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# Does inflation targeting matter for output and inflation volatility?

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**Abstract**

We address this question by examining the conditional dynamics of inflation and output growth in response to markup shocks for 14 industrialized countries. Markup shocks create a trade-off between output gap and inflation stabilization purposes, and the theory predicts that conditional on such shocks output growth should be more volatile than inflation in inflation targeting countries. Data suggest no differences between targeting and non-targeting countries in the post 1990s. Moreover, we document a similar increase in the conditional relative variability of output growth after the adoption of inflation targeting for both groups of countries. We argue that changes in the conduct of monetary policy can explain this pattern.

*JEL classification:* E31, E42, E58
*Keywords:* conditional moments, inflation targeting, markup shocks, new policy trade-off, policy ratio, SVAR, trade-off ratio.

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# 1 Introduction

The issue of whether inflation targeting (IT henceforth) substantially affects economic performance or not has attracted a lot of attention in the early 1990s when, following the example of New Zealand, many industrial and emerging-economy countries have explicitly adopted an IT regime. The shift of policy focus toward IT has stimulated a vast empirical literature and, since the evidence is controversial, a lively debate on the issue ensued.

For IT countries, Bernanke et al. (1999) find no increases in the size of output fluctuations relative to a pre-IT regime, while Neumann and von Hagen (2002) report reductions in the level and the volatility of inflation and of the interest rate; Corbo et al. (2002) document a fall in the "sacrifice ratio", the cumulative output loss arising from a permanent reduction in inflation; and Levin et al. (2004) find that long-run inflation expectations are better anchored and inflation persistence reduced. Ball and Sheridan (2003), on the other hand, comparing seven OECD countries that adopted IT to thirteen that did not, find that differences in performance are explained by the fact that targeting countries performed worse than non-targeting in the 1980s, and that there is regression toward the mean. Overall, the current state of the debate is well summarized in Mishkin and Schmidt-Hebbel (2007): depending on the sample, the estimation techniques and the measures of economic performance one uses, it is possible to find evidence in favor or against IT.

With the exception of Mishkin and Schmidt-Hebbel (2007), all the above mentioned studies focus on the unconditional moments of inflation and output to draw conclusions. However, unconditional analysis may be problematic because the effects of IT can be mixed with many other changes. In this paper we adopt a conditional perspective. Specifically, we analyze the performance of IT and non-IT countries by looking at the dynamics of inflation and output conditional on markup shocks. Markup shocks are a standard feature of models used in policy discussions and capture shifts in the degree of the distortion of the production process (see, for example, Clarida, Gali, and Gertler (2002), Steinsson (2003), Ball, Mankiw, and Reis (2005)). The reason why we focus on such shocks is that they induce a trade-off[1] between stabilizing inflation and stabilizing the output gap given that they generate movements of opposite sign in prices and output.[2] This has two clear cut implications. First, conditional on mark-up shocks, economies in which the central bank

[1]Other important cyclical shocks, such as technology or investment-specific shocks, do not produce such a trade-off, unless wages are assumed to be sticky (see Blanchard (1997) and Erceg et al. (1998))

[2]John Taylor has characterized this short run trade-off as the *new policy trade-off*.

targets inflation should display a higher "trade-off ratio", i.e. the ratio of the volatility of output growth to the volatility of inflation. Second, the trade-off ratio should increase after the adoption of an IT regime.

This paper tests these two predictions. To this end, we use a standard Neo-Keynesian model to obtain robust implications about the sign of the response of key macroeconomic variables to a mark-up shock. Using data for 14 industrialized countries, we estimate, separately for each country, a VAR including the growth rate of GDP, CPI inflation, real wage growth, interest rates and labor productivity growth and use sign restrictions to identify the mark-up shock in each country. In order to evaluate the role of inflation targeting, we estimate trade-off ratios conditional on mark up shocks and compare them over time (before and after the adoption of the IT regime) and across countries (IT vs. non-IT).

We find that after the adoption of an IT regime IT countries have experienced an increase in the trade-off ratio. However, a similar increase is also observed for non-IT countries. At the same time we fail to detect significant differences between IT and non-IT countries in the inflation targeting era. To interpret these results we complement the analysis using the "policy ratio", i.e. the ratio of the volatility of nominal interest rate to the volatility of inflation conditional to a mark-up shock, which captures the strength with which central banks react to inflationary pressures stemming from markup shocks. As for the trade-off ratio a clear cut implication of the adoption of an IT regime is that the policy ratio should increase. Our findings suggest it is higher in the IT period but in both groups of countries and there are no significant differences in its size in the post IT era. Given that the simultaneous increase in the two ratios can hardly be generated by other structural changes, we conclude that non-targeting countries are in reality "covert inflation targeters", i.e. inflation stabilization matters more in the objective function of the central banks of *all* the countries. The fact that some of them has announced it and some of them did not, does not seem to matter.

The rest of the paper is organized as follows. Section 2 describes the countries, samples and presents unconditional statistics. Section 3 describes the theoretical model and highlights the main theoretical predictions to be confronted in the data; section 4 presents the methodology for extracting markup shocks and section 5 the empirical findings. Section 6 complements the analysis with additional exercises to examine the robustness of the results and section 7 concludes. Various appendices describe the data, the parameter ranges used in the numerical exercise, simulation results and estimation details.

## 2 The choice of regime and some preliminary evidence

For the choice of the countries in the sample and the selection of IT and non-IT periods, we follow Ball and Sheridan (2003). We consider all OECD members as of 1990 and exclude countries that i) lacked independent currency before the Euro (i.e., Luxemburg), ii) have experienced high inflation rates (i.e., Greece, Iceland, and Turkey), iii) do not have real wage data (Denmark, Portugal and Switzerland) or discontinuous data series (Ireland and Norway). We also exclude Germany, as the German unification makes the experience problematic. As a result, we are left with 14 countries, six adopted an IT and the other eight did not.

