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Abstract

We re-assess the links between inflation targeting and economic performance in a sample of developing countries. We estimate the effects of inflation targeting (IT) using quantile regressions, thus enabling us to consider the whole distribution rather than focusing on the effects at the mean. Our findings indicate that following the implementation of IT, it is the least successful countries – those that have reduced inflation the least – that benefit the most. For the remainder there are no benefits to be had from IT. We also find no evidence that IT affects economic volatility. We provide a small model to account for this evidence.

JEL classification: E52; E58.

Keywords: Quantile regression; inflation targeting; emerging markets; monetary policy

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1 Introduction

Starting with New Zealand in 1988, the adoption of inflation targeting (IT) as a monetary policy regime is often regarded as the best framework for central banks. Indeed, the number of countries that have adopted IT is approaching thirty, while none has abandoned it in favour of an alternative regime. The primacy of price stability as the policy objective, along with a flexible interpretation that enables the policy maker to stabilise output, are meant to anchor inflation expectations and deliver superior equilibrium outcomes. That, at least, is the theoretical underpinning in favour of IT.

But does the empirical evidence support IT? Much of the work in this area has centred on OECD economies with only a small proportion finding that IT has beneficial effects.[1] It is fair to say that most of the empirical evidence on IT in industrialised economies finds that it has not yielded additional benefits. Representative among these, Ball and Sheridan (2004) find that IT did not have statistically significant effects on average output, inflation, or their volatilities once regression to the mean was taken into account. Similarly, Ball (2010) uses data up to 2007 and after considering a variety of monetary regimes – such as the adoption of the euro – reaches similar conclusions.

Empirical research on emerging market economies (EMEs) has been somewhat more supportive of IT. Gonçalves and Salles (2008), Batini and Laxton (2007), Lin and Ye (2009), Lee (2010) and Vega and Winkelried (2005) find that for these countries IT resulted in an improvement in economic performance, especially in terms of the behaviour of inflation. However, an exception to this is Brito and Bystedt (2010), who obtain evidence of weaker declines in inflation compared to previous work coupled with lower output growth for IT countries.

In this paper, we re-assess the evidence on IT in emerging markets through two key contributions. First, in contrast to previous work, we conduct our empirical analysis using a quantile regression approach. The key benefit of our approach is that it provides estimates of the impacts of IT on the entire distribution of the regressand, not merely at its conditional mean. Our econometric approach allows us to learn more about the impact of IT at the different levels of the variables of interest: the changes in the inflation rate, its volatility and that of output growth. Second, our sample period covers the period 1980-2014, thereby taking into account the consequences of the Great Recession. In addition, we also present a very simple and stylised model that provides some intuition for our results.

There are several reasons why focusing on IT in EMEs is a worthwhile endeavour. From a development economics perspective, developing countries as a group have inherited a history of price instability of a greater magnitude than that of industrialised countries, sometimes including hyperinflationary episodes. This history is closely linked to weak institutions and low degrees of central bank credibility (Frankel, 2010). It is therefore EMEs that stand to gain the most from a monetary policy framework that can deliver low and stable inflation without adverse effects on output. As an alternative to inflation targeting, monetary policy frameworks in EMEs include:

[1] See Neumann and Von Hagen (2002) and Fatas et al. (2007), for example.

targets for monetary aggregates; using the exchange rate as a nominal anchor – either via full dollarisation, hard or soft pegs – or what Ball (2010) describes as 'just do it' pure discretion. A further benefit of using developing countries to assess inflation targeting is empirical. As Walsh (2009) points out, relying on EMEs rather than industrialised countries is likely to facilitate the identification of any effects arising from IT, since the former comprise a more heterogeneous group with more diverse inflation experiences.

For EMEs much of the evidence to date is that IT has been beneficial, as it has led to falls in both the average level and the volatility of inflation. These have often been in the range of 2.2 to 4.8 percentage points for inflation and 2.0 to 3.6 points for its standard deviation. Moreover, these results have been obtained using a variety of econometric methods. For example, Gonçalves and Salles (2008), and Batini and Laxton (2007) use cross-section difference in differences, Lin and Ye (2009) and Vega and Winkelried (2005) employ propensity score matching, while Lee (2010) uses a synthetic control method.

Most of the papers cited above have solely focused on the effects of IT on the behaviour of inflation. An exception is Gonçalves and Salles (2008), who find that the volatility of GDP growth following the implementation of IT decreased by approximately 1.4 percentage points. Similarly, de Carvalho Filho (2011) finds that inflation targeters fared better in terms of GDP growth following the Great Recession. Hence, IT can be regarded as having provided greater overall macroeconomic stability. However, the findings in Brito and Bystedt (2010) have been more critical. Estimating a panel with 46 countries over the period 1980-2006 and using a system-GMM estimator, they find that IT leads to a decrease in the cumulative growth of output of 1.2%. Thus, while IT is successful in bringing inflation under control it comes with a cost. Nonetheless, it is unclear whether IT could have permanent real effects.[2]

In addition to the overall results on the effects of IT, it is of as much interest to understand some of the mechanisms and subtleties at play. For instance, Fatas et al. (2007) find that although IT may be superior to alternative policy frameworks, it is having a quantitative target for monetary policy that provides the greatest benefits. Similarly, Batini and Laxton (2007) argue that many inflation targeting EMEs were successful in controlling inflation despite not having met all the necessary pre-conditions for adopting the policy, such as institutional independence. They conducted a survey among central bankers, finding that no IT central banks satisfied all the preconditions generally thought of as essential for the success of the policy. Thus, they conclude that it is not that institutional improvements make IT successful, but that IT enables institutional and technical improvement. Similarly, the results in Alpanda and Honig (2014) indicate that, once one takes into account the role of central bank independence, IT in EMEs leads to a reduction in inflation with the policy being more effective the lower the degree of independence.

To summarise, most of the evidence indicates that in general IT has led to lower and more stable inflation in EMEs, but these findings have focused on the mean effects. By contrast,

[2]This would run counter to most macroeconomics theories and also the evidence in McCandless and Weber (1995).

studies considering inflation targeting in industrialised economies have not found any statistically significant effects.

Our results provide new insights into the links between IT and economic performance in emerging markets. We find that there is no evidence that IT has real effects or that it reduces inflation volatility, but it is associated with decreases in inflation relative to the control group. However, this beneficial effect accrues only to the "least successful" economies, i.e., countries that – compared to other countries in our sample – did not quite manage to reduce inflation by as much. Our results thus shed new light into the heterogeneous impact that IT has had on the countries that have adopted it. Taking a global view that considers both advanced and emerging economies – from most to least successful – one can interpret the findings in this paper as indicative that IT will only provide benefits for the latter group. The reasoning for this conclusion is that for countries with good reputations, institutions and monetary policy frameworks, there are no clear benefits to be had. For economies lacking in these attributes, IT is the "low hanging fruit" that will enable them to improve upon their stabilisation outcomes. In some ways this is a remarkable result as the large increases in commodity prices during 2007-08 as well as the Great Recession – both included in the sample period that we consider – led to some economists calling for a rejection of IT in emerging market economies (Frankel, 2010).

