.11	8.07	7.73	14.18
MC-99%	17.29	16.90	11.66	11.78	19.10
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	19.09	3.64		5.00	35.33
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	16.25*	1.36	14.08*	31.69*	30.33*
BT-95%	11.63	11.21	10.78	10.63	14.83
BT-99%	16.43	16.20	15.04	18.01	23.12
MC-95%	10.18	9.56	5.93	5.76	11.08
MC-99%	14.67	14.89	8.17	8.33	15.83

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1980Q1 -2000Q4
Period 2: 2001Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 22: Implied output growth volatility: Mexico
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
		Period 1		Period 2	
Variance (σ^2)		16.41		5.98	
Mean		2.97		2.06	
CV		1.36		1.19	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	15.71	5.72		5.51	16.29
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	0.58	0.20	10.20*	10.58*	10.78*
BT-95%	8.08	7.91	7.46	7.66	10.74
BT-99%	11.15	11.35	9.89	10.85	14.58
MC-95%	7.80	7.79	5.51	5.81	9.66
MC-99%	13.05	10.99	7.65	7.98	14.28
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	15.14	5.80		4.63	485.50
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	470.40*	1.18	10.51*	479.70*	480.90*
BT-95%	9.37	7.83	7.21	8.32	11.55
BT-99%	15.31	12.61	10.33	14.92	20.69
MC-95%	6.86	6.42	3.75	3.42	7.28
MC-99%	9.86	8.81	5.33	5.35	11.15

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1980Q1 - 2000Q4
Period 2: 2001Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 23: Implied output growth volatility: New Zealand
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
		Period 1		Period 2	
Variance (σ^2)		13.04		5.09	
Mean		1.72		2.88	
CV		2.10		0.78	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	11.73	4.74		2.99	18.60
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	6.87*	1.75	8.74*	13.86*	15.61*
BT-95%	4.20	4.03	6.49	6.34	7.62
BT-99%	5.85	6.16	9.80	8.58	10.87
MC-95%	3.63	3.88	3.30	3.53	4.71
MC-99%	5.49	5.24	4.51	4.56	7.07
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	11.46	4.55		3.18	17.84
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	6.38*	1.37	8.28*	13.29*	14.66*
BT-95%	3.72	4.10	5.49	5.04	6.55
BT-99%	5.48	6.58	8.11	6.89	9.63
MC-95%	3.31	3.69	2.81	2.69	4.72
MC-99%	4.51	4.98	4.11	3.60	6.22

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1974Q1 - 1989Q4
Period 2: 1990Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 24: Implied output growth volatility: Philippines
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
		Period 1		Period 2	
Variance (σ^2)		17.77		3.19	
Mean		2.33		5.50	
CV		1.81		0.32	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	17.35	3.12		5.03	10.75
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	6.60	1.92	12.32*	7.63*	5.71
BT-95%	11.09	10.39	8.40	8.34	14.17
BT-99%	16.55	16.15	12.62	12.19	20.64
MC-95%	10.74	10.34	5.95	5.94	11.80
MC-99%	16.10	15.40	8.60	8.77	17.82
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	17.03	2.61		2.96	24.80
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	7.77*	0.35	14.07*	22.19*	21.83*
BT-95%	9.94	10.35	8.20	9.56	12.95
BT-99%	14.57	16.29	12.96	14.06	19.94
MC-95%	7.29	6.59	3.43	3.64	7.77
MC-99%	10.12	8.96	4.81	5.58	10.69

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1982Q1 - 2001Q4
Period 2: 2002Q1 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 25: Implied output growth volatility: Sweden
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

		Actual			
	Period 1			Period 2	
Variance (σ^2)	3.70			6.75	
Mean	1.82			2.48	
CV	1.06			1.05	
		(A) Univariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	3.97	5.12		3.45	5.88
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	1.92	1.67	0.52	0.77	2.43
BT-95%	3.73	3.59	3.36	3.40	5.03
BT-99%	5.80	5.20	5.17	5.49	7.38
MC-95%	3.78	3.93	2.50	2.43	4.41
MC-99%	5.15	5.62	3.51	3.78	6.82
		(B) Multivariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	3.90	4.80		2.73	7.53
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	3.62*	2.07	1.17	2.73*	4.80
BT-95%	2.92	3.25	2.57	2.30	4.00
BT-99%	4.32	4.94	3.93	2.80	5.49
MC-95%	3.51	4.01	2.23	2.12	4.13
MC-99%	5.49	5.78	3.58	2.93	6.24

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1982Q1 - 1993Q1
Period 2: 1993Q2 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 26: Implied output growth volatility: Thailand
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

		Actual			
	Period 1			Period 2	
Variance (σ^2)	41.02			9.49	
Mean	2.86			4.01	
CV	2.24			0.77	
		(A) Univariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	33.36	9.40		18.97	16.53
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	16.83*	9.57	14.39*	7.13	2.44
BT-95%	15.00	15.03	15.98	17.16	21.78
BT-99%	23.83	23.85	26.88	22.01	31.58
MC-95%	13.34	13.59	9.78	10.82	15.87
MC-99%	22.33	22.16	14.17	14.79	26.08
		(B) Multivariate Model			
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	33.74	9.30		63.88	14.64
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	19.09*	54.57*	30.14*	5.34	49.23*
BT-95%	16.57	29.32	23.09	12.29	32.17
BT-99%	56.60	84.62	47.27	16.29	90.39
MC-95%	13.46	18.51	12.81	10.04	22.10
MC-99%	25.76	35.37	22.63	13.18	39.61

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1994Q1 - 2000Q1
Period 2: 2000Q2 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 27: Implied output growth volatility: United Kingdom
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1	Period 2			
Variance (σ^2)	7.05	3.26			
Mean	2.20	2.23			
CV	1.21	0.81			
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	5.97	3.22		1.08	17.78
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	11.81*	2.14	4.8	14.5	16.69*
BT-95%	3.21	3.12	4.29	4.32	5.31
BT-99%	4.86	4.24	6.49	6.27	7.42
MC-95%	3.24	3.44	1.99	1.98	3.77
MC-99%	4.64	4.67	2.85	2.63	5.38
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	5.24	3.27		1.70	23.77
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	18.53*	1.56	3.54*	20.50*	22.06*
BT-95%	2.69	3.04	2.58	2.35	3.80
BT-99%	4.65	5.54	3.89	3.42	6.04
MC-95%	2.19	2.45	1.31	1.29	2.65
MC-99%	3.10	3.50	2.12	1.74	3.85

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1979Q1 - 1992Q3
Period 2: 1992Q4 - 2017Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