For targeters we examine only periods of constant inflation targeting, i.e. where the target is unchanged, or varies within a specific range. The targeting period starts at the first full quarter where a specific inflation target or target range was implemented. We chose to exclude transitional targeting periods to make the comparison sharper but none of the results we present depend on including or excluding them [3]. The targeting period lasts through 2007 for all IT countries, except Finland which ends in 1998.

As in Ball and Sheridan (2003), we start the IT period for non-IT countries at the mean of the start dates for targeters, 1994:1. Our post targeting period ends in 2007:1 for both European and non-European countries[4]. Table 1 compactly presents this information. Data sources are in Appendix A.

### 2.1 Unconditional statistics

We first examine the unconditional volatility of CPI inflation and output growth for the 14 countries in our sample. In Table 2 we report the volatility of output growth and the CPI inflation volatility for the two groups of countries before (pre-IT) and after (IT) the adoption of IT.

[3]For that reason Spain is not classified as IT, since its target fell throughout 1994:1 and 1998:4. To control for transitional dynamics we have also conducted our exercise by ending the non-IT period in 1991:4 and starting the IT period in 1995:1 for all countries. Results are robust to the exact split of the sample.

[4]Ball and Sheridan's sample stops at 1998 for European countries. Since there are no qualitative differences in the pattern of estimates between 1994-98 and 1994-2007 and since there is little evidence that the introduction of the Euro produced a structural break in the European economies (See, Canova, Cicarelli and Ortega (2006)), we have decided to base our analysis on the longer sample.

The table confirms existing findings. First, inflation targeting has reduced inflation volatility while output volatility has not worsened - if anything, it has improved after the adoption of the IT regime. Second, the variability of inflation and output has been reduced in both groups of countries in the second sample. Third, in the pre-IT period, and with the exception of US and Italy, all non-IT countries experienced smaller output variability than IT countries. The estimated variabilities for targeters and non-targeters are roughly similar in the IT period. Thus, controlling for regression to the mean, Table 2 fails to show any advantage for targeters. If welfare depends negatively on output and inflation variability, as is usually the case in micro founded DSGE models with nominal rigidities, one must conclude that all the countries in the sample have experienced welfare gains. But, how much of this improvement can be attributed to monetary policy?

Assuming that a trade off between output and inflation variability exists, we can think of policymakers as choosing a point on an output-inflation variability curve, namely the Taylor curve. Inflation targeting represents a movement along this frontier, where inflation variability is lower and output variability higher than it otherwise would have been. In Table 2 we portray such movements by presenting in the last two columns the ratios of the unconditional output growth to inflation variability before and after the adoption of the IT. Inflation targeting does imply movements along the Taylor curve, the average output inflation variability ratio increases from 0.9 to 1.4 in the IT period for targeters. But this ratio increases significantly also for non-targeters. Moreover, the last column of Table 2 shows practically no differences in the ratios between IT and non IT countries in the IT period. Hence the unconditional evidence in Table 2 suggests that monetary policy changes do not seem to matter for the observed changes. However, unconditional evidence cannot help in answering this question since changes in economic structure and in shocks' configuration could have also induced the observed changes. To isolate the role that the choice of the monetary regime has, one needs to examine the volatility of output, inflation and the interest rate in response to shocks which induce a relevant trade-off and isolate changes in policy from other changes.

As mentioned, and unlike demand shocks, markup shocks do create a trade-off between output gap and inflation stabilization. Other supply shocks, such as technology, or labor supply shocks, may also generate such a trade-off but only in the presence of sticky wages (see, e.g. Blanchard (1997) and Erceg et al. (2000)). However, while markup shocks leave potential output unaffected, the latter shocks move both actual and potential output, making imperative to use controversial measures of the output gap in the analysis. Thus, we will continue by evaluating whether the adoption of an inflation targeting creates a trade off between output gap and inflation stabilization by looking both at the evidence both across time and across countries in the IT period.

# 3 Inflation targeting and the Taylor curve: Theoretical predictions

## 3.1 A New Keynesian model

We employ a version of the New Keynesian model with sticky prices and markup shocks used by Ireland (2004). The model economy consists of a representative household, a representative final good producer, a continuum of intermediate good producers indexed by $i \in [0, 1]$, and a central bank.

### 3.1.1 The representative household

The representative household derives utility from private consumption, $C_t$, and leisure, $1 - N_t$. Preferences are defined by:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\varepsilon_t^b \left[ C_t^{\phi} (1 - \varepsilon_t^n N_t)^{1-\phi} \right]^{1-\sigma} - 1}{1 - \sigma} \tag{3.1}$$

where $0 < \phi < 1$, and $\sigma > 0$ are preference parameters, $0 < \beta < 1$ is the subjective discount factor and $\varepsilon_t^n$ is a labor supply shock, and $\varepsilon_t^b$ denotes a preference shock that affects the intertemporal substitution of households.

The household has access to a complete set of nominal state-contingent claims and maximizes (3.1) subject to an intertemporal budget constraint that is given by:

$$P_t C_t + B_t Q_t \leq P_t w_t N_t + B_{t-1} + D_t + A_t \tag{3.2}$$

The households income consists of nominal labor income, $P_t w_t N_t$; ; the net cash inflow from participating in state contingent securities at time $t$, denoted by $A_t$; income from bonds maturing at $t$, $B_{t-1}$ and the dividends derived from the imperfect competitive intermediate good firms $D_t$. With the disposable income the household purchases consumption goods, $C_t$, and new bonds $B_t$ at price $Q_t$.

### 3.1.2 The representative final good firm

In the production sector, a competitive firm aggregates intermediate goods into a final good using the following constant-returns-to-scale technology:

$$Y_t \leq \left[ \int_0^1 y_t^{i\frac{1}{1+\lambda_{pt}}} di \right]^{1+\lambda_{pt}} \tag{3.3}$$

$\lambda_{pt}$ measures the time varying elasticity of demand for each intermediate good and represents a shock to the markup. Profits are maximized by choosing: $y_t^{id} = \left(\frac{P_t^i}{P_t}\right)^{-\frac{1+\lambda_{pt}}{\lambda_{pt}}} Y_t$. The zero profits condition implies that the price index is : $P_t = \left[ \int_0^1 P_t^{i-\frac{1}{\lambda_{pt}}} di \right]^{-\lambda_{pt}}$.