This paper is organised as follows. In the next section, we discuss our empirical approach. Section 3 introduces quantile regression and our benchmark model. We report our results and discuss the empirical findings in Section 4. Section 5 investigates whether our benchmark results are sensitive to the timing of the adoption of IT and alternative model specifications. A simple theoretical model explaining our empirical findings is derived in Section 6. Finally, Section 7 concludes the paper.

2 Data

Our data set covers forty countries and spans the period 1980 – 2014.[3] We use annual data on inflation as well as the standard deviations of inflation and output growth. The data were downloaded from the IMF's International Financial Statistics website. For our benchmark results, the dates for the adoption of IT are taken from Gonçalves and Salles (2008), and Hammond (2012) for the post-2005 period. Our sample includes 19 inflation targeters and 21 non-targeters and as a further robustness check we also consider below the consequences of using the dates in Hammond (2012) for the adoption of IT. The list of countries is shown in Table 1.

Figure 1 plots the average inflation rates for each group of countries considered in this paper, over the period 1998 – 2014. It plots the inflation rates for the non-IT countries as well as those that adopted IT, which are split into two groups: those that had not yet adopted the policy as well as the countries that had implemented IT. Several key features emerge: there was a general trend towards lower inflation, as shown in the top panel of Figure 1. Inflation fell and became

[3]Due to lack of data availability the starting date for some countries is later than this: Brazil (1981), Bulgaria (1986), China (1987), Czech Republic (1994), Romania (1991), Serbia (1994) and Tunisia (1984).

less volatile for most of the countries in the sample, including those that did not adopt IT.[4] This reflects the effect that the Great Moderation had in the developing countries in our sample, which carried over to the Great Recession. One interpretation is that this represents a greater willingness across central banks to deliver lower inflation. Secondly, the bottom panel of the figure shows that relative to those that did not adopt IT, countries that would later adopt IT experienced higher inflation, while it was lower for those countries that had already implemented IT.[5] This is particularly relevant to our study, as one of the key arguments put forward by Brito and Bystedt (2010) in critiquing IT is that inflation targeters had already achieved lower inflation rates than the non-targeters prior to implementing the policy, biasing empirical studies in favour of the former. This is not the case in our study. With respect to output, there is no clear pattern regarding the relationship between IT and GDP growth as will become evident when the regression results are reported below.

We examine economic performance by splitting our sample into three time periods: from 1980 to 2001 (the mean year for the adoption of IT); 2002-2007 and 2008-2014 so that we treat the Great Recession as a separate period. Doing so will enable us to assess the critique of IT in Frankel (2010) that the Great Recession revealed the limitations of using the CPI for IT.

3 Quantile Regression

When a model is estimated using the conventional method of ordinary least squares (OLS), the relation between the dependent variable and the covariates is computed at the conditional mean value of the dependent variable. Koenker and Hallock (2001) refer to this type of model as a pure location shift model where only the location – not the scale – of the response variable is affected by variation in the covariates. Even though the effect of the covariate, estimated at the mean of the dependent variable, is informative, it could be misleading. The relation between variables could differ significantly when the dependent variable takes values other than the mean.

Literatures on the effectiveness of IT typically focus on the impact of IT at the mean value of the variable of interest. For instance, Ball and Sheridan (2004) employ the OLS method to estimate the "differences in differences" model to investigate the effects of IT on economic performance in advanced economies. The resulting estimates quantify additional improvement in the performance (i.e., reduction in inflation, inflation and output volatility) for inflation targeters as compared to non-targeters. Their approach focuses exclusively at the "average" level of performance improvement, not recognising that the effectiveness of IT may not be the same for these countries. The estimated impact of IT at the mean does not discriminate between countries which have been successful in reducing inflation and countries which have been less successful in achieving price stability.

Acknowledging this shortcoming, we employ the quantile regression method to examine

[4] For example, Venezuela is the only country where inflation was higher in 2014 than in the first observation.

[5] The earlier years are left out of the figure as the very high inflation in some years would have obscured the relative economic performance that accrued afterwards.

whether the impact of IT on the improvement in economic performance is the same for emerging economies. We do this by assuming that the location on the distribution of the dependent variable measuring performance improvement is a proxy for how "successful" the country has been in achieving its goals: reducing the inflation rate as well as the volatilities of output and inflation. The models are estimated using quantile regression, allowing for the impact of IT to be measured at the different quantiles of the dependent variable on its distribution. Specifically, our benchmark model has the following functional form:

$$q_\tau\left(\Delta X_i|\Omega\right) = \alpha_\tau + \beta_{1\tau} T_{2i} + \beta_{2\tau} IT_i + \beta_{3\tau}\left(High_i \cdot IT_i\right) + \beta_{4\tau}\left(T_{1i} \cdot X_{0i}\right) + \beta_{5\tau}\left(T_{2i} \cdot X_{0i}\right) \quad (1)$$

where $q_\tau\left(\Delta X_i|\Omega\right)$, $\tau \in (0,1)$, is the τth conditional quantile function of ΔX_i given Ω where Ω is the set of explanatory variables. *IT* is a dummy variable taking the value of one if IT has been adopted and *High* is another dummy variable if the period under investigation contains high inflation episodes.[6] The variable X_{0i}, denoting the starting value in the comparison period, is included in the model to allow for reversion to the long-run value. T_{1i} and T_{2i} represent dummy variables for first and the second comparison periods and therefore the interactions $T_{1i} \cdot X_{0i}$ and $T_{2i} \cdot X_{0i}$ control for the starting value of the variable for the first and the second comparison periods, respectively.

The dependent variable ΔX_i in equation (1) represents a change in the variable of interest between two consecutive periods: changes in the rate of inflation as well as the standard deviations of inflation and GDP growth. Hence, our quantile regressions assess performance by comparing the impact of IT on the changes between the first and the second periods, as well as between the second and the third periods, across all the quantiles of the distribution of ΔX_i whose location on the distribution acts as a proxy of how "successful" the country was in improving its economic performance. Take inflation as an example: a large negative value of ΔX_i, located on the extreme left tail of the distribution, indicates a large reduction in the rate of inflation, signifying a highly successful policy maker, whereas a small negative (or even a positive) value of ΔX_i suggests a small reduction (or an increase) in the rate of inflation, implying a less successful policy maker.