A.4 Summary Tables of Implied Inflation Volatility

Table 28: Summary of Implied Inflation Volatility: 4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	15.77	10.26	239.86	43.10	1519.47	19.29	123.91	6.35	7.73	19.25
	σ_2	1.63	1.24	12.57	1.42	1.23	2.07	4.22	1.81	3.95	0.72
Estimates	σ_{11}	10.29	4.93	221.50	9.07	1391.00	15.75	122.90	9.67	7.12	10.15
	σ_{22}	1.40	0.79	4.85	0.97	1.02	1.24	3.43	1.50	3.74	0.71
	σ_{12}	3.54	5.53	115.70	2.73	20.65	3.24	27.45	7.70	29.88	6.04
	σ_{21}	5.59	0.99	24.42	8.02	273.90	8.10	57.32	3.02	3.56	6.20
Statistics	$\lvert\sigma_{11} - \sigma_{21}\rvert$	4.70*	3.94*	197.10*	1.05	1118.00*	7.65	65.62*	6.64*	3.56	3.95
(MC-95%)		(3.97)	(2.79)	(97.63)	(4.12)	(647.30)	(14.78)	(55.31)	(3.36)	(5.55)	(5.06)
	$\lvert\sigma_{12} - \sigma_{22}\rvert$	2.14	4.74*	110.90*	1.76	19.63	2.00	24.02	6.21*	26.14*	5.33
		(4.03)	(2.66)	(87.11)	(3.81)	(573.70)	(16.03)	(55.98)	(3.79)	(7.23)	(5.35)
	$\lvert\sigma_{11} - \sigma_{12}\rvert$	6.75*	0.61	105.80*	6.34*	1371.00*	12.51*	95.49*	1.96*	22.76*	4.11*
		(1.99)	(1.23)	(54.73)	(2.08)	(297.90)	(6.87)	(30.71)	(1.73)	(4.24)	(2.69)
	$\lvert\sigma_{21} - \sigma_{22}\rvert$	4.19*	0.20	19.57	7.05*	272.90	6.86	53.89*	1.53	0.18	5.49*
		(1.95)	(1.20)	(58.71)	(2.09)	(294.60)	(7.36)	(28.92)	(1.89)	(3.88)	(2.73)
	$\lvert\sigma_{12} - \sigma_{21}\rvert$	2.05	4.54*	91.28	5.29*	253.20	4.86	29.88	4.68*	26.32*	0.16
		(4.25)	(2.83)	(111.60)	(4.05)	(640.40)	(16.62)	(61.19)	(3.62)	(7.97)	(5.70)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 29: Summary of Implied Inflation Volatility: 3-variable VAR (Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	15.77	10.26	239.86	43.10	1519.47	19.29	123.91	6.35	7.73	19.25
	σ_2	1.63	1.24	12.57	1.42	1.23	2.07	4.22	1.81	3.95	0.72
Estimates	σ_{11}	11.51	5.61	233.10	14.91	1385.00	19.20	122.90	7.89	7.45	15.75
	σ_{22}	1.41	0.79	5.03	0.85	1.03	1.37	3.51	1.38	3.99	0.71
	σ_{12}	3.13	4.39	16.53	1.67	16.35	3.62	7.21	3.68	6.39	1.75
	σ_{21}	5.46	1.06	37.99	7.50	355.60	8.41	74.13	6.46	1.82	8.02
Statistics	$\lvert\sigma_{11} - \sigma_{21}\rvert$	6.05*	4.55*	195.10*	7.41*	1030.00*	10.79	48.75	1.43	5.63*	7.73*
(MC-95%)		(5.42)	(4.15)	(92.01)	(6.93)	(723.90)	(19.57)	(59.36)	(4.13)	(5.60)	(6.86)
	$\lvert\sigma_{12} - \sigma_{22}\rvert$	1.73	3.60	11.50	0.82	15.32	2.25	3.70	2.31	2.40	1.04
		(5.15)	(4.15)	(88.52)	(6.39)	(693.10)	(21.54)	(56.49)	(4.98)	(7.67)	(7.35)
	$\lvert\sigma_{11} - \sigma_{12}\rvert$	8.38*	1.21	216.60*	13.24*	1369.00*	15.58*	115.70*	4.21*	1.06	14.00*
		(2.47)	(1.67)	(48.43)	(3.49)	(322.60)	(9.56)	(29.61)	(2.33)	(5.20)	(3.25)
	$\lvert\sigma_{21} - \sigma_{22}\rvert$	4.05*	0.27	32.96	6.66*	354.60*	7.04	70.62*	5.08*	2.17	7.31*
		(2.42)	(1.78)	(53.17)	(4.04)	(328.50)	(9.86)	(31.11)	(2.37)	(3.73)	(3.66)
	$\lvert\sigma_{12} - \sigma_{21}\rvert$	2.33	3.34	21.46	5.83	339.30	4.80	66.92*	2.77	4.57	6.27
		(5.81)	(4.39)	(105.00)	(7.75)	(764.40)	(23.90)	(64.59)	(4.98)	(9.96)	(7.43)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 30: Summary of Implied Inflation Volatility: 4-variable VAR (World Oil Prices, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	15.77	10.26	239.86	43.10	1519.47	19.29	123.91	6.35	7.73	19.25
	σ_2	1.63	1.24	12.57	1.42	1.23	2.07	4.22	1.81	3.95	0.72
Estimates	σ_{11}	12.32	5.55	237.30	14.32	1392.00	17.84	123.40	10.68	28.84	13.25
	σ_{22}	1.62	0.79	4.64	0.85	1.04	1.31	3.33	1.50	3.97	0.70
	σ_{12}	3.21	4.53	39.67	4.51	39.08	2.76	10.68	9.75	82.15	4.85
	σ_{21}	10.04	1.66	26.45	5.54	286.00	7.23	44.34	2.65	1.62	5.44
Statistics	$\lvert\sigma_{11} - \sigma_{21}\rvert$	2.27	3.88*	210.90*	8.79*	1106.00*	10.61	79.01*	8.03*	27.21*	7.81*
(MC-95%)		(6.60)	(3.78)	(94.10)	(6.41)	(651.30)	(22.94)	(56.99)	(3.60)	(6.80)	(5.10)
	$\lvert\sigma_{12} - \sigma_{22}\rvert$	1.59	3.74*	35.04	3.66	38.04	1.45	7.35	8.25*	78.18	4.15
		(6.62)	(3.66)	(87.74)	(6.37)	(583.70)	(25.75)	(59.03)	(3.83)	(10.24)	(5.81)
	$\lvert\sigma_{11} - \sigma_{12}\rvert$	9.11*	1.02	197.60*	9.82*	1353.00*	15.08*	112.70*	0.93	53.32*	8.40*
		(3.21)	(1.63)	(51.49)	(3.19)	(300.20)	(10.26)	(32.04)	(1.84)	(8.09)	(2.66)
	$\lvert\sigma_{21} - \sigma_{22}\rvert$	8.42*	0.87	21.82	4.69*	284.90	5.92	41.01*	1.15	2.35	4.74*
		(3.17)	(1.56)	(57.02)	(3.23)	(285.90)	(11.41)	(31.42)	(1.88)	(4.21)	(2.91)
	$\lvert\sigma_{12} - \sigma_{21}\rvert$	6.84	2.86	13.22	1.03	246.90	4.47	33.66	7.10*	80.53*	0.59
		(6.94)	(4.07)	(107.20)	(6.77)	(656.80)	(25.27)	(64.92)	(3.95)	(12.27)	(5.72)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 31: Summary of Implied Inflation Volatility: 4-variable VAR (World GDP Growth, Interest Rates, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	15.77	10.26	239.86	43.10	1519.47	19.29	123.91	6.35	7.73	19.25
	σ_2	1.63	1.24	12.57	1.42	1.23	2.07	4.22	1.81	3.95	0.72
Estimates	σ_{11}	11.12	5.67	219.50	14.70	1394.00	18.00	129.30	12.30	8.04	14.44
	σ_{22}	1.47	0.79	4.77	0.83	0.98	1.27	3.54	1.48	3.98	0.71
	σ_{12}	3.21	4.39	23.02	1.70	56.85	3.20	43.48	7.25	9.34	2.01
	σ_{21}	4.51	1.06	28.30	7.39	346.20	7.75	69.74	3.30	1.47	7.21
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	6.61*	4.62*	191.20*	7.31*	1048.00*	10.25	59.59*	9.00*	6.56*	7.24*
(MC-95%)		(4.97)	(3.74)	(99.52)	(7.21)	(787.10)	(20.63)	(54.34)	(3.79)	(5.83)	(6.24)
	$\|\sigma_{12} - \sigma_{22}\|$	1.74	3.60	18.26	0.87	55.87	1.93	39.94	5.77*	5.37	1.30
		(4.95)	(3.82)	(87.80)	(6.81)	(715.50)	(22.99)	(53.54)	(3.88)	(10.04)	(6.48)
	$\|\sigma_{11} - \sigma_{12}\|$	7.92*	1.29	196.50*	13.00*	1337.00*	14.79*	85.84*	5.06*	1.31	12.43*
		(2.40)	1.70)	(52.44)	(3.45)	(356.00)	(9.51)	(27.76)	(1.71)	(7.26)	(3.27)
	$\|\sigma_{21} - \sigma_{22}\|$	3.04*	0.27	23.54	6.56*	345.30	6.48	66.20*	1.82	2.51	6.50*
		(2.40)	(1.61)	(54.93)	(3.65)	(355.40)	(10.67)	(29.03)	(1.93)	(3.89)	(3.27)
	$\|\sigma_{12} - \sigma_{21}\|$	1.30	3.33	5.28	5.69	289.40	4.55	26.26	3.95*	7.87	5.19
		(5.23)	(4.15)	(105.70)	(7.80)	(772.80)	(23.09)	(61.46)	(3.90)	(11.79)	(6.96)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 32: Summary of Implied Inflation Volatility: 5-variable VAR (World GDP Growth, World Inflation, Interest Rates, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	15.77	10.26	239.86	43.10	1519.47	19.29	123.91	6.35	7.73	19.25
	σ_2	1.63	1.24	12.57	1.42	1.23	2.07	4.22	1.81	3.95	0.72
Estimates	σ_{11}	9.63	3.64	215.50	9.49	1379.00	15.67	136.60	8.80	7.11	10.21
	σ_{22}	1.47	0.87	5.18	0.97	0.97	1.25	3.44	1.48	3.70	0.71
	σ_{12}	4.38	4.27	156.60	2.79	37.36	3.33	88.72	6.98	30.30	5.21
	σ_{21}	5.11	0.98	261.40	7.95	280.00	7.86	45.66	3.15	3.15	5.74
Statistics	$\lvert\sigma_{11} - \sigma_{21}\rvert$	4.52*	2.66*	45.94	1.54	1099.00*	7.81	90.98*	5.65*	3.96	4.47
(MC-95%)		(3.96)	(2.23)	(101.70)	(3.84)	(665.30)	(13.51)	(55.91)	(3.24)	(6.03)	(4.91)
	$\lvert\sigma_{12} - \sigma_{22}\rvert$	2.91	3.40*	151.40*	1.82	36.39	2.09	85.28*	5.50*	26.59*	4.50
		(4.02)	(2.29)	(91.10)	(3.88)	(603.20)	(15.43)	(51.51)	(3.81)	(8.32)	(5.76)
	$\lvert\sigma_{11} - \sigma_{12}\rvert$	5.25*	0.63	58.91*	6.71*	1342.00*	12.34*	47.92*	1.82*	23.18*	5.00*
		(2.05)	(1.12)	(49.17)	(2.22)	(315.00)	(8.05)	(25.77)	(1.80)	(4.98)	(2.63)
	$\lvert\sigma_{21} - \sigma_{22}\rvert$	3.64*	0.11	256.20*	6.98*	279.00	6.61	42.22*	1.67	0.55	5.03*
		(1.90)	(1.03)	(59.42)	(2.03)	(297.00)	(7.01)	(27.45)	(1.83)	(3.97)	(2.77)
	$\lvert\sigma_{12} - \sigma_{21}\rvert$	0.73	3.29*	104.90	5.17*	242.60	4.53	43.06	3.83*	27.14*	0.53
		(4.29)	2.33)	(113.20)	(4.21)	(681.40)	(16.70)	(58.40)	(3.82)	(9.20)	(5.66)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