### 3.1.3 Intermediate good firms

Each intermediate firm $i$ hires $N_t^i$ units of labor and produces output, $y_t^i$, according to:

$$y_t^i = Z_t N_t^{i1-\alpha}$$

The logarithm of the technology shock, $Z_t$, follows a random walk with positive drift.

Intermediate firms are price takers in the input market and monopolistic competitors in the product markets. They stagger their pricing decisions in the spirit of Calvo (1983). Specifically, in each period of time, each firm receives an i.i.d. random signal that determines whether or not it can set a new price. The probability that a firm can adjust its price is $1-\gamma$. Thus, by the law of large numbers, a fraction $1-\gamma$ of all intermediate firms can adjust prices, while the rest of the firms cannot. If a firm who produces type-$i$ intermediate good can set a new price, it chooses $P_t^i$ to maximize its expected present value of profits. Profit maximization implies:

$$\mathrm{E}_t \sum_{\tau=t}^{\infty} \gamma^{\tau-t} Q_{t,\tau} y_\tau^{id} [P_t^i - (1-\lambda_{p\tau}) V_{N\tau}] = 0, \tag{3.4}$$

where $V_{Nt}$ is the unit labor cost and $y_t^{id}$ is the demand schedule for type $i$ intermediate good originating from the final good producer. Regardless of whether a firm can adjust its price, it has to solve a cost-minimizing problem. Its solution yields the unit cost function: $V_{Nt} = \frac{1}{1-\alpha}\frac{w_t}{Z_t} N_t^{\alpha}$ and a conditional factor demand function: $N_t^i = \left(\frac{Y_t}{Z_t}\right)_0^{\frac{1}{1-\alpha}} 1 \left(\frac{P_t^i}{P_t}\right)^{-\frac{1+\lambda_{pt}}{\lambda_{pt}(1-\alpha)}} di.$

### 3.1.4 The linearized model

We log-linearize all variables around a steady state balance growth path, where output, $y_t = Y_t/Z_t$, and consumption, $c_t = C_t/Z_t$ are stationary. Let lower case letters with hats, denote percentage deviations of variables from their steady state level. The log-linearized version of the model is briefly summarized below. The *Aggregate demand* is characterized by:

$$\widehat{x}_t = E_t\widehat{x}_{t+1} + \frac{1}{\omega\xi}(\widehat{r}_t - E_t\widehat{\pi}_{t+1}) - \frac{1}{\omega\xi}(1-\rho_b)\widehat{\varepsilon}_t^b + (1-\rho_n)\Theta_n\widehat{\varepsilon}_t^n \tag{3.5}$$

where $\omega = (1-\sigma)\phi - 1 < 0$, $\xi = 1 - \frac{N(1-\phi)(1-\sigma)}{1-N}$ and $\Theta_n = \frac{1-\xi}{\xi} + \frac{N(1-\alpha)}{1-\alpha+\alpha N}$.

The variable $\widehat{x}_t$ is the output gap defined as the deviation of the sticky price level of output from its efficient level, i.e., as the level that would prevail under flexible prices and in the absence of markup shocks. In equilibrium the output gap is equal to: $\widehat{x}_t = \widehat{y}_t + \frac{N(1-\alpha)}{1-\alpha+\alpha N}\widehat{\varepsilon}_t^n$. The *supply side* is described by:

$$\widehat{\pi}_t = \beta E_t\widehat{\pi}_{t+1} + \kappa\widehat{mc}_t + \widehat{\eta}_{pt} \tag{3.6}$$

$$\widehat{g}_{yt} = \widehat{y}_t - \widehat{y}_{t-1} + \widehat{z}_t \tag{3.7}$$

$$\widehat{lp}_t = -\frac{\alpha}{1-\alpha}\widehat{x}_t + \frac{\alpha N}{1-\alpha-\alpha N}\widehat{\varepsilon}_t^n \tag{3.8}$$

Equation (3.6) links inflation to the marginal costs, $\widehat{mc}_t = \widehat{w}_t + \frac{\alpha}{1-\alpha}\widehat{y}_t$. The slope parameter $\kappa = \frac{(1-\alpha)\lambda_p}{\alpha+\lambda_p}\kappa_p$, where $\kappa_p = \frac{(1-\beta\gamma)(1-\gamma)}{\gamma}$, depends on $\gamma$, the probability that firms face for not being able to change their price. The shock, $\widehat{\eta}_t^p = \kappa_p(\lambda_{pt} - \lambda_p)$ is the markup shock and in its absence, (3.5) and (3.6) imply that the central bank can replicate the efficient allocation by targeting inflation. Variations in the markup generate a trade-off for the monetary authority, since they make it impossible to attain simultaneously inflation and output gap stabilization. Equations (3.7) and (3.8) define the growth rate of output and labor productivity, respectively.

### 3.1.5 Monetary policy

The monetary policy rule is represented by a generalized Taylor (1993) rule. Monetary policy is assumed to react to current inflation, output gap and output growth fluctuations:

$$\widehat{r}_t = \rho_R\widehat{r}_{t-1} + (1-\rho_R)(\rho_\pi\widehat{\pi}_t + \rho_{gy}\widehat{g}_{yt} + \rho_x\widehat{x}_t) + \widehat{\varepsilon}_t^R \tag{3.9}$$

where $\widehat{\varepsilon}_t^R$ is a monetary policy shock and $\rho_R$ is a smoothing parameter.