Our key parameters of interest are $\beta_{2\tau}$ and $\beta_{3\tau}$, which indicate whether performance under IT has differed relative to that of the control group at the τth quantile. The estimates of $\beta_{2\tau}$ and $\beta_{3\tau}$ are the solutions to the following minimisation problem:

$$\min_{\beta_{2\tau},\beta_{3\tau}} \sum_{i=1}^{N} \rho_\tau \left[\Delta X_i - \alpha_\tau - \beta_{1\tau} T_{2i} - \beta_{2\tau} IT_i - \beta_{3\tau}\left(High_i \cdot IT_i\right) - \beta_{4\tau}\left(T_{1i} \cdot X_{0i}\right) - \beta_{5\tau}\left(T_{2i} \cdot X_{0i}\right)\right] \quad (2)$$

where $\rho_\tau(z) = z\left(\tau - \mathbf{1}_{[z\leq 0]}\right)$. The check function $\mathbf{1}_{[z\leq 0]} = 1$ if $z \leq 0$ and 0 otherwise. The function $\rho_\tau(z)$ introduces different weights on the residuals in the minimisation problem in

[6] Gonçalves and Salles (2008) excluded from their sample observations when inflation was above 50%. We prefer to keep those observations within our sample although the robustness analysis below will tackle this issue further.

equation (2). When $\tau = 0.95$, for example, positive residuals receive a weight of 95% while negative residuals are given a weight of 5%. When the value of τ equals 0.5, we obtain the median estimator as the solution.[7]

4 Results & Discussion

The quantile regression results for the benchmark model for $\tau = 0.05, 0.1, 0.2, \ldots, 0.9, 0.95$ are presented in Table 2. Columns 2–3, 4–5, and 6–7 show the estimated values of β_2 and β_3 in equation (1) along with the bootstrapped standard errors, calculated following Buchinsky (1995), when the dependent variable, ΔX_i, is the change in the inflation rate, the change in inflation volatility and the change in output volatility, respectively. Accompanying our quantile regression results are plots of the quantile process estimates, shown in figures (2a)-(2f), which depict the estimates of β_2 and β_3 across quantiles for the different dependent variables. The horizontal (red) line represents the effects at the mean, along with the dashed lines for the corresponding 90% confidence interval.

Figure (2a) shows that the effect of IT on the change in inflation at the mean is negative and statistically significant with a coefficient of -2.9. Our estimate is very similar to previous findings in the literature – Batini and Laxton (2007), Brito and Bystedt (2010), Lee (2010), Gonçalves and Salles (2008) – despite our sample extending to cover the Great Recession. Nonetheless, this result masks a substantial degree of heterogeneity. In particular, the effects of IT are insignificant at the lower quantiles but then at the higher quantiles are statistically significant as can be seen in Figure (2a) and also in column 2 in Table 2. The coefficient is strongly negative between the 60th and 90th quantiles indicating that for countries in this category, IT was accompanied by a further reduction in inflation of between 2.50 and 5.20 percentage points relative to the control group.[8]

As our regression is in terms of differences-in-differences, the interpretation is as follows. For the countries that reduced inflation the most – which we can interpret as the most successful economies which are located at the lowest quantiles – there are no benefits to IT. By contrast, for the least successful countries, those that reduced inflation the least or that even experienced increases in inflation, IT yields strong benefits in terms of lower inflation. Column 3 in Table 2 presents the estimated value of β_3, which captures the effect of IT specific to countries that experienced high inflation while the corresponding quantile process estimates are shown in Figure (2b). It can be seen that not only is it insignificant at the mean but also across quantiles, indicating that our results are not driven by this subgroup of countries. This will be considered further below. As discussed above, monetary policy frameworks in EMEs that are alternatives to inflation targeting include those that use the exchange rate as an anchor as well as purely discretionary arrangements without explicit objectives. Representative of the countries in our

[7] All the estimation is performed in R using package `quantreg` created and maintained by Roger Koenker. The package can be downloaded from: https://cran.r-project.org/web/packages/quantreg/index.html

[8] It can be seen that the effects vary across quantiles by noting that the confidence intervals at the low and high quantiles do not overlap.

sample that are not targeting inflation, the least successful in reducing inflation include India and Pakistan, which could be largely described as having pursued purely 'discretionary' monetary policies with a managed exchange rate. By contrast, the most successful countries include Costa Rica and El Salvador, where the exchange rate is used as the nominal anchor of monetary policy to the extent that the latter has adopted the dollar as legal tender.[9] Most relevant for this paper, India adopted inflation targeting in 2016 and Costa Rica is undertaking preliminary steps towards implementing it. Our results suggest that India is the country that will benefit the most in terms of maintaining low inflation, whereas for Costa Rica the effects will be negligible.

The quantile regression results in columns 4–5 and 6–7 in Table 2 and the quantile process estimates in Figures (2c)-(2f) show that the effects of IT on the volatilities of inflation and output growth are insignificant across all quantiles.[10] Previous evidence regarding the impact of IT on inflation volatility has ranged from zero (Vega and Winkelried, 2005) to a reduction of 3.6 percentage points (Batini and Laxton, 2007). The corresponding estimates for output growth volatility have ranged from reductions of 0.3 (Brito and Bystedt, 2010) to 1.4 (Gonçalves and Salles, 2008) percentage points. Our analysis implies that the greater emphasis placed on inflation by the IT framework enabled developing countries that adopted it to achieve a reduction in the level of inflation without incurring an increase in economic volatility. As we include the Great Recession in our sample, our estimates indicate that IT does not confer any stabilisation gains in response to shocks, but nor does it lead to a deterioration in performance.

Overall, our results indicate that countries that adopt IT experience a decrease in the average value of inflation but that the effects only accrue to those countries that have been least able to control inflation. There is no evidence that IT reduces economic volatility. In this regard one may interpret the results of this paper as suggesting that IT represents a stronger commitment to a low value of inflation – one that the best performers may have already achieved – rather than a greater relative weight being placed on inflation in the central bank's loss function. Moreover, such a gain in reducing inflation has not come at the cost of increased output volatility.

5 Robustness of Results

In this section we assess whether our results hinge on the specific sample period used, the defined timings of IT adoption as well as the form of the estimated equation. As a first robustness check, following Gonçalves and Salles (2008), we exclude observations with high inflation so that the high inflation dummy is omitted from the set of explanatory variables. The functional form of the conditional quantile function to be estimated is:

$$q_\tau\left(\Delta X_i|\Omega\right) = \alpha_\tau + \beta_{1\tau}T_{2i} + \beta_{2\tau}IT_i + \beta_{3\tau}\left(T_{1i}\cdot X_{0i}\right) + \beta_{4\tau}\left(T_{2i}\cdot X_{0i}\right). \tag{3}$$

[9] These descriptions follow International Monetary Fund (2016).

[10] The reduction in inflation volatility at the very high quantiles is not particularly robust, as can be seen in the next subsection.

The quantile regression results for equation (3), shown in figures (3a)-(3c) are consistent with those obtained earlier, both qualitatively and quantitatively.[11] Thus, our results are not driven by those countries that experienced high inflation prior to adopting IT. Next, we re-estimate equation (3) but only for the 1990-2014 period. The results are shown in figures (4a)-(4c). Despite omitting the 1980s, which represented a period of high inflation for many countries in our sample, it remains the case that IT adoption resulted in a strong and significant reduction in inflation for those economies that were in the high quantiles of the distribution. In other words, for those countries that were least successful in reducing inflation, the adoption of IT resulted in a further decrease in inflation of approximately four percentage points. As in the previous specifications, the results are not dependent on the performance of the high inflation countries and there is no link between IT and economic volatility, with the coefficient on the IT dummy being insignificant.

One potential limitation of the results presented above is that they rely on a specific dating of the adoption of IT, that used by Gonçalves and Salles (2008). Consequently, we re-do our analysis using the timings in Hammond (2012).[12] The value of the IT dummy across quantiles is shown in figures (5a)-(5c) and are remarkably similar to the benchmark results. IT is associated with approximately a 4 percentage point decrease in inflation – relative to the control group – for economies at the high quantiles of the distribution while its effect at the low quantiles is insignificant. Moreover, the volatilities of inflation and GDP growth remain unaffected by IT.