A.5 Summary Tables of Implied Output Volatility

Table 33: Summary of Implied Output Growth Volatility: 4-variable VAR (World Inflation, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	6.53	6.25	32.57	22.38	16.41	13.04	17.77	3.70	41.02	7.05
	σ_2	1.20	3.68	0.43	3.91	5.98	5.09	3.19	6.75	9.49	3.26
Estimates	σ_{11}	5.74	4.61	30.82	19.09	15.14	11.46	17.03	3.90	33.74	5.24
	σ_{22}	1.16	2.65	0.25	3.64	5.80	4.55	2.61	4.80	9.30	3.27
	σ_{12}	1.22	1.34	15.96	5.00	4.63	3.18	2.96	2.73	63.88	1.70
	σ_{21}	5.79	7.32	8.81	35.33	485.50	17.84	24.80	7.53	14.64	23.77
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	0.05	2.70*	22.00*	16.25*	470.40*	6.38*	7.77*	3.60*	19.09*	18.53*
(MC-95%)		(1.69)	(2.66)	(15.62)	(10.18)	(6.86)	(3.31)	(7.29)	(3.51)	(13.46)	(2.19)
	$\|\sigma_{12} - \sigma_{22}\|$	0.06	1.31	15.71*	1.36	1.18	1.37	0.35	2.07	54.57*	1.56
		(1.63)	2.67)	(13.95)	(9.56)	(6.42)	(3.69)	(6.59)	(4.01)	(18.51)	(2.45)
	$\|\sigma_{11} - \sigma_{12}\|$	4.52*	3.27*	14.85*	14.08*	10.51*	8.28*	14.07*	1.17	30.14*	3.54*
		(1.20)	1.52)	(8.28)	(5.93)	(3.75)	(2.81)	(3.43)	(2.23)	(12.81)	(1.31)
	$\|\sigma_{21} - \sigma_{22}\|$	4.63*	4.66*	8.56*	31.69*	479.70*	13.29*	22.19*	2.73*	5.34	20.50*
		(1.22)	(1.41)	(8.53)	(5.76)	(3.42)	(2.69)	(3.64)	(2.12)	(10.04)	(1.29)
	$\|\sigma_{12} - \sigma_{21}\|$	4.57*	5.97*	7.15	30.33*	480.90*	14.66*	21.83*	4.80*	49.23*	22.06*
		(2.03)	(3.15)	(17.15)	(11.08)	(7.28)	(4.72)	(7.77)	(4.13)	(22.10)	(2.65)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 34: Summary of Implied Output Growth Volatility: 3-variable VAR (Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	6.53	6.25	32.57	22.38	16.41	13.04	17.77	3.70	41.02	7.05
	σ_2	1.20	3.68	0.43	3.91	5.98	5.09	3.19	6.75	9.49	3.26
Estimates	σ_{11}	5.81	4.79	31.29	17.45	15.67	11.12	17.44	4.83	27.76	5.73
	σ_{22}	1.15	2.66	0.25	3.57	5.92	4.51	2.65	5.31	9.04	3.28
	σ_{12}	1.18	1.62	1.58	1.84	3.86	2.81	2.38	3.00	28.13	0.78
	σ_{21}	5.64	7.13	9.39	41.31	909.40	19.33	28.45	11.61	9.62	34.18
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	0.17	2.34	21.91*	23.86*	893.70*	8.21*	11.01*	6.78*	18.14*	28.45*
(MC-95%)		(1.66)	2.79)	(14.59)	(8.75)	(7.32)	(3.39)	(7.17)	(3.98)	(15.18)	(2.49)
	$\|\sigma_{12} - \sigma_{22}\|$	0.03	1.03	1.33	1.73	2.05	1.70	0.26	2.31	19.09	2.50
		(1.60)	(2.68)	(13.43)	(8.58)	(7.17)	(3.68)	(6.77)	(4.76)	(23.04)	(2.70)
	$\|\sigma_{11} - \sigma_{12}\|$	4.63*	3.16*	29.72*	15.61*	11.81*	8.31*	15.06*	1.83	0.38	4.95*
		(1.34)	(1.54)	(7.19)	(5.52)	(4.65)	(2.83)	(3.59)	(3.32)	(16.81)	(1.36)
	$\|\sigma_{21} - \sigma_{22}\|$	4.49*	4.47*	9.14*	37.74*	903.50*	14.82*	25.80*	6.30*	0.58	30.90*
		(1.27)	(1.67)	(7.63)	(5.51)	(4.94)	(2.85)	(3.82)	(2.76)	(10.74)	(1.40)
	$\|\sigma_{12} - \sigma_{21}\|$	4.46*	5.50*	7.81	39.47*	905.60*	16.52*	26.06*	8.61*	18.51	33.39*
		(2.00)	(3.10)	(15.89)	(9.64)	(8.62)	(4.65)	(7.95)	(5.75)	(27.91)	(3.01)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 35: Summary of Implied Output Growth Volatility: 4-variable VAR (World Oil Price, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	6.53	6.25	32.57	22.38	16.41	13.04	17.77	3.70	41.02	7.05
	σ_2	1.20	3.68	0.43	3.91	5.98	5.09	3.19	6.75	9.49	3.26
Estimates	σ_{11}	5.90	4.79	32.13	17.59	15.64	11.59	17.46	3.93	321.30	5.52
	σ_{22}	1.14	2.75	0.23	3.60	5.79	4.67	2.56	4.60	9.07	3.21
	σ_{12}	1.18	1.68	3.85	1.89	3.02	2.72	2.59	2.76	1020.00	1.79
	σ_{21}	6.74	9.70	7.94	37.71	786.00	19.44	20.53	8.35	9.11	26.67
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	0.84	4.91*	24.19*	20.12*	770.40*	7.85*	3.06	4.42*	312.20*	21.15*
(MC-95%)		(1.89)	(2.81)	(15.84)	(8.34)	(7.33)	(3.79)	(7.66)	(3.33)	(16.97)	(2.18)
	$\|\sigma_{12} - \sigma_{22}\|$	0.04	1.06	3.61	1.71	2.77	1.95	0.03	1.84	1011.00	1.42
		(1.91)	(2.79)	(13.78)	(8.34)	(6.99)	(4.22)	(7.35)	(3.77)	(28.55)	(2.33)
	$\|\sigma_{11} - \sigma_{12}\|$	4.72*	3.11*	28.28*	15.70*	12.63*	8.87*	14.87*	1.16	699.20*	3.73*
		(1.29)	(1.57)	(7.95)	(5.01)	(4.13)	(2.92)	(3.61)	(2.07)	(20.55)	(1.30)
	$\|\sigma_{21} - \sigma_{22}\|$	5.60*	6.96*	7.70	34.11*	780.20*	14.78*	17.96*	3.75*	0.04	23.46*
		(1.24)	(1.42)	(8.42)	(4.89)	(3.95)	(2.74)	(3.72)	(2.12)	(11.86)	(1.27)
	$\|\sigma_{12} - \sigma_{21}\|$	5.56*	8.02*	4.09	35.82*	783.00*	16.73*	17.93*	5.59*	1011.00*	24.88*