#### 3.1.6 Shocks

The model features five exogenous processes: total factor productivity, $\hat{z}_t$, labor supply , $\widehat{\varepsilon}_t^n$, preference, $\widehat{\varepsilon}_t^b$, monetary policy, $\hat{\varepsilon}_t^R$, and the price markup shock, $\hat{\lambda}_{pt}$. The vector of the shocks, $\hat{s}_t = [\hat{z}_t, \widehat{\varepsilon}_t^n, \hat{\varepsilon}_t^b, \widehat{\epsilon}_t^R, \widehat{\lambda}_{pt}]'$, is assumed to evolve according to

$$\hat{s}_t = \varrho \hat{s}_{t-1} + V_t \tag{3.10}$$

where $V$ is a (5x1) vector of orthogonal White Noise and $\varrho$ is a (5x5) diagonal matrix. We assume that $\varrho_{1,1} = 1$ and $|\varrho_{j,j}| < 1$ for $j \neq 1$.

### 3.2 Theoretical predictions

In this subsection we analyze the theoretical implications of the adoption of inflation targeting in terms of volatilities of output and inflation. In particular we focus on the trade-off ratio, defined as the ratio between the standard deviations of output growth and inflation conditional to a mark-up shock, as a measure of the movements along the trade-off curve. We model the adoption of inflation targeting with a reduction in the coefficients of output growth, or output gap, $\rho_{gy}$ and $\rho_x$, from positive values to zero. Alternatively one could define it as an increase in the parameter $\rho_\pi$. As it will be clear below results both definitions yield the same results.

Let us focus first on a simple analytical example. Consider equations (3.5), (3.6) and (3.9) when all disturbances but the markup shock are set to zero and assume that $\rho_R = \rho_{gy} = 0$. Then, the equilibrium conditions under (3.9) are:

$$\begin{bmatrix} 1 - \frac{\rho_x}{\omega\xi} & -\frac{\rho_\pi}{\omega\xi} \\ -\kappa_x & 1 \end{bmatrix} \begin{bmatrix} \widehat{x}_t \\ \widehat{\pi}_t \end{bmatrix} = \begin{bmatrix} 1 & -\frac{1}{\omega\xi} \\ 0 & \beta \end{bmatrix} \begin{bmatrix} E_t\widehat{x}_{t+1} \\ E_t\widehat{\pi}_{t+1} \end{bmatrix} + \begin{bmatrix} 0 \\ \widehat{\eta}_t^p \end{bmatrix}$$

Using the method of undetermined coefficients, we can write the solution as:

$$\widehat{x}_t = a_1 \widehat{\eta}_t^p$$
$$\widehat{\pi}_t = b_1 \widehat{\eta}_t^p$$

where

$$\begin{aligned} a_1 &= -\frac{\rho_\pi - \rho_\eta}{(\rho_\pi - \rho_\eta)\kappa_x - ((1-\rho_\eta)\omega\xi - \rho_x)(1-\beta\rho_\eta)} < 0 \\ b_1 &= \frac{\rho_x - (1-\rho_\eta)\omega\xi}{(\rho_\pi - \rho_\eta)\kappa_x - ((1-\rho_\eta)\omega\xi - \rho_x)(1-\beta\rho_\eta)} > 0 \end{aligned}$$

The trade-off ratio is

$$TOR = \sqrt{\frac{Var(\widehat{g}_{xt})}{Var(\widehat{\pi}_t)}} = \sqrt{2}\frac{(\rho_\pi - \rho_\eta)}{\rho_x - \omega\xi(1-\rho_\eta)}$$

where $\rho_\eta$ is the persistence of the markup shock. Clearly, $\frac{\partial TOR}{\partial \rho_\pi} > 0$ and $\frac{\partial TOR}{\partial \rho_x} < 0$, however, we need to show that this prediction holds in the general unrestricted model. To check whether a reduction to zero of $\rho_{gy}$ and $\rho_x$ yields an increase in the trade-off ratio we uniformly draw 10000 realizations of the remaining structural parameters parameters from admissible ranges [5] and check whether the corresponding trade-off ratio increases. Table 3 indicates that the trade-off ratio increases in 92% and 87% of the parameterizations respectively. When inflation targeting adoption is defined as an increase in $\rho_\pi$ the trade-off ratio increases in 96% of the possible parameterizations.

# 4 Identifying markup shocks

To study the effects of a markup shock we use the methodology of Canova and Paustian (2008). The exercise consists of two steps:

1. We search for robust implications in terms of the sign of the impact responses of some variables of interest to a markup shock under various specifications of the theoretical model of section 3 and check whether such restrictions can uniquely identify the shock.

2. We use these restrictions in a VAR to estimate the shock.

## 4.1 Robust restrictions

The first step of our procedure is designed to take into consideration the uncertainty involved in calibration exercises. An implication is called robust if it holds independently of parameterization used. For example, if inflation falls and the output gap increases in response to markup shocks, regardless of the parameter values, we call this implication robust. Our method seeks robust implications in terms of sign of the responses which can be used to identify the shock in the data. Obviously, there may be disturbances which do not generate robust implications. Also, some shocks may share the same implications. For example, output increases and inflation falls in response to both TFP and markup shocks.

[5] Admissible ranges for the remaining parameters are: $\gamma \in [0.4, 0.9]$, $\sigma \in [1, 4]$, $\phi \in [0.6, 0.8]$, $\alpha \in [0.2, 0.4]$, $\rho_\eta \in [0, 0.95]$.

For that reason it is important to establish that none of the other shocks in the model can generate the same restrictions we use to identify markup shocks.

To implement this first step we uniformly draw all structural parameters from some specified range (see Appendix B for the details), except $\beta$ which is set equal to 4%, and we compute the corresponding impulse response functions. We draw 1000 realizations and we compute the 84th and 16th percentiles of the simulated distribution for each impulse response function. If the sign of the two percentiles coincide for some impulse response function, we call that sign a robust sign restriction.

We summarize the qualitative features of the responses of the variables of interest to the five shocks in the impact period in Table 4. Figure 1 plots the 68-percent confidence bands for the responses of these variables to the five shocks. The set of restrictions we use to identify markup shocks are as follows. Markup shocks should increase output growth, the real wage and decrease the interest rate and inflation on impact and the response of real wages to such shocks should be higher than the response of labor productivity. Gambetti and Pappa (2007) show that these restrictions hold in more general environments with capital accumulation, rigidities in both the wage and the price setting, and additional frictions, such as habit in consumption, investment adjustment costs, variable capacity utilization and wage and price indexation.