As a further robustness check, we also considered the consequences of IT by estimating the following conditional quantile function:

$$q_\tau\left(\Delta X_i|\Omega\right) = \alpha_\tau + \beta_{1\tau} T_{2i} + \beta_{2\tau} IT_i + \beta_{3\tau} High_i + \beta_{4\tau}\left(High_i \cdot IT_i\right) + \beta_{5\tau}\left(T_{1i} \cdot X_{0i}\right) + \beta_{6\tau}\left(T_{2i} \cdot X_{0i}\right) \tag{4}$$

which allows the high inflation dummy variable to control both for periods of high inflation as well as the interaction with IT. The results from using this more general equation are shown in figures (6a)-(6f). In this case the coefficient on the IT dummy for the inflation regression is only significant at the very high quantiles and this is not driven by the high inflation economies. Moreover, quantitatively the magnitude of the IT effect is largely unchanged. In terms of economic volatility, also at the very high quantiles, IT has had a strong stabilising effect on both inflation and output growth, but only for countries that experienced high inflation prior to the adoption of IT. It is worth noting that the mean effect of IT for this subgroup of countries is strongly negative and significant, which could have led a researcher to conclude that this effect could be generalised to all countries in the sample.

Nonetheless, the reduction in economic volatility following the introduction of IT is not a general feature of our previous estimates and pertains to very few observations in our sample.

[11] We present all the results of the robustness analysis using plots of the quantile process estimates only as they convey the same information as the estimated values of the coefficients and the standard errors. The quantile regression results for the robustness analysis will be provided by the authors upon request.

[12] As discussed above, even in the benchmark results we use the timings in Hammond (2012) for the period after 2005 since the sample in Gonçalves and Salles (2008) ends in that year.

Hence, we do not view this finding as sufficiently robust to be thought of as evidence in favour of IT.

6 Theoretical Model

This is a simple one-period model with three agents: the government, the central bank and the private sector.[13] The government's aim is to minimise a loss function that depends on deviations of inflation and the output gap from their respective targets but crucially, the positive value of the latter gives rise to the inflation bias.

The government's – and society's – loss function is given by

$$L^g = \frac{1}{2}E\left[(\pi - \overline{\pi})^2 + \lambda(y - \overline{y})^2 + \gamma C(I) + \varphi\left(\kappa_1 - \kappa_0\right)^2\right] \tag{5}$$

where π is the inflation rate and y output gap, with target levels $\overline{\pi}$ and $\overline{y}$, respectively. The government begins the period with a predetermined level of credibility – quality of institutions – denoted by κ_0 and chooses the current period's value, κ_1.[14] The model assumes quadratic costs of improving institutional quality in addition to the fixed cost $\gamma C(I)$, where $C(I)$ is an indicator function equal to one if $\kappa_1 \neq \kappa_0$ and zero otherwise. This formulation ensures that the government will not always decide to increase κ and that if it does, it will not automatically raise it to its largest possible value. In the absence of any changes in credibility, $\kappa_1 = \kappa_0$ and we obtain the standard result that in equilibrium the output gap equals zero and inflation will be above $\overline{\pi}$ due to the inflation bias.

The government delegates monetary policy to the central bank who implements monetary policy under discretion by choosing the inflation rate to minimise its loss, given by

$$L^{cb} = \frac{1}{2}E\left[(\pi - \overline{\overline{\pi}})^2 + \lambda(y - \overline{y})^2\right]. \tag{6}$$

Thus the central bank's objective, like the government's, is to minimise the deviation of inflation and the output gap from their respective gaps, but they differ in terms of the inflation target. We assume that the central banker's inflation target, $\overline{\overline{\pi}}$ is linked to the government's via

$$\overline{\overline{\pi}} = \frac{\overline{\pi}}{\kappa_1} \tag{7}$$

so that under a poor institutional framework – a low value of κ – political and fiscal weakness lead the government to pressure the central bank into engaging in inflationary policy. This results in a higher (implicit) inflation target for the central bank. Moreover, we assume that credibility exhibits diminishing returns. The value of $\overline{\overline{\pi}}$ is assumed to be known by agents when forming expectations. In this context, we interpret inflation targeting as a policy framework

[13] This is a slight modification of the Kydland and Prescott (1977) model of time inconsistency. For a textbook treatment see Walsh (2010).

[14] For simplicity, we assume that $\kappa \in (0, 1]$.

that leads to an increase in the government's commitment to achieve low inflation, captured by the parameter κ.

Lastly, the role of the private sector is to form expectations of inflation – π^e – which are assumed to be rational. These expectations are set before the realisation of the technology shock ϵ in the following Phillips curve

$$y = \pi - \pi^e - \epsilon. \tag{8}$$

We can then think of the Phillips curve as a constraint affecting the central banker when setting its policy instrument subject to expectations being rational.

The timing is then as follows: the government sets the value of κ_1, which determines the value of $\overline{\overline{\pi}}$. After this, agents form expectations of inflation knowing the central banker's loss function. The technology shock is then realised and lastly, the central bank implements monetary policy so that we obtain the equilibrium values of inflation and the output gap.

6.1 Solution

We solve the model backwards. The central bank's optimisation problem, minimising (6) subject to (8) and taking expectations as given, results in the following targeting rule:

$$\pi = \overline{\overline{\pi}} + \lambda\overline{y} - \lambda\left(\pi - \pi^e + \epsilon\right). \tag{9}$$

Given rational expectations, the equilibrium levels of inflation and output are given by

$$\pi = \overline{\overline{\pi}} + \lambda\overline{y} - \frac{\lambda}{1+\lambda}\epsilon \tag{10}$$

and

$$y = \frac{1}{1+\lambda}\epsilon, \tag{11}$$

respectively. For later reference, note that the equilibrium solution for inflation can be decomposed as

$$\pi = \left[\overline{\pi}\left(\frac{1-\kappa_1}{\kappa_1}\right) + \lambda\overline{y}\right] + \overline{\pi} - \frac{\lambda}{1+\lambda}\epsilon.$$

The inflation bias in this model – contained within the square brackets – depends not only on the degree to which the natural level of output is suboptimal, but also on the extent of institutional weakness.