		(2.23)	(3.24)	(17.19)	(9.09)	(8.06)	(4.94)	(8.29)	(4.17)	(32.67)	(2.59)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 36: Summary of Implied Output Growth Volatility: 4-variable VAR (World GDP Growth, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	6.53	6.25	32.57	22.38	16.41	13.04	17.77	3.70	41.02	7.05
	σ_2	1.20	3.68	0.43	3.91	5.98	5.09	3.19	6.75	9.49	3.26
Estimates	σ_{11}	5.97	5.03	29.46	17.30	15.60	11.56	18.20	3.46	49.85	5.64
	σ_{22}	1.15	2.69	0.24	3.52	5.47	4.46	2.70	4.92	9.03	3.23
	σ_{12}	1.18	1.86	2.05	2.56	2.60	2.85	5.36	2.25	75.65	0.87
	σ_{21}	5.24	6.41	7.56	31.91	818.70	19.33	28.05	9.50	6.06	28.11
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	0.73	1.38	21.90*	14.61*	803.10*	7.77*	9.85*	6.04*	43.79*	22.47*
(MC-95%)		(1.66)	(2.49)	(15.33)	(7.71)	(6.63)	(3.82)	(7.16)	(2.61)	(16.56)	(2.24)
	$\|\sigma_{12} - \sigma_{22}\|$	0.03	0.83	1.81	0.96	2.87	1.61	2.66	2.67	66.63*	2.36
		(1.64)	(2.48)	(13.42)	(7.33)	(6.33)	(3.90)	(6.66)	(3.05)	(26.40)	(2.37)
	$\|\sigma_{11} - \sigma_{12}\|$	4.79*	3.17*	27.41*	14.74*	13.01*	8.71*	12.84*	1.21	25.81*	4.77*
		(1.05)	(1.18)	(7.95)	(4.61)	(3.88)	(2.88)	(3.38)	(1.74)	(19.74)	(1.51)
	$\|\sigma_{21} - \sigma_{22}\|$	4.09*	3.71*	7.32	28.38*	813.20*	14.87*	25.35*	4.58*	2.97*	24.88*
		(1.04)	(1.15)	(8.15)	(4.56)	(3.73)	(2.69)	(3.57)	(1.65)	(11.50)	(1.37)
	$\|\sigma_{12} - \sigma_{21}\|$	4.06*	4.55*	5.51	29.34*	816.10*	16.48*	22.68*	7.25*	69.60*	27.24*
		(1.92)	(2.66)	(16.14)	(8.69)	(7.27)	(4.73)	(7.89)	(3.37)	(32.54)	(2.82)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 37: Summary of Implied Output Growth Volatility: 5-variable VAR (World GDP Growth, World Inflation, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	TH	UK
Actual	σ_1	6.53	6.25	32.57	22.38	16.41	13.04	17.77	3.70	41.02	7.05
	σ_2	1.20	3.68	0.43	3.91	5.98	5.09	3.19	6.75	9.49	3.26
Estimates	σ_{11}	5.60	3.92	28.61	19.54	15.13	11.70	17.98	3.45	35.00	5.34
	σ_{22}	1.16	2.22	0.35	3.65	5.49	4.50	2.65	5.33	9.20	3.23
	σ_{12}	1.33	1.59	32.70	4.99	3.48	3.53	6.16	2.18	141.50	1.41
	σ_{21}	5.36	4.96	22.52	29.88	544.10	18.05	22.42	8.32	10.69	18.25
Statistics	$\lvert\sigma_{11}-\sigma_{21}\rvert$	0.23	1.04	6.09	10.33*	528.90*	6.35*	4.44	4.87*	24.31*	12.92*
(MC-95%)		(1.52)	(2.23)	(15.78)	(9.57)	(5.89)	(3.19)	(6.81)	(2.63)	(14.80)	(2.17)
	$\lvert\sigma_{12}-\sigma_{22}\rvert$	0.17	0.63	32.35*	1.34	2.00	0.97	3.50	3.14*	132.30*	1.82
		(1.46)	(2.30)	(14.77)	(9.31)	(5.53)	(3.62)	(6.57)	(3.04)	(21.26)	(2.47)
	$\lvert\sigma_{11}-\sigma_{12}\rvert$	4.26*	2.33*	4.10	14.56*	11.64*	8.17*	11.83*	1.27	106.50*	3.93*
		(0.99)	(1.01)	(7.77)	(5.71)	(3.33)	(2.99)	(3.41)	(1.93)	(14.11)	(1.42)
	$\lvert\sigma_{21}-\sigma_{22}\rvert$	4.20*	2.74*	22.17*	26.22*	538.60*	13.55*	19.76*	2.99*	1.50	15.03*
		(1.00)	(1.11)	(8.35)	(5.64)	(3.46)	(2.94)	(3.62)	(1.80)	(10.20)	(1.32)
	$\lvert\sigma_{12}-\sigma_{21}\rvert$	4.03*	3.37*	10.18*	24.89*	540.60*	14.53*	16.26*	6.13*	130.80*	16.85*
		(1.80)	(2.37)	(17.04)	(10.57)	(6.37)	(4.38)	(7.41)	(3.61)	(25.27)	(2.68)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

A.6 Implications

Table 38: Model Implications: 4-variable VAR
(World Inflation, Interest Rates, GDP Growth, Inflation)

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
AU	More stable	Calmer*	Less stable*	Calmer*
CA	More stable*	Mixed	Less stable*	Calmer*
ID	More stable*	Calmer*	More stable*	Calmer*
KR	More stable	Calmer*	Less stable*	Calmer*
MX	More stable*	Calmer*	Less stable*	Calmer*
NZ	More stable	Calmer*	Less stable*	Calmer*
PH	More stable*	Calmer*	Less stable*	Calmer*
SE	More stable*	Calmer*	Less stable*	Calmer*
TH	More stable*	More volatile*	More stable*	Mixed*
UK	More stable	Calmer*	Less stable*	Calmer*

Note: * indicates significance at the 5 percent level

Table 39: Model Implications: 3-variable VAR
(Interest Rates, GDP Growth, Inflation)

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
AU	More stable*	Calmer*	More stable	Calmer*
CA	More stable*	Calmer	Less stable	Calmer*
ID	More stable*	Calmer*	More stable*	Calmer*
KR	More stable*	Calmer*	Less stable*	Calmer*
MX	More stable*	Calmer*	Less stable*	Calmer*
NZ	More stable	Calmer*	Less stable*	Calmer*
PH	More stable	Calmer*	Less stable*	Calmer*
SE	More stable	Calmer*	Less stable*	Calmer*
TH	More stable*	Mixed	More stable*	Mixed
UK	More stable*	Calmer*	Less stable*	Calmer*