In order to ensure that the above restrictions uniquely identify the markup shock, we examine the responses of the five variables of interest to the other shocks. As it is apparent from the remaining rows of Table 4, no other shocks can produce the set of restrictions markup shocks produce. In particular, the sign of the impact effect of the real wage, the nominal interest rate and inflation to the exogenous disturbances is sufficient to differentiate the dynamic responses of markup shocks from those of other disturbances in the NK model. The qualitative restriction on the size of the response of the real wage relative to labor productivity is crucial for differencing the effects of TFP shocks in an RBC model and markup shocks in the NK model. Since wages in the NK model are defined as the sum of labor productivity and marginal costs, real wages tend to increase more in reaction to a negative markup shock than labor productivity. The conditional responses of the output gap can also be used to differentiate the two shocks, but since the output gap is unobservable, the restrictions on the real wage and labor productivity are the only plausible options left for identification purposes.

### 4.2 Implementing the restrictions in a VAR

For each country we let $Y_t$ be a vector including the annual growth rate of real GDP, the short term nominal interest rate, the annual growth rate of real CPI wage, the annual growth rate of labor productivity, measured as output per worker, and the annual CPI inflation rate and assume

$$A(L)Y_t = \epsilon_t$$

where $A(L) = I - A_1L - ... - A_pL^p$, $L$ is the lag operator, $p = 2$ for all countries and $\epsilon_t$ is a Gaussian white noise process with covariance matrix $\Sigma$. Let $P$ be the Cholesky factor of $\Sigma$. The markup shock is obtained as $e_t^m = h'P^{-1}\varepsilon_t$, where $h$ is a unit vector such that the implied response functions $A(L)^{-1}Ph$ satisfy the identification restrictions of Table 4. We restrict the responses only in the impact period. To estimate the structural model, we assume a diffuse prior as in Uhlig (2005) and draw $h$ from a from a uniform distribution over the unit-sphere. We draw a candidate $h$ and when the restrictions are satisfied we retain the responses and calculate the statistics of interest. We keep 1000 draws.

## 5 The evidence

### 5.1 The identified shocks

Ireland (2004) and Smets and Wouters (2007) (SW henceforth), have estimated implicitly markup shocks by estimating dynamic stochastic general equilibrium models with nominal rigidities. They find estimated price markup shocks to be the most important source of variability in inflation in the short and medium term but to explain a moderate fraction of output variability. Since in these models markup shocks are modeled as stochastic variations in the elasticity of substitution between differentiated goods, it is a bit hard to believe that this type of variations drive inflation dynamics in the US. Furthermore, since in these models markup shocks play the role of residual shocks, capturing all unmodelled variations in the data, there are further reasons to doubt the credibility of the estimation outcome. Instead, our procedure uses part of the information of the model but not all of them and focuses on qualitative rather than quantitative restrictions. Unsurprisingly, our results differ from those of SW and Ireland (2004). Table 5 reports the explanatory power of our identified markup shocks for these two variables at long horizons (45 quarters) for the two groups of countries.

The relative contribution of markup shocks to output growth and inflation variability in both samples and both groups of countries is moderate and varies between 10% and 20%. Exceptions are Canada for output, and Sweden for inflation in the post 1990 era. Perhaps more importantly, the importance of markup shocks for inflation and output growth variability does not seem to have changed across sub periods. Markup shocks matter more for inflation fluctuations in the IT period for all countries, except Austria and Finland; their importance for output growth fluctuations increased for Canada, the US and Japan, and fell significantly for Italy.

Interestingly, since the importance of markup shocks for output and inflation volatility in the pre-1990 sample is similar in the two groups of countries, the choice of the IT regime does not appear to be endogenous to the structure of the economy. In other words, policymakers did not choose an IT regime because markup shocks were less important in their economies.

### 5.2 Does inflation targeting matter?

The first two columns of Table 6 report the trade-off ratios for the two sample periods for the two groups of countries. The emergence of a new policy trade-off is evident in all IT countries but Sweden and, with the exception of Australia, IT countries have experienced significant increases in this ratio. However, the increase is also shared by non-IT countries. The trade-off ratio drastically increases for Japan and France, while for the US and Belgium the magnitude of the changes is comparable with those of the IT countries. Actually, changes in the trade-off ratio are higher, on average, for non-IT than for IT countries, although differences across groups are not statistically significant.

A reason why we fail to detect substantial differences, is that the adoption of the IT regime could have coincided with other changes that more significantly altered the structure of the economies.[6] Cecchetti and Ehrmann (2000) suggest that the environment of the 1990s was generally benevolent and that the choice of monetary policy strategy, within a class of reasonable strategies, might have been irrelevant. However, when we examine the performance of IT countries versus non IT countries in the post 1990 period, we also fail to detect differences between the two groups. Inflation targeting countries have an average trade-off ratio of about 2, while non IT countries have an average ratio of about 3, although

[6]Part of these results might be due to the Great Moderation (see, McConnell and Perez Quiroz, (2000), Cogley and Sargent (2001, 2005), Sims and Zha (2006), Stock y Watson (2003), and Gambetti, et.al. (2005), among others), since the pre-IT sample includes periods of high inflation and output volatility relative to the post IT period where both inflation and output volatility had been more moderate for all countries.

the standard errors of each of these statistics appear huge (1.7 and 2.8 respectively), making hard to claim any differences for the two groups of countries.

Summarizing none of the basic predictions from the model seem to fit the data. It is true that the trade-off ratio has increased after the adoption of the inflation targeting but this is also true for non inflation targeting countries. Moreover, within the IT regime period the trade off ratio is similar in the two groups of countries.