The government can improve its institutional capacity but at a cost. Hence, it chooses the optimal value of κ_1 – denoted κ_1^* – to minimise its loss. Substituting (10) and (11) into its loss and differentiating with respect to κ_1 yields[15]

$$-\frac{\overline{\pi}}{\kappa_1^{*2}}\left[\left(\frac{1}{\kappa_1^*} - 1\right)\overline{\pi} + \lambda\overline{y}\right] + \varphi\left(\kappa_1^* - \kappa_0\right) = 0. \tag{12}$$

The government will only decide to improve its credibility if it leads to a lower loss than the

[15] We assume that $\lambda\overline{y}$ is sufficiently small to ensure that $\kappa_1 \leq 1$.

status quo.[16] The loss from increasing κ to its optimal value κ_1^* is given by

$$L^{g_1} = \frac{1}{2}\left[(1-\kappa_1^*)^2\,\overline{\pi}^2 + 2\lambda\overline{y}\overline{\pi}\,(1-\kappa_1^*) + \gamma + \varphi\left(\frac{\overline{\pi}(1-\kappa_0)}{\varphi+\overline{\pi}^2}\right)\right] \tag{13}$$

while if $\kappa_1 = \kappa_0$, the status quo, losses are equal to

$$L^{g_1} = \frac{1}{2}E\left[(1-\kappa_0)^2\,\overline{\pi}^2 + 2\lambda\overline{y}\overline{\pi}\,(1-\kappa_0)\right]. \tag{14}$$

Therefore, the government will decide to increase κ if the gain from doing so is greater than the cost it involves:

$$\overline{\pi}^2\left[\left(\frac{1}{\kappa_0}-1\right)^2 - \left(\frac{1}{\kappa_1^*}-1\right)^2\right] + 2\overline{\pi}\lambda\overline{y}\left(\frac{1}{\kappa_0}-\frac{1}{\kappa_1^*}\right) > \gamma + \varphi\left(\kappa_1^*-\kappa_0\right)^2. \tag{15}$$

6.2 Quantitative Example

In the model presented above, the decision to adopt IT (to raise κ) will depend on the country-specific costs that changing to a new regime involves. Crucially, the model predicts that the reduction in inflation that the policy improvement entails will be a decreasing function of the starting strength of a country's institutions. Put differently, for a country with good policy frameworks (high κ), adopting IT will yield small gains. The mechanism put forward in this paper regarding the effects of inflation targeting is consistent not only with our results, but also with those in Alpanda and Honig (2014) as well as in Batini and Laxton (2007).

The model presented above cannot be solved analytically but a small quantitative example will suffice to clarify the key mechanism driving the model. We set $\overline{\pi} = 3$, $\lambda = 0.5$, $\overline{y} = 0.1$, $\varphi = 1$ for $\kappa_0 \in [0, 1)$. The resulting decline in inflation is shown in figure (7).

7 Conclusion

The choice of monetary policy framework is more important for emerging market economies than it is for industrialised countries. For the latter, their institutional stability and strong credibility have ensured that inflation is not a source of major economic instability. By contrast, the structural characteristics of EMEs generally imply weaker institutions and greater exposure to international shocks so that the appropriate monetary policy arrangements can have substantial economic benefits. This is one key reason why discussions regarding the desirability of adopting inflation targeting may be of greater relevance for developing countries than for industrialised economies.

The bulk of the evidence on the effectiveness of IT has found that while it has not had any noticeable economic effects in industrialised countries, it has led to strong and significant benefits in emerging economies. These economies as a group have experienced lower and more stable inflation, which could be attributed to a general preference for low inflation, but this lower trend

[16] Terms that are common to the losses with either $\kappa = 0$ or $\kappa = \kappa_1^*$ are ignored.

has been more pronounced in those countries that have adopted IT. By employing the quantile regression method we have found large heterogeneous effects following the adoption of inflation targeting. Our econometric approach therefore enables us to capture the asymmetric effects of IT.

We find that it is those countries that have been least successful in reducing inflation that benefit the most from targeting inflation, whereas the most successful do not experience any changes from adopting the policy. Moreover, these gains do not involve a cost in terms of greater volatility in inflation or output growth. Using a theoretical model to interpret the mechanism driving these results, we interpret IT as representing one of a range of ”good policy frameworks” that enable policy makers to deliver greater stabilisation and is thus beneficial only to those countries that are yet to develop a strong policy regime. Moreover, as our sample also includes the Great Recession our results also highlight the robustness of inflation targeting, suggesting that IT will remain one of the preferred policy frameworks in emerging market economies for the foreseeable future.

Our results show that the links between IT and economic performance are more subtle than are generally acknowledged and that simply focusing on the consequences of IT for the mean (emerging) economy provides limited insights.

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Table 1

List of Countries in the Sample

This table list countries in our sample used in the empirical analysis. Panel A shows countries which adopted the inflation targeting along with year which the policy framework was adopted. Panel B show non-inflation targeting countries which are employed as the control group.

	Year IT Adopted	
	Gonçalves and Salles (2008)	Hammond (2012)
	Panel A: IT Countries	
Brazil	1999	1999
Chile	1991	2000
Colombia	2000	2000
Czech R.	1998	1998
Ghana	-	2007
Guatemala	-	2005
Hungary	2001	2001
Indonesia	-	2006
Israel	1992	1997
S. Korea	1998	1998
Mexico	1999	2001
Peru	1994	2002
Philippines	2002	2002
Poland	1999	1998
Romania	-	2006
Serbia	-	2009
South Africa	2000	2000
Thailand	2000	2000
Turkey	-	2006
	Panel B: Non-IT Countries (Control Group)	
Argentina	India	Venezuela
Bulgaria	Lebanon	
China	Malaysia	
Chinese Taipei	Morocco	
Costa Rica	Nigeria	
Cote d'Ivoire	Pakistan	
Dominican Republic	Panama	
Ecuador	Singapore	
Egypt	Tunisia	
El Salvador	Uruguay	

Table 2

Quantile Regression Results

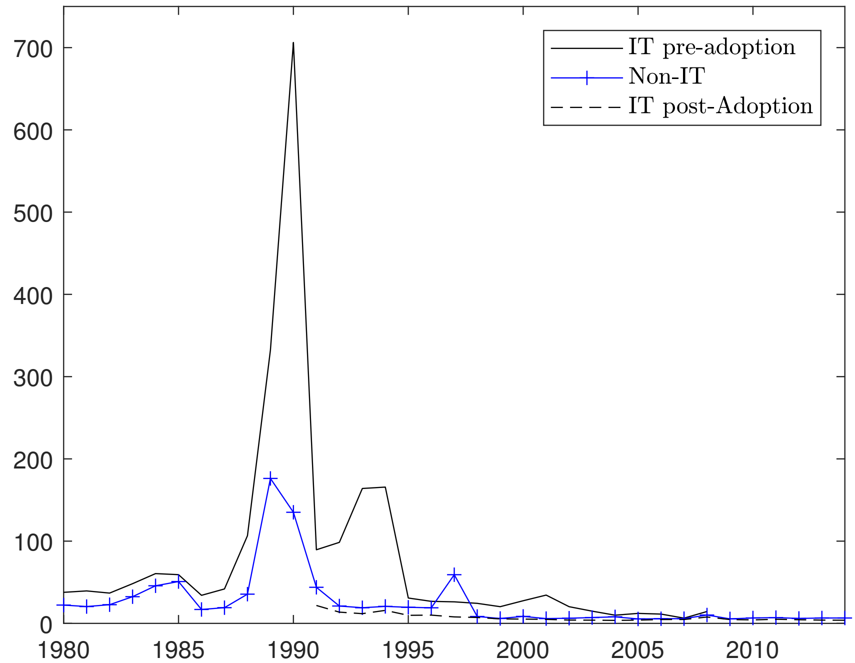
This table reports the quantile regression estimates for $\hat{\beta}_2$ and $\hat{\beta}_3$ for the model shown in equation (1) for $\tau = 0.05, 0.1, \ldots, 0.9, 0.95$. The sample period is 1980–2014. The timing of IT adoption is identified following Gonçalves and Salles (2008). The bootstrapped standard errors, calculated following Buchinsky (1995), are shown in the parentheses. Statistical significance at the 10%, 5% and 1% levels are indicated by *, **, *** respectively.