Note: * indicates significance at the 5 percent level

Table 40: Model Implications: 4-variable VAR
(World Oil Price, Interest Rates, GDP Growth, Inflation)

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
AU	More stable	Calmer*	Mixed	Calmer*
CA	More stable*	Calmer	Less stable*	Calmer*
ID	More stable*	Calmer*	More stable*	Calmer*
KR	More stable*	Calmer*	Less stable*	Calmer*
MX	More stable*	Calmer*	Less stable*	Calmer*
NZ	More stable	Calmer*	Less stable*	Calmer*
PH	More stable*	Calmer*	Less stable*	Calmer*
SE	More stable*	Calmer	Less stable*	Calmer*
TH	More stable*	More volatile*	More stable*	More volatile*
UK	More stable*	Calmer*	Less stable*	Calmer*

Note: * indicates significance at the 5 percent level

Table 41: Model Implications: 4-variable VAR
(World GDP Growth, Interest Rates, GDP Growth, Inflation)

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
AU	More stable*	Calmer*	More stable	Calmer*
CA	More stable*	Calmer	Less stable	Calmer*
ID	More stable*	Calmer*	More stable*	Calmer*
KR	More stable	Calmer*	Less stable*	Calmer*
MX	More stable*	Calmer*	Less stable*	Calmer*
NZ	More stable	Calmer*	Less stable*	Calmer*
PH	More stable*	Calmer*	Less stable*	Calmer*
SE	More stable*	Calmer*	Less stable*	Calmer*
TH	More stable*	More volatile	More stable*	More volatile*
UK	More stable*	Calmer*	Less stable*	Calmer*

Note: * indicates significance at the 5 percent level

Table 42: Model Implications: 5-variable VAR
(World GDP Growth, World Inflation, Interest Rates, GDP Growth, Inflation)

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
AU	More stable*	Calmer*	More stable	Calmer*
CA	More stable*	Mixed	Less stable	Calmer*
ID	Mixed	Calmer*	More stable*	Calmer*
KR	More stable	Calmer*	Less stable*	Calmer*
MX	More stable*	Calmer*	Less stable*	Calmer*
NZ	More stable	Calmer*	Less stable*	Calmer*
PH	More stable*	Calmer*	Less stable*	Calmer*
SE	More stable*	Calmer*	Less stable*	Calmer*
TH	More stable	More volatile	More stable*	More volatile*
UK	More stable*	Calmer*	Less stable*	Calmer*

Note: * indicates significance at the 5 percent level

A.7 Decomposition

Table 43: Decomposition of the Sources of the Change in Volatility: Inflation
Model: 4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Estimated Variances				Differences in Variances			Decomposition	
	σ_{11}	σ_{22}	σ_{12}	σ_{21}	$\lvert\sigma_{22}-\sigma_{11}\rvert$	$\lvert\sigma_{22}-\sigma_{21}\rvert$	$\lvert\sigma_{21}-\sigma_{11}\rvert$	Propagation	Impulses
	(1)	(2)	(3)	(4)	(5=2-1)	(6=2-4)	(7=4-1)	(8=7/5)	(9=6/5)
AU	10.29	1.40	3.54	5.59	-8.89	-4.19	-4.70	0.53	0.47
CA	4.93	0.79	5.53	0.99	-4.14	-0.20	-3.94	0.95	0.05
ID	221.50	4.85	115.70	24.42	-216.65	-19.57	-197.08	0.91	0.09
KR	9.07	0.97	2.73	8.02	-8.10	-7.05	-1.05	0.13	0.87
MX	1391.00	1.02	20.65	273.90	-1389.98	-272.88	-1117.10	0.80	0.20
NZ	15.75	1.24	3.24	8.10	-14.51	-6.86	-7.65	0.53	0.47
PH	122.90	3.43	27.45	57.32	-119.47	-53.89	-65.58	0.55	0.45
SE	9.67	1.50	7.70	3.02	-8.17	-1.53	-6.64	0.81	0.19
TH	7.12	3.74	29.88	3.56	-3.38	0.18	-3.56	1.05	-0.05
UK	10.15	0.71	6.04	6.20	-9.44	-5.49	-3.95	0.42	0.58

Table 44: Decomposition of the Sources of the Change in Volatility: Output
Model: 4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Estimated Variances				Differences in Variances			Decomposition	
	σ_{11}	σ_{22}	σ_{12}	σ_{21}	$\lvert\sigma_{22}-\sigma_{11}\rvert$	$\lvert\sigma_{22}-\sigma_{21}\rvert$	$\lvert\sigma_{21}-\sigma_{11}\rvert$	Propagation	Impulses
	(1)	(2)	(3)	(4)	(5=2-1)	(6=2-4)	(7=4-1)	(8=7/5)	(9=6/5)
AU	5.74	1.16	1.22	5.79	-4.58	-4.63	0.05	-0.01	1.01
CA	4.61	2.65	1.34	7.32	-1.96	-4.66	2.70	-1.38	2.38
ID	30.82	0.25	15.96	8.81	-30.57	-8.56	-22.01	0.72	0.28
KR	19.09	3.64	5.00	35.33	-15.45	-31.69	16.24	-1.05	2.05
MX	15.14	5.80	4.63	485.50	-9.34	-479.70	470.36	-50.38	51.38
NZ	11.46	4.55	3.18	17.84	-6.91	-13.29	6.38	-0.92	1.92
PH	17.03	2.61	2.96	24.80	-14.42	-22.19	7.77	-0.54	1.54
SE	3.90	4.80	2.73	7.53	0.90	-2.73	3.62	4.04	-3.04
TH	33.74	9.30	63.88	14.64	-24.44	-5.34	-19.10	0.78	0.22
UK	5.24	3.27	1.70	23.77	-1.97	-20.51	18.53	-9.39	10.39

Table 45: Decomposition of the Sources of the Change in Volatility: Inflation

	Model 2		Model 3		Model 4		Model 5	
	Propagation	Impulses	Propagation	Impulses	Propagation	Impulses	Propagation	Impulses
AU	0.60	0.40	0.21	0.79	0.68	0.32	0.55	0.45
CA	0.94	0.06	0.82	0.18	0.95	0.05	0.96	0.04
ID	0.86	0.14	0.91	0.09	0.89	0.11	-0.22	1.22
KR	0.53	0.47	0.65	0.35	0.53	0.47	0.18	0.82
MX	0.74	0.26	0.80	0.20	0.75	0.25	0.80	0.20
NZ	0.60	0.40	0.64	0.36	0.61	0.39	0.54	0.46
PH	0.41	0.59	0.66	0.34	0.47	0.53	0.68	0.32
SE	0.22	0.78	0.87	0.13	0.83	0.17	0.77	0.23
TH	1.63	-0.63	1.09	-0.09	1.62	-0.62	1.16	-0.16
UK	0.51	0.49	0.62	0.38	0.53	0.47	0.47	0.53

Notes:
Model 2: 3-variable VAR (Interest Rates, GDP Growth, Inflation)
Model 3: 4-variable VAR (World Oil Inflation, Interest Rates, GDP Growth, Inflation)
Model 4: 4-variable VAR (World GDP Growth, Interest Rates, GDP Growth, Inflation)
Model 5: 5-variable VAR (World GDP Growth, World Inflation, Interest Rates, GDP Growth, Inflation)

Table 46: Decomposition of the Sources of the Change in Volatility: Output

	Model 2		Model 3		Model 4		Model 5	
	Propagation	Impulses	Propagation	Impulses	Propagation	Impulses	Propagation	Impulses
AU	0.04	0.96	-0.18	1.18	0.15	0.85	0.05	0.95
CA	-1.10	2.10	-2.40	3.40	-0.59	1.59	-0.61	1.61
ID	0.71	0.29	0.76	0.24	0.75	0.25	0.22	0.78
KR	-1.72	2.72	-1.44	2.44	-1.06	2.06	-0.65	1.65
MX	-91.62	92.62	-78.17	79.17	-79.30	80.30	-54.85	55.85
NZ	-1.24	2.24	-1.13	2.13	-1.09	2.09	-0.88	1.88
PH	-0.74	1.74	-0.21	1.21	-0.64	1.64	-0.29	1.29
SE	14.10	-13.10	6.59	-5.59	4.15	-3.15	2.59	-1.59
TH	0.97	0.03	1.00	0.00	1.07	-0.07	0.94	0.06
UK	-11.62	12.62	-9.17	10.17	-9.33	10.33	-6.12	7.12