### 5.3 Why inflation targeting does not matter?

The first two columns of Table 6 fail to detect any differences in the trade-off ratio for countries that adopted an IT regime. In this section we try to assess a possible explanation for the observed patterns for the trade-off ratios.

Specifically we investigate whether these can be attributable to common policy changes. Our conjecture here is that differences in macroeconomic outcomes are not significant simply because there are no differences in macroeconomic policies. To do so we employ a measure that captures changes in monetary policy conditional on markup shocks. We call this measure the "policy ratio". The policy ratio is defined as the ratio of the standard deviation of the nominal interest rate to the standard deviation of inflation conditional on markup shocks. Theoretically, the adoption of inflation targeting, as defined in section 3, increase the policy ratio: reductions in $\rho_{gy}$ and $\rho_x$ from positive values to zero increase the policy ratio in 75% and 80% of the parameterizations respectively, and increases in $\rho_\pi$ raises the policy ratio in 90% of the parameterizations. If our conjecture is right we should find that changes in policy go hand in hand with changes in the trade-off ratio. That is, we should observe a significant increase of the policy ratio for all countries.

The third and fourth columns of Table 6 report the values of the policy ratio in the two sub periods for the two groups. The ratio has increased significantly for all countries in the sample, except Australia, Japan and the Netherlands and the difference in the changes between IT and non-IT economies is insignificant. Japan is special, since the zero bound restriction on the interest rate held back the variability of the policy instrument, whereas the case of Australia is hard to explain, since the policy ratio falls rather than increase. Moreover in the post 1990 period the policy ratio is, if anything higher for non-IT countries on average, although, again, differences between the two groups are not significant.

The data seem to support our conjecture. In the majority of the countries, the relative weight that output gap and inflation variability receive in the objective function of central banks must have changed. This conclusion, however, is hard to reconcile with the fact that some countries have announced an IT regime and other countries have not, unless actions speak by themselves and announcing an inflation target does not matter.

Can other structural changes account for these patterns? In theory, increases in the coefficient of relative risk aversion, $\sigma$, increase the policy ratio but make the trade-off and the policy ratio move in opposite directions. This is because increases in the relative risk aversion coefficient reduce the responsiveness of output to changes in the interest rate, therefore decreasing output variability and the trade-off ratio. At the same time, since they limit the effects of markup shocks on demand and, hence, on inflation, the policy ratio must increase. Thus, changes in the preferences of the agents in non-IT countries, could be responsible for the similarities between non-IT and IT countries if increases in the trade-off ratio are accompanied by decreases in the policy ratio. As table 4 suggest, this is the case only for the Netherlands.

Reductions in the degree of price stickiness, $\gamma$, or the persistence of the markup shock, $\rho_\eta$, can increase the two ratios with a relatively high probability (in 52% of the parameterizations of the model). They also induce reductions in the conditional persistence of inflation and the interest rate: in the model a fall in $\gamma$ decreases inflation and interest rate persistence in 70% of the parameterizations of the model and a fall in the persistence of the shock always reduces persistence in both series (in 97% of the parameterizations for inflation and in 99% of the parameterizations for the interest rate). Could differential changes in these two parameters across the two groups of countries be responsible for the fact that the performance of IT and non-IT countries is similar? The last four columns of Table 6 report the conditional AR(1) coefficients of CPI inflation and interest rate in the two groups of countries for the two sub periods. Inflation persistence dropped in all countries in the second subsample. Targeting countries experienced a larger decrease in inflation persistence relative to non-targeting ones, but difference-in-differences estimates (see Appendix C, Panel I) are imprecise and indicate that differences are insignificant. Changes in the conditional persistence of nominal interest rates are more heterogeneous - persistence has remained almost unchanged in Australia, and Finland (which are targeters) and Belgium and Japan (which are non-targeters) it has increased in seven countries (UK and Sweden from IT and US, Spain, the Netherlands, Austria and Italy from non-IT) and it has fallen for the remaining three countries - but, overall inconsistent with the idea that non-IT economies experienced a relatively larger reduction in the shock persistence or in the degree of nominal rigidities.

Differences across countries in the post 1990 period are also insignificant, so we are led to conclude that the only structural change compatible with the evidence is an increase in the aversion of policymakers to inflation fluctuations in the last decades.

# 6 Robustness

## 6.1 Supply shocks

In our analysis so far we have implicitly assumed that policymakers face a trade-off between output gap and inflation fluctuations. However, output growth might matter more than output gap measures for policy decisions in practice. In this case, in fact, TFP and labor supply shocks may also induce a trade-off between output and inflation stabilization (see Table 4). Therefore, by examining how the ratios behave in response to these shocks, one can draw firmer conclusions on the importance of the IT regime for output and inflation fluctuations.

Rather than separately identifying TPF and labor supply shocks, which is hard to do in the context of the model, since the implications they produce are not necessarily robust, we identify a generic supply shock, imposing the restriction that it moves output growth and inflation in opposite directions on impact, and examine whether the conclusions we have reached change, conditional on this generic shock.

Table 7, which contains the estimated trade-off and policy ratios, has the same qualitative message as Table 6: both the trade-off and the policy ratios conditional on supply shocks have increased across sub periods, and the increase is similar for both IT and non-IT economies. Also averages of the two ratios are not significantly different in the post 1990 period. Both the trade-off and the policy ratio are higher for non IT countries in the last subsample, but given standard errors, differences are insignificant. Given that these generic supply shocks explain a higher percentage of output and inflation fluctuations (on average 40% of output and 30% of inflation fluctuations), failure to find any difference between IT and non-IT countries is even more striking in this case.