τ	Inflation		Inflation Volatility		Output Volatility	
	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_2$	$\hat{\beta}_3$
0.05	1.3084	−4.7316	−0.0185	0.9229	−0.0951	0.655**
	(0.961)	(4.6902)	(0.4037)	(0.9866)	(0.2016)	(0.3014)
0.1	0.5276	−6.6675	0.3617	0.3041	0.0742	0.4197
	(0.8557)	(4.8201)	(0.4143)	(4.5298)	(0.2639)	(0.3553)
0.2	0.1681	−8.562	0.1951	0.2319	0.0318	0.3659
	(0.6304)	(5.3648)	(0.3081)	(2.6332)	(0.3696)	(0.4027)
0.3	0.1461	0.4918	0.214	0.1145	−0.3891	0.5191
	(0.7134)	(4.8965)	(0.2985)	(1.0963)	(0.3591)	(0.3857)
0.4	−1.095	0.5749	−0.1215	−0.0349	−0.2268	0.3313
	(0.9649)	(3.9954)	(0.322)	(1.2853)	(0.3628)	(0.4078)
0.5	−1.5705	−0.385	−0.2575	1.1983	0.2373	−0.0399
	(1.0191)	(3.8579)	(0.345)	(2.2043)	(0.3716)	(0.4129)
0.6	−2.4772**	−1.1605	−0.4829	0.2713	0.4075	−0.255
	(1.0788)	(2.8169)	(0.4824)	(3.5856)	(0.4218)	(0.4844)
0.7	−3.3348**	−0.3015	−1.1806*	0.2817	0.1408	−0.2771
	(1.296)	(3.0857)	(0.684)	(2.1597)	(0.5429)	(0.6619)
0.8	−5.2158***	−1.5635	−1.0266	−0.8604	−0.5543	−0.2298
	(1.5156)	(4.6339)	(1.072)	(3.0696)	(0.777)	(0.9946)
0.9	−4.4955**	−4.291	−5.0674*	−0.5417	−0.8693	−1.9324
	(1.7237)	(5.2411)	(3.0904)	(3.6713)	(0.9437)	(1.5648)
0.95	−4.3576*	−4.4289	−10.2879**	−1.5259	−0.3093	0.5933
	(2.3372)	(6.9709)	(4.2857)	(24.8505)	(0.8376)	(2.1295)

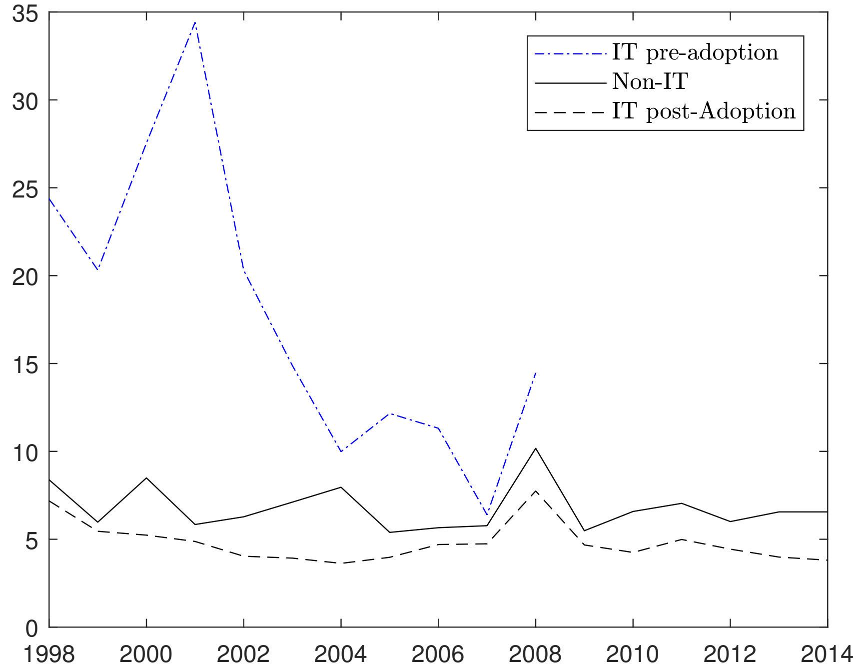
Figure 1

Average rates of inflation for each country group

Figures below show the average rates of inflation for periods 1980–2014 (Figure (1a)) and 1997-2014 (Figure (1b)).



(a) Average inflation 1980 – 2014.

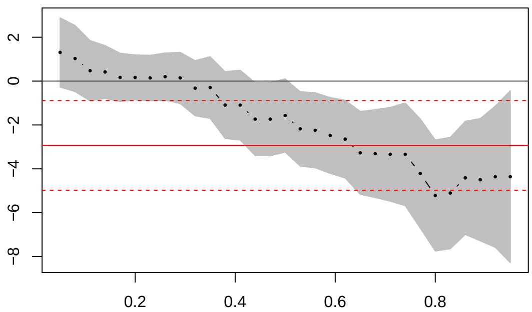


(b) Average inflation 1997 – 2014.

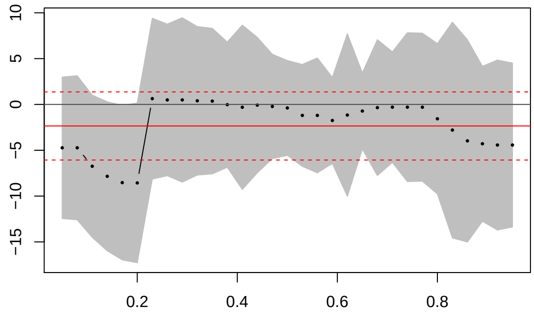
Figure 2

Quantile Process Estimates

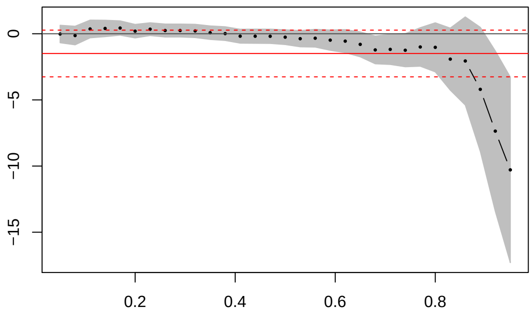
Figures below show plots of the quantile process estimates of the slope parameters $\beta_{2\tau}$ and $\beta_{3\tau}$ for equation (1) where $\tau = 0.05, 0.10, 0.15, \ldots, 0.95$. Figures (2a)-(2b), (2c)-(2d), (2e)-(2f), show the estimated slope parameters when the dependent variable ΔX_i is the change in the inflation rate, the change in inflation volatility and the change in output volatility, respectively. The sample period is 1980–2014. The timing of IT adoption is identified following Gonçalves and Salles (2008). The 90% confidence intervals are depicted by the shaded areas in the plots.