Notes:
Model 2: 3-variable VAR (Interest Rates, GDP Growth, Inflation)
Model 3: 4-variable VAR (World Oil Inflation, Interest Rates, GDP Growth, Inflation)
Model 4: 4-variable VAR (World GDP Growth, Interest Rates, GDP Growth, Inflation)
Model 5: 5-variable VAR (World GDP Growth, World Inflation, Interest Rates, GDP Growth, Inflation)

A.8 Alternative Decomposition

Table 47: Alternative Decomposition of the Sources of the Change in Volatility: Inflation
Model: 4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Estimated Variances				Differences in Variances			Decomposition	
	σ_{11}	σ_{22}	σ_{12}	σ_{21}	$\|\sigma_{22}-\sigma_{11}\|$	$\|\sigma_{22}-\sigma_{12}\|$	$\|\sigma_{12}-\sigma_{11}\|$	Propagation	Impulses
	(1)	(2)	(3)	(4)	(5=2-1)	(6=2-4)	(7=4-1)	(8=6/5)	(9=7/5)
AU	10.29	1.40	3.54	5.59	-8.89	-2.14	-6.75	0.24	0.76
CA	4.93	0.79	5.53	0.99	-4.14	-4.74	0.61	1.15	-0.15
ID	221.50	4.85	115.70	24.42	-216.65	-110.85	-105.80	0.51	0.49
KR	9.07	0.97	2.73	8.02	-8.10	-1.76	-6.34	0.22	0.78
MX	1391.00	1.02	20.65	273.90	-1389.98	-19.63	-1370.35	0.01	0.99
NZ	15.75	1.24	3.24	8.10	-14.51	-2.00	-12.51	0.14	0.86
PH	122.90	3.43	27.45	57.32	-119.47	-24.02	-95.45	0.20	0.80
SE	9.67	1.50	7.70	3.02	-8.17	-6.21	-1.96	0.76	0.24
TH	7.12	3.74	29.88	3.56	-3.38	-26.14	22.76	7.74	-6.74
UK	10.15	0.71	6.04	6.20	-9.44	-5.33	-4.11	0.56	0.44

Table 48: Alternative Decomposition of the Sources of the Change in Volatility: Output
Model: 4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Estimated Variances				Differences in Variances			Decomposition	
	σ_{11}	σ_{22}	σ_{12}	σ_{21}	$\|\sigma_{22}-\sigma_{11}\|$	$\|\sigma_{22}-\sigma_{12}\|$	$\|\sigma_{12}-\sigma_{11}\|$	Propagation	Impulses
	(1)	(2)	(3)	(4)	(5=2-1)	(6=2-4)	(7=4-1)	(8=6/5)	(9=7/5)
AU	5.74	1.16	1.22	5.79	-4.58	-0.06	-4.52	0.01	0.99
CA	4.61	2.65	1.34	7.32	-1.96	1.31	-3.27	-0.67	1.67
ID	30.82	0.25	15.96	8.81	-30.57	-15.71	-14.86	0.51	0.49
KR	19.09	3.64	5.00	35.33	-15.45	-1.36	-14.09	0.09	0.91
MX	15.14	5.80	4.63	485.50	-9.34	1.18	-10.51	-0.13	1.13
NZ	11.46	4.55	3.18	17.84	-6.91	1.37	-8.28	-0.20	1.20
PH	17.03	2.61	2.96	24.80	-14.42	-0.36	-14.07	0.02	0.98
SE	3.90	4.80	2.73	7.53	0.90	2.07	-1.17	2.31	-1.31
TH	33.74	9.30	63.88	14.64	-24.44	-54.58	30.14	2.23	-1.23
UK	5.24	3.27	1.70	23.77	-1.97	1.56	-3.54	-0.79	1.79

A.9 Pseudo-placebo Test Results: Pre-IT Period

Table 49: Summary of Implied Inflation Volatility: 4-variable VAR (World Inflation, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	UK
Actual	σ_1	21.50	9.71	2.02	79.85	1752.50	6.48	229.02	3.21	27.23
	σ_2	9.39	8.14	414.76	6.37	109.67	25.77	17.22	8.76	2.60
Estimates	σ_{11}	11.00	5.70	1.90	14.99	1339.00	4.62	264.50	5.55	22.96
	σ_{22}	10.41	3.16	387.70	3.72	97.53	25.12	4.90	21.04	2.36
	σ_{12}	6.37	4.12	63.79	4.56	808.90	16.28	93.58	10.43	11.54
	σ_{21}	15.76	2.24	93.24	12.09	488.00	6.65	67.72	42.35	8.55
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	4.77	3.46*	91.34	2.90	850.60	2.03	196.80*	36.80*	14.41
(MC-95%)		(8.41)	(2.90)	(271.40)	(7.09)	(1194.00)	(23.19)	(167.40)	(8.74)	(17.02)
	$\|\sigma_{12} - \sigma_{22}\|$	4.04	0.96	323.90*	0.84	711.30	8.84	88.68	10.61*	9.17
		(8.44)	(2.97)	(292.10)	(7.79)	(1241.00)	(24.20)	(163.00)	(9.43)	(17.70)
	$\|\sigma_{11} - \sigma_{12}\|$	4.63*	1.58	61.89	10.43*	529.70	11.66*	170.90*	4.89	11.43*
		(3.92)	(1.66)	(169.20)	(3.92)	(596.20)	(11.39)	(69.72)	(5.02)	(8.54)
	$\|\sigma_{21} - \sigma_{22}\|$	5.35*	0.92	294.40*	8.37*	390.50	18.47*	62.82	21.30*	6.19
		(4.25)	(1.54)	(142.90)	(4.14)	(647.20)	(11.03)	(80.48)	(4.62)	(8.03)
	$\|\sigma_{12} - \sigma_{21}\|$	9.39*	1.89	29.45	7.53	320.90	9.63	25.86	31.91*	2.98
		(8.85)	(3.08)	(315.40)	(8.21)	(1330.00)	(24.16)	(167.00)	(9.76)	(18.38)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 50: Summary of Implied Output Volatility: 4-variable VAR (World Inflation, Interest Rate, GDP Growth, Inflation)

		AU	CA	ID	KR	MX	NZ	PH	SE	UK
Actual	σ_1	5.83	4.47	2.82	22.39	18.02	9.44	31.84	2.42	7.54
	σ_2	7.02	6.25	42.28	21.79	14.42	12.99	5.99	4.20	6.24
Estimates	σ_{11}	4.60	2.94	2.72	11.42	11.62	3.40	31.99	1.91	6.33
	σ_{22}	7.32	4.85	40.37	21.86	13.34	13.12	4.29	4.92	5.65
	σ_{12}	2.91	3.88	14.56	6.60	10.48	21.62	9.32	0.86	2.76
	σ_{21}	14.35	3.74	10.79	27.53	53.91	1.99	14.30	7.88	20.59
Statistics	$\|\sigma_{11} - \sigma_{21}\|$	9.75*	0.80	8.07	16.11	42.30*	1.41	17.69*	5.98*	14.26*
(MC-95%)		(4.32)	(2.72)	(49.94)	(17.19)	(13.21)	(8.14)	(14.58)	(5.14)	(5.83)
	$\|\sigma_{12} - \sigma_{22}\|$	4.42*	0.96	25.81	15.26	2.85	8.50	5.02	4.06	2.89
		(4.29)	(2.69)	(55.08)	(17.38)	(14.51)	(8.59)	(14.69)	(6.01)	(6.21)
	$\|\sigma_{11} - \sigma_{12}\|$	1.69	0.95	11.84	4.82	1.13	18.22*	22.68*	1.04	3.56
		(2.66)	(1.65)	(29.83)	(10.75)	(7.86)	(7.20)	(6.60)	(3.07)	(3.58)
	$\|\sigma_{21} - \sigma_{22}\|$	7.02*	1.11	29.58*	5.67	40.57*	11.13*	10.01*	2.96	14.94*
		(2.60)	(1.60)	(26.09)	(9.75)	(7.91)	(6.40)	(6.75)	(3.01)	(3.33)
	$\|\sigma_{12} - \sigma_{21}\|$	11.44*	0.15	3.77	20.93*	43.43*	19.63*	4.99	7.02*	17.83*
		(5.11)	(3.10)	(57.47)	(19.42)	(15.12)	(11.28)	(15.47)	(6.55)	(6.83)