## 6.2 Changes in expectations

Changes in inflation expectations after the adoption of an IT regime could have affected the dynamics of output and inflation in response to markup shocks. With a more credible regime policymakers could have reduced inflation without having to sacrifice output variability by affecting inflation expectations, producing an inward shift in the trade-off curve that our measures cannot capture. To examine such a possibility we repeated our exercise adding long term rates to our VAR. Studying a system with the long term rate shields us from the possibility that the results we have obtained are spurious and due to omission of inflation expectation proxies. We present results in Table 8[7]. Results in Table 8 are directly comparable qualitatively with the results in Table 6. The magnitude of the changes in the trade-off and policy ratios in the two groups of countries is unaffected by the addition of long term rates. Except for Spain, the behavior of the trade-off ratio in the pre-IT relative to the IT period mimics the one of the specification without inflation expectations. The same is true for the policy ratio, except for the movements in the policy ratio in Austria. Again, for the IT period differences in the mean of the ratios between IT and non IT countries are insignificant. Hence, even controlling for changes in inflation expectations, the macroeconomic performance of the two groups of countries is similar.

## 7 Conclusions

The paper examines whether the adoption of an IT regime affects macroeconomic performance, when we condition the analysis on a shock that generates a trade-off between inflation and output stabilization purposes. The theory provides clear cut predictions that can be tested in the data. In fact, in any DSGE model with nominal rigidities, a change in the relative weight that output and inflation variability have in the objective function of central banks implies movements along the output-inflation variability trade-off curve toward a region where inflation is less and output is more variable than it would otherwise have been. A movement of this type is present in the data but its size does not differ for IT and non-IT countries.

Our measure of the policy stance, the policy ratio, reveals similar changes in the behavior of non-IT and IT countries. We also show that the similarities in performance are not due to the peculiarity of the identified markup shocks - generic supply shocks generate similar pictures and that changes in inflation expectations induced by a generalized improvement of credibility cannot account for the empirical pattern either. Our analysis leads us to conclude that *announcing* an IT regime does not matter for output and inflation dynamics as long as monetary policy put sufficient importance to inflation stabilization.

[7]Finland is not included in this analysis due to shortage of series for long term rates.

## Appendix A

The appendix presents provides a brief description of the data used for each of the countries considered in the sample.

| Variable | Source | Definition |
|---|---|---|
| RGDP | OECD | Real Gross Domestic Product |
| HOURS | OECD/IFS | Total Hours Worked per employee in the Business Sector |
| TOTEMP | OECD/IFS | Total employment |
| WAGES | OECD/IFS | Wages and Salaries of employees (net wage + social security contributions) |
| COMP | OECD | net wage + social security contributions paid by employees and employers |
| INT | IFS | short term nominal (money market) rate |
| CPI | IFS/OECD | consumer price index |
| LONG_INT | IFS/OECD | yield 10-year government bond |

Table A1: Data: sources and definitions

## Appendix B

| Parameter | Description | Range |
|---|---|---|
| $\beta$ | discount factor | $1.04^{-1/4}$ |
| $\sigma$ | risk aversion coefficient | [1,4] |
| $\phi$ | determines steady state level of hours | [0.6,0.8] |
| $1-\alpha$ | labor share | [0.6,0.8] |
| $z$ | steady state growth rate | [1.004,1.0055] |
| $\lambda_p$ | steady state markup | [0.0,0.25] |
| $\gamma$ | degree of price stickiness | [0.4,0.9] |
| $\rho_R$ | lagged interest rate coefficient | [0.2,0.9] |
| $\rho_\pi$ | inflation coefficient on interest rate rule | [1.1,5.0] |
| $\rho_x$ | output gap coefficient on interest rate rule | [0.0,1.0] |
| $\rho_{gy}$ | output growth coefficient on interest rate rule | [0.0,1.0] |
| $\varrho$ | persistence of shocks | [0,0.97] |

Table B1: Parameter ranges

## Appendix C

| Difference-in-differences regressions | | | | |
|---|---|---|---|---|
| $X_{post} - X_{pre} = a_0 + a_1 D + a_2 X_{pre} + e$ | | | | |
| $X_{post}$ : a country's statistic $X$ in the IT period | | | | |
| $X_{pre}$ : a country's statistic $X$ in the pre-IT period | | | | |
| $D$ : dummy variable which is one if a country adopted IT | | | | |
| *X measures/ coefficients* | $a_0$ | $a_1$ | $a_2$ | Adj. $R^2$ |
| PANEL I: Conditional on markup shocks, basic VAR | | | | |
| trade-off ratio | 1.62 (1.08) | -0.99 (1.17) | 0.92 (1.00) | -0.03 |
| Policy ratio | 0.79 (0.99) | -0.53 (0.89) | 0.46 (0.77) | -0.07 |
| Persistence $\pi$ | 1.41 (0.86) | -0.06 (0.04) | -1.57 (0.90) | 0.10 |
| Persistence $r$ | 1.26 (0.12) | -0.04 (0.015) | -1.36 (0.13) | 0.88 |
| PANEL II: Conditional on markup shocks, VAR with long term rates | | | | |
| trade-off ratio | 1.68 (0.83) | -1.06 (0.96) | 0.43 (0.70) | -0.03 |
| Policy ratio | 0.57 (1.08) | -0.45 (0.95) | 0.61 (0.85) | 0.10 |
| PANEL III: Conditional on supply shocks, basic VAR | | | | |
| trade-off ratio | 2.87 (1.03) | -1.05 (1.13) | 0.06 (0.46) | -0.08 |
| Policy ratio | 0.96 (1.81) | -1.02 (1.46) | 1.65 (1.37) | 0.05 |

Table C1: Difference in difference regressions (standard errors are in parenthesis).