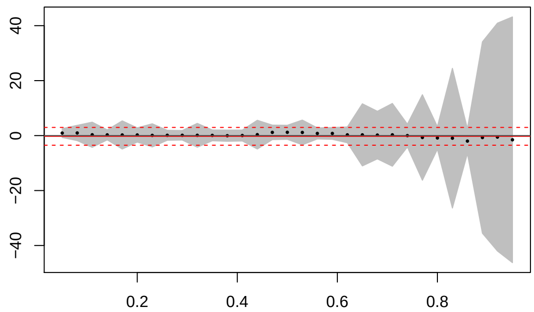
(a) $\hat{\beta}_{2\tau}$ (Inflation)



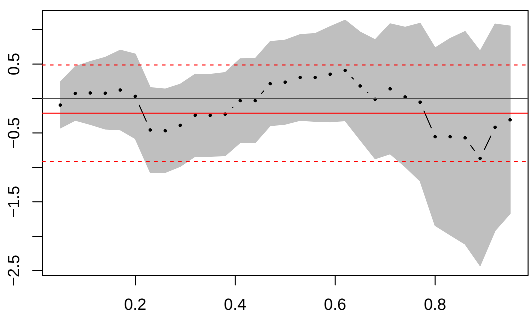
(b) $\hat{\beta}_{3\tau}$ (Inflation)



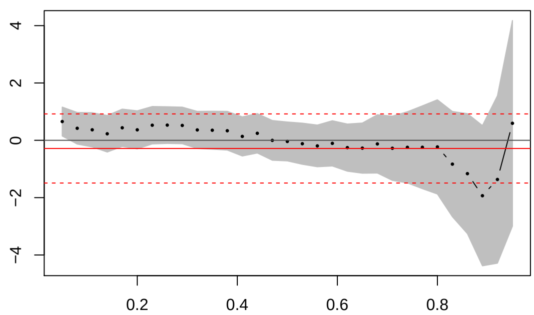
(c) $\hat{\beta}_{2\tau}$ (Inflation Volatility)



(d) $\hat{\beta}_{3\tau}$ (Inflation Volatility)



(e) $\hat{\beta}_{2\tau}$ (Output Volatility)

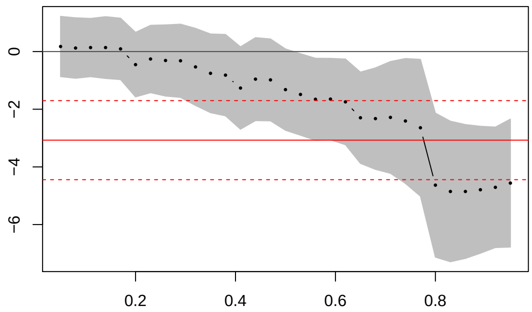


(f) $\hat{\beta}_{3\tau}$ (Output Volatility)

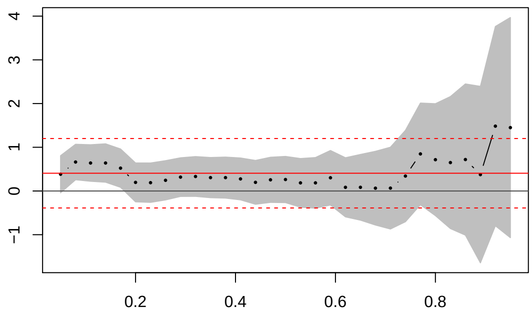
Figure 3

Quantile Process Estimates

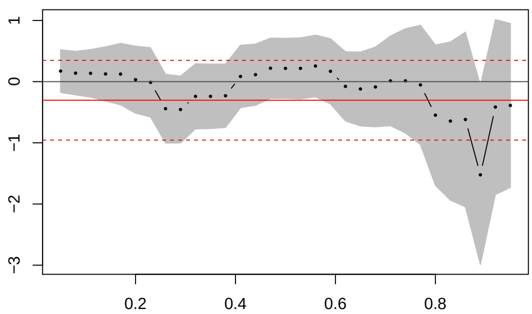
Figures below show plots of the quantile process estimates of the slope parameter $\beta_{2\tau}$ for equation (3) where $\tau = 0.05, 0.10, 0.15, \ldots, 0.95$. Figures (3a), (3b) and (3c) show the estimated slope parameters when the dependent variable ΔX_i is the change in the inflation rate, the change in inflation volatility and the change in output volatility, respectively. The sample period is 1980–2014. The timing of IT adoption is identified following Gonçalves and Salles (2008). The 90% confidence intervals are depicted by the shaded areas in the plots.



(a) $\hat{\beta}_{2\tau}$ (Inflation)



(b) $\hat{\beta}_{2\tau}$ (Inflation Volatility)

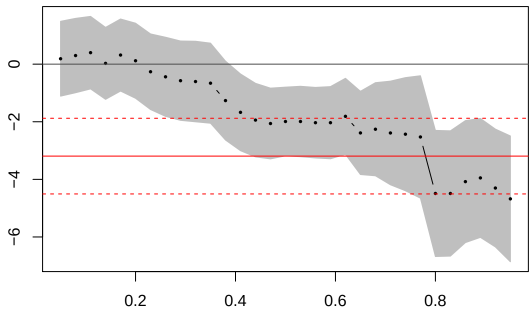


(c) $\hat{\beta}_{2\tau}$ (Output Volatility)

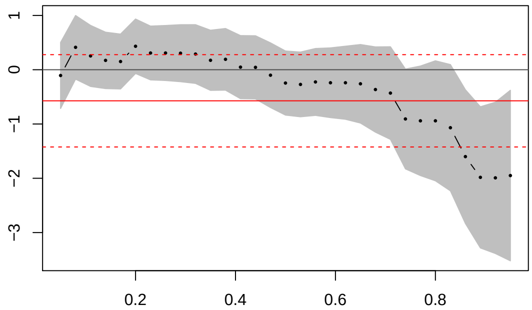
Figure 4

Quantile Process Estimates

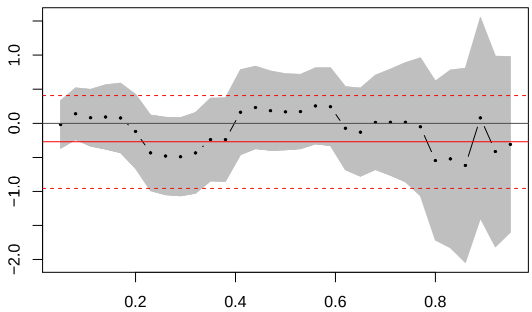
Figures below show plots of the quantile process estimates of the slope parameter $\beta_{2\tau}$ for equation (3) where $\tau = 0.05, 0.10, 0.15, \ldots, 0.95$. Figures (4a), (4b) and (4c) show the estimated slope parameters when the dependent variable ΔX_i is the change in the inflation rate, the change in inflation volatility and the change in output volatility, respectively. The sample period is 1990–2014. The timing of IT adoption is identified following Gonçalves and Salles (2008). The 90% confidence intervals are depicted by the shaded areas in the plots.