Note: * indicates statistical significance at the 5 percent level using the critical values generated from the Monte Carlo method

Table 51: Model Implications: 4-variable VAR
(World Inflation, Interest Rates, GDP Growth, Inflation)

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
AU	Not sig	Calmer*	Less stable*	Calmer*
CA	More stable*	Not sig	Not sig	Not sig
ID	Less stable*	More volatile*	Not sig	More volatile*
KR	Not sig	Calmer*	Not sig	Calmer*
MX	More stable*	Calmer*	Less stable*	Calmer*
NZ	Not sig	More volatile*	Not sig	More volatile*
PH	More stable*	Calmer*	More stable*	Calmer*
SE	Less stable*	Calmer*	Less stable*	Not sig
UK	Not sig	Calmer	Less stable*	Calmer*

Note: * indicates significance at the 5 percent level

A.10 Pseudo-Placebo Test Results: Japan and US

Table 52: Implied inflation volatility: Japan
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

			Actual		
	Period 1			Period 2	
Variance (σ^2)	1.38			0.73	
Mean	1.55			-0.08	
CV	0.76			-10.27	
			(A) Univariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	1.35	0.74		0.92	1.08
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	0.27	0.18	0.42	0.34	0.16
BT-95%	1.21	1.27	0.82	0.84	1.38
BT-99%	1.79	1.95	1.24	1.12	2.09
MC-95%	1.29	1.32	0.69	0.77	1.52
MC-99%	1.80	1.90	1.17	1.14	2.19
			(B) Multivariate Model		
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	1.51	0.73		2.16	6.98
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	5.47*	1.43*	0.66*	6.25*	4.81*
BT-95%	0.90	1.10	0.78	0.67	1.24
BT-99%	1.42	1.72	1.31	0.96	2.02
MC-95%	0.68	0.84	0.48	0.40	0.95
MC-99%	1.16	1.32	0.72	0.57	1.53

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1985Q3 - 1994Q4
Period 2: 1995Q1 - 2012Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 53: Implied inflation volatility: US
3-variable VAR (Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	10.66			1.32	
Mean	5.97			2.22	
CV	0.55			0.52	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	9.54	1.32		10.15	1.24
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	8.30*	8.83*	0.61	0.08	8.91*
BT-95%	7.24	7.36	5.94	5.69	8.93
BT-99%	11.24	10.63	9.17	9.23	12.76
MC-95%	7.11	7.06	3.31	3.34	8.11
MC-99%	10.32	9.81	5.47	5.12	11.52
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	7.45	1.32		7.80	1.43
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	6.03*	6.48*	0.35	0.10	6.37*
BT-95%	7.60	7.24	6.18	6.16	9.01
BT-99%	12.52	11.62	9.48	9.76	14.64
MC-95%	5.54	5.61	2.67	2.57	6.20
MC-99%	7.86	7.99	3.71	4.03	9.37

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1973Q1 - 1994Q4
Period 2: 1995Q1 - 2011Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 54: Implied output volatility: Japan
4-variable VAR (World Inflation, Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	7.55			5.47	
Mean	3.55			0.92	
CV	0.77			2.55	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	6.48	5.37		4.64	7.50
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	1.02	0.73	1.84	2.13	2.86
BT-95%	5.84	5.75	5.27	5.75	7.84
BT-99%	9.83	9.09	8.05	8.41	12.46
MC-95%	5.87	6.06	3.92	3.91	7.28
MC-99%	8.78	9.72	6.03	5.70	12.00
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	5.63	5.18		4.03	20.06
	$\lvert\sigma_{11} - \sigma_{21}\rvert$	$\lvert\sigma_{12} - \sigma_{22}\rvert$	$\lvert\sigma_{11} - \sigma_{12}\rvert$	$\lvert\sigma_{21} - \sigma_{22}\rvert$	$\lvert\sigma_{12} - \sigma_{21}\rvert$
	14.43*	1.15	1.59	14.87*	16.02*
BT-95%	4.49	5.87	4.38	3.65	6.89
BT-99%	7.98	9.48	7.08	4.76	10.79
MC-95%	4.44	5.47	3.24	2.74	6.39
MC-99%	7.14	7.98	4.81	3.96	9.29

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1985Q3 - 1994Q4
Period 2: 1995Q1 - 2012Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 55: Implied output volatility: US
3-variable VAR (Interest Rates, GDP Growth, Inflation)

	Actual				
	Period 1			Period 2	
Variance (σ^2)	6.50			3.02	
Mean	3.05			2.46	
CV	0.84			0.71	
	(A) Univariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	6.15	3.92		2.55	9.46
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	3.31	1.37	3.60*	5.54*	6.91*
BT-95%	3.87	3.87	3.15	3.09	5.20
BT-99%	5.95	5.76	4.46	4.61	7.10
MC-95%	3.86	3.76	2.39	2.27	4.34
MC-99%	5.19	5.19	3.20	3.54	6.01
	(B) Multivariate Model				
	Factual			Counterfactual	
	$\sigma_{11} = \sigma(A_1, \Sigma_1)$	$\sigma_{22} = \sigma(A_2, \Sigma_2)$		$\sigma_{12} = \sigma(A_1, \Sigma_2)$	$\sigma_{21} = \sigma(A_2, \Sigma_1)$
	5.52	3.99		2.51	8.12
	$\|\sigma_{11} - \sigma_{21}\|$	$\|\sigma_{12} - \sigma_{22}\|$	$\|\sigma_{11} - \sigma_{12}\|$	$\|\sigma_{21} - \sigma_{22}\|$	$\|\sigma_{12} - \sigma_{21}\|$
	2.60	1.48	3.01*	4.13*	5.61*
BT-95%	3.60	3.40	2.45	2.55	4.25
BT-99%	5.23	4.81	3.47	3.73	6.05
MC-95%	3.83	3.65	2.19	2.16	4.11
MC-99%	5.42	5.04	2.99	3.43	6.10

Notes:
*Denotes significance at the 5 percent significant level using Monte Carlo critical values
Period 1: 1973Q1 - 1994Q4
Period 2: 1995Q1 - 2011Q4
BT and MC provide the Bootstrap and Monte Carlo critical values, respectively, from 1,000 replications.

Table 56: Variance Decomposition

	Estimated Variances				Differences in Variances			Decomposition	
	Inflation								
	σ_{11}	σ_{22}	σ_{12}	σ_{21}	$\lvert\sigma_{22}-\sigma_{11}\rvert$	$\lvert\sigma_{22}-\sigma_{21}\rvert$	$\lvert\sigma_{21}-\sigma_{11}\rvert$	Propagation	Impulses
	(1)	(2)	(3)	(4)	(5=2-1)	(6=2-4)	(7=4-1)	(8=7/5)	(9=6/5)
JP	1.51	1.03	2.03	3.51	-0.48	-2.49	2.00	-4.15	5.15
US	7.45	1.23	6.84	2.25	-6.22	-1.02	-5.20	0.84	0.16
	Output								
	σ_{11}	σ_{22}	σ_{12}	σ_{21}	$\lvert\sigma_{22}-\sigma_{11}\rvert$	$\lvert\sigma_{22}-\sigma_{12}\rvert$	$\lvert\sigma_{12}-\sigma_{11}\rvert$	Propagation	Impulses
	(1)	(2)	(3)	(4)	(5=2-1)	(6=2-4)	(7=4-1)	(8=6/5)	(9=7/5)
JP	5.63	4.41	4.23	14.87	-1.21	0.19	-1.40	-0.15	1.15
US	5.52	2.98	2.45	7.59	-2.54	0.53	-3.07	-0.21	1.21

Notes:
Estimates are based on the following models:
1. Japan: 4-variable VAR (World Inflation, Yields, GDP Growth Inflation)
2. US: 3-variable VAR (Yields, GDP Growth Inflation)

Table 57: Model Implications

	Inflation		Output Growth	
	Structure	Shocks	Structure	Shocks
JP	Mixed*	Mixed*	Less stable*	Calmer*
US	More stable*	Mixed	Less stable	Calmer*

Note: * indicates significance at the 5 percent level
Estimates are based on the following models:
1. Japan: 4-variable VAR (World Inflation, Yields, GDP Growth Inflation)
2. US: 3-variable VAR (Yields, GDP Growth Inflation)

A.11 Figures

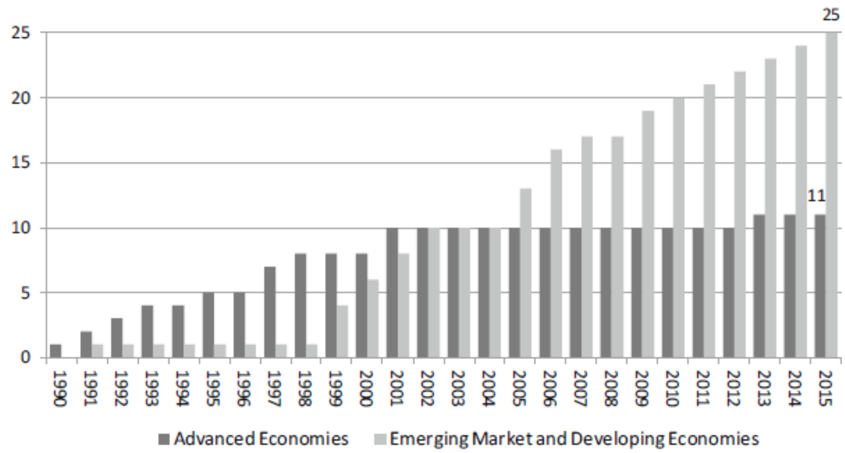

Figure 1: Number of IT countries
Source: Schmidt-Hebbel and Carrasco (2016)

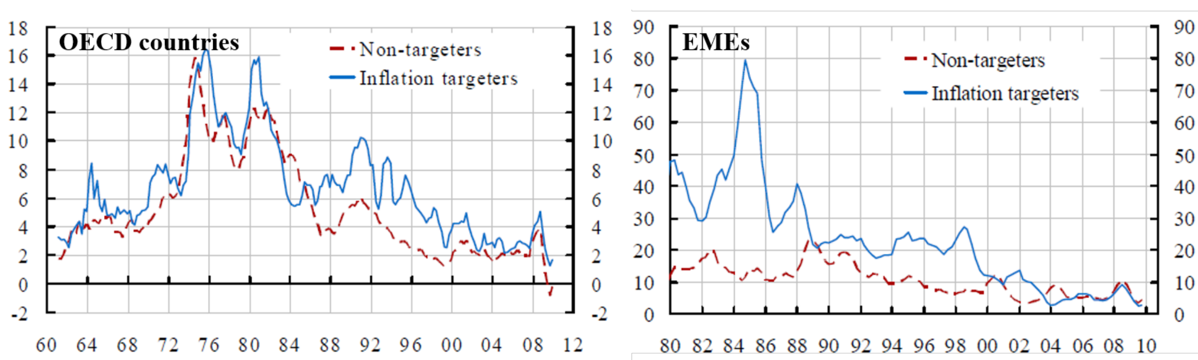

Figure 2: Average Inflation in IT and NIT countries
Source: Svensson (2010)

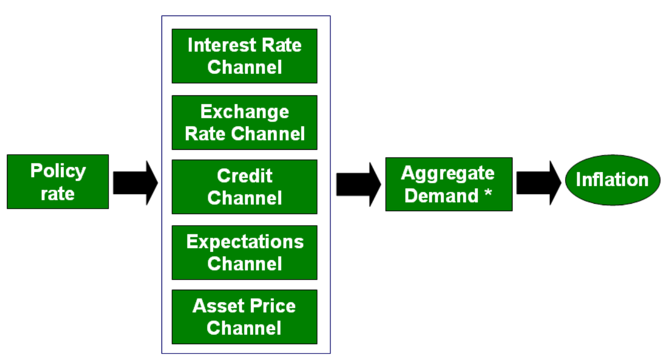

Figure 3: Monetary Policy Transmission Channels

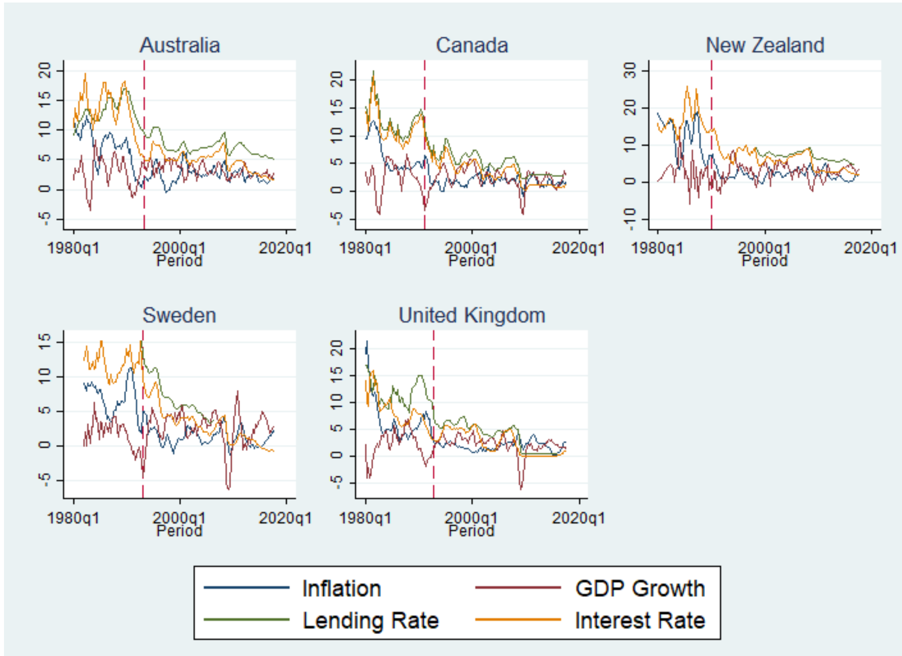

Figure 4: Macroeconomic Trends, Advanced Economies

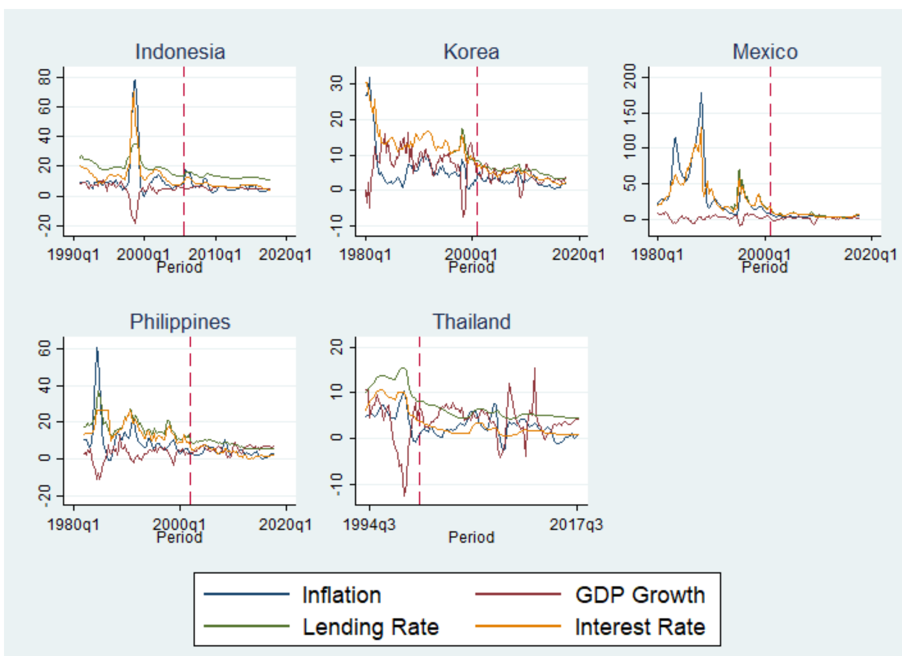

Figure 5: Macroeconomic Trends, Emerging Market Economies

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