(a) $\hat{\beta}_{2\tau}$ (Inflation)



(b) $\hat{\beta}_{2\tau}$ (Inflation Volatility)

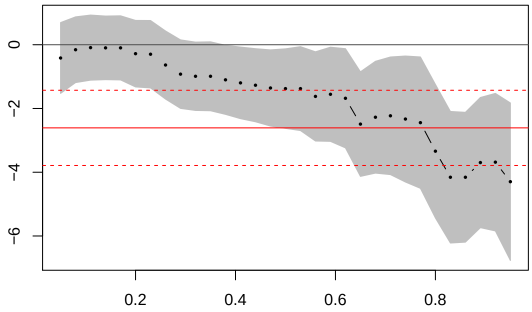


(c) $\hat{\beta}_{2\tau}$ (Output Volatility)

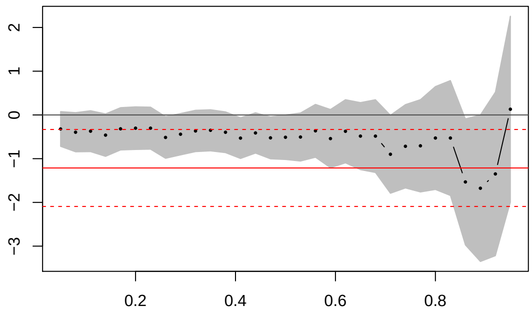
Figure 5

Quantile Process Estimates

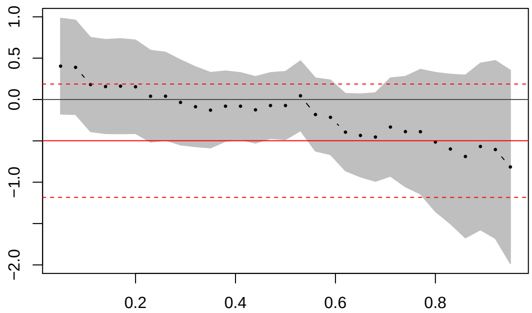
Figures below show plots of the quantile process estimates of the slope parameter $\beta_{2\tau}$ for equation (3) where $\tau = 0.05, 0.10, 0.15, \ldots, 0.95$. Figures (5a), (5b) and (5c) show the estimated slope parameters when the dependent variable ΔX_i is the change in the inflation rate, the change in inflation volatility and the change in output volatility, respectively. The sample period is 1980–2014. The timing of IT adoption is identified following Hammond (2012). The 90% confidence intervals are depicted by the shaded areas in the plots.



(a) $\hat{\beta}_{2\tau}$ (Inflation)



(b) $\hat{\beta}_{2\tau}$ (Inflation Volatility)

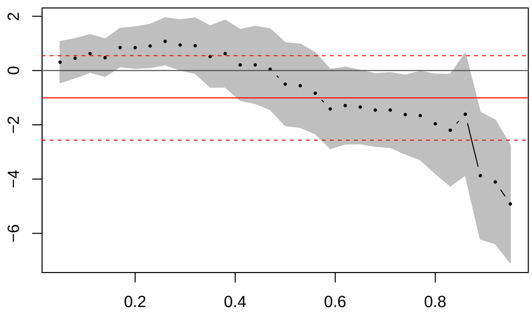


(c) $\hat{\beta}_{2\tau}$ (Output Volatility)

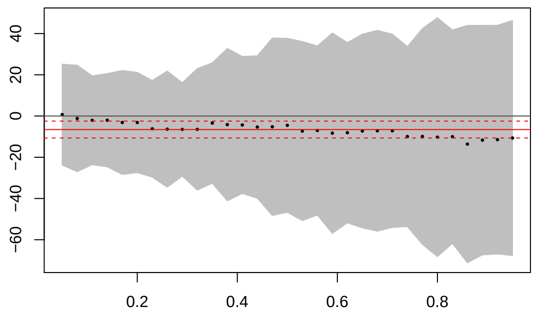
Figure 6

Quantile Process Estimates

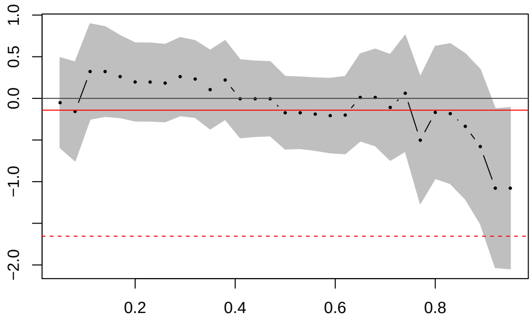
Figures below show plots of the quantile process estimates of the slope parameters $\beta_{2\tau}$ and $\beta_{4\tau}$ for equation (4) where $\tau = 0.05, 0.10, 0.15, \ldots, 0.95$. Figures (6a) and (6b), (6c) and (6d), 6e and (6f), show the estimated slope parameters when the dependent variable ΔX_i is the change in the inflation rate, the change in inflation volatility and the change in output volatility, respectively. The sample period is 1980–2014. The timing of IT adoption is identified following Gonçalves and Salles (2008). The 90% confidence intervals are depicted by the shaded areas in the plots.



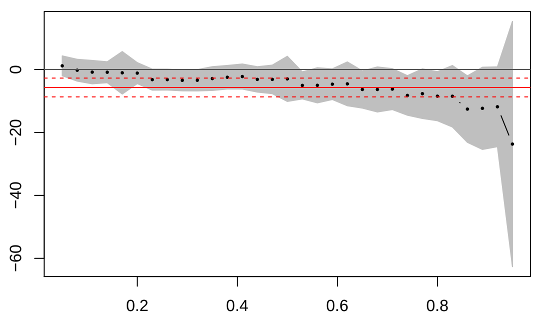
(a) $\hat{\beta}_{2\tau}$ (Inflation)



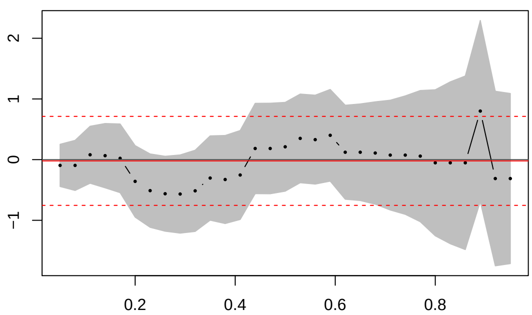
(b) $\hat{\beta}_{4\tau}$ (Inflation)



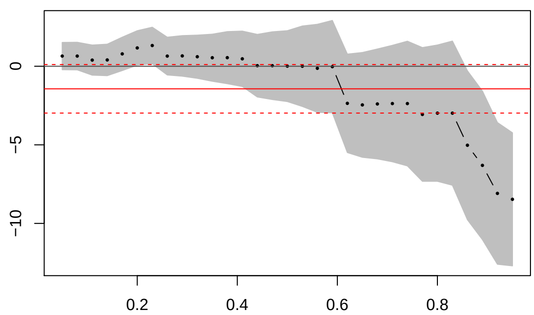
(c) $\hat{\beta}_{2\tau}$ (Inflation Volatility)



(d) $\hat{\beta}_{4\tau}$ (Inflation Volatility)



(e) $\hat{\beta}_{2\tau}$ (Output Volatility)



(f) $\hat{\beta}_{4\tau}$ (Output Volatility)

Figure 7

Decline in inflation from increasing κ to κ_1^*.

The figure below shows the decline in inflation for a central bank that decides to strengthen its institutions (increase κ) given an initial value of κ_0 to its new optimal value, derived in equation (12).