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## Tables

| Country | pre-IT sample | IT sample |
|---|---|---|
| IT: | | |
| Australia | 1970:1-1994:3 | 1994:4-2007:1 |
| Canada | 1970:1-1993:4 | 1994:1-2007:1 |
| Finland | 1970:1-1993:4 | 1994:1-1998:4 |
| New Zealand | 1970:1-1992:4 | 1993:1-2007:1 |
| Sweden | 1970:1-1994:4 | 1995:1-2007:1 |
| UK | 1970:1-1992:4 | 1993:1-2007:1 |
| Non IT: | | |
| Austria | 1970:1-1993:4 | 1994:1-2007:1 |
| Belgium | 1980:1-1993:4 | 1994:1-2007:1 |
| France | 1970:1-1993:4 | 1994:1-2007:1 |
| Italy | 1971:1-1993:4 | 1994:1-2007:1 |
| Japan | 1970:1-1993:4 | 1994:1-2007:1 |
| Netherlands | 1970:1-1993:4 | 1994:1-2007:1 |
| Spain | 1977:1-1993:4 | 1994:1-2007:1 |
| US | 1970:1-1993:4 | 1994:1-2007:1 |

Table 1: Regime periods.

| Country | $v(y)^{preIT}$ | $v(y)^{IT}$ | $v(\pi)^{preIT}$ | $v(\pi)^{IT}$ | $\frac{v(y)^{preIT}}{v(\pi)^{preIT}}$ | $\frac{v(y)^{IT}}{v(\pi)^{IT}}$ |
|---|---|---|---|---|---|---|
| IT | | | | | | |
| Australia | 2.34 | 1.08 | 3.67 | 1.50 | 0.64 | 0.71 |
| Canada | 2.53 | 1.39 | 2.95 | 0.88 | 0.86 | 1.57 |
| Finland | 3.49 | 1.53 | 3.92 | 0.85 | 0.89 | 1.80 |
| New Zealand | 5.25 | 1.78 | 4.59 | 1.10 | 1.14 | 1.63 |
| Sweden | 3.64 | 1.82 | 2.78 | 1.02 | 1.31 | 1.79 |
| UK | 2.55 | 0.77 | 5.19 | 0.67 | 0.49 | 1.14 |
| Average | 3.30 | 1.40 | 3.85 | 1.00 | 0.89 | 1.44 |
| Non IT | | | | | | |
| Austria | 2.18 | 1.14 | 2.12 | 0.79 | 1.03 | 1.44 |
| Belgium | 1.47 | 0.74 | 2.21 | 0.51 | 0.66 | 1.47 |
| France | 1.63 | 1.07 | 3.58 | 0.60 | 0.45 | 1.80 |
| Italy | 2.56 | 1.30 | 5.08 | 1.05 | 0.50 | 1.23 |
| Japan | 2.30 | 1.64 | 4.76 | 0.81 | 0.48 | 2.03 |
| Netherlands | 2.27 | 1.40 | 2.99 | 0.79 | 0.76 | 1.77 |
| Spain | 2.06 | 1.01 | 4.27 | 0.92 | 0.48 | 1.10 |
| US | 3.45 | 1.52 | 2.34 | 0.56 | 1.47 | 2.69 |
| Average | 3.30 | 1.40 | 3.85 | 1.00 | 0.73 | 1.69 |

Table 2: Unconditional statistics

| Parameters | Ranges | Prob($\uparrow TOR$) |
|---|---|---|
| $\rho_{gy}$ | [0.2,1],0 | 87% |
| $\rho_x$ | [0.2,1],0 | 92% |
| $\rho_\pi$ | [1,5] | 96% |

Table 3: Parameter changes and probabilities of an increase in $TOR$.

| | $\widehat{g}_{yt}$ | $\hat{\pi}_t$ | $\widehat{r}_t$ | $\widehat{w}_t$ | $\widehat{w}_t - \widehat{lp}_t$ | $\widehat{y}_t$ | $\hat{x}_t$ |
|---|---|---|---|---|---|---|---|
| Markup | + | − | − | + | + | + | + |
| TFP | + | − | | | − | + | − |
| Labor Supply | + | − | − | − | | + | − |
| Preference | + | + | + | + | + | + | + |
| Monetary Policy | + | + | − | + | + | + | + |

Table 4: Sign restrictions.

| Country | pre-IT sample | | IT sample | |
|---|---|---|---|---|
| IT | $v(y)$ | $v(\pi)$ | $v(y)$ | $v(\pi)$ |
| Australia | 11.4 | 13.6 | 15.2 | 21.5 |
| Canada | 18.8 | 18.2 | 33.3 | 19.0 |
| Finland | 18.3 | 16.9 | 18.2 | 14.0 |
| New Zealand | 12.6 | 13.2 | 20.1 | 22.6 |
| Sweden | 11.7 | 16.7 | 13.2 | 32.4 |
| UK | 13.1 | 10.5 | 12.6 | 20.6 |
| Average | 14.3 | 14.8 | 18.7 | 21.7 |
| Non-IT | $v(y)$ | $v(\pi)$ | $v(y)$ | $v(\pi)$ |
| Austria | 19.1 | 21.2 | 13.9 | 22.5 |
| Belgium | 14.2 | 14.9 | 11.3 | 15.8 |
| France | 14.5 | 15.0 | 13.9 | 16.2 |
| Italy | 20.4 | 13.1 | 10.0 | 20.2 |
| Japan | 13.4 | 16.1 | 21.5 | 21.3 |
| Netherlands | 16.9 | 10.9 | 12.5 | 14.9 |
| Spain | 17.9 | 0.4 | 18.1 | 25.0 |
| US | 9.5 | 8.4 | 18.1 | 13.6 |
| Average | 15.7 | 14.9 | 14.9 | 18.7 |

Table 5: Variance decomposition

| Country | pre-IT | IT | pre-IT | IT | pre-IT | IT | pre-IT | IT |
|---|---|---|---|---|---|---|---|---|
| *IT* | trade-off ratio | | policy ratio | | persistence $\pi$ | | persistence $r$ | |
| Australia | 0.32 | 0.34 | 1.05 | 0.18 | 0.93 | 0.89 | 0.91 | 0.91 |
| Canada | 0.64 | 4.10 | 0.94 | 2.31 | 0.97 | 0.72 | 0.94 | 0.87 |
| Finland | 0.83 | 4.32 | 0.39 | 1.06 | 0.97 | 0.82 | 0.90 | 0.91 |
| New Zealand | 0.50 | 1.50 | 0.60 | 1.33 | 0.92 | 0.87 | 0.89 | 0.86 |
| Sweden | 1.83 | 1.21 | 0.73 | 1.25 | 0.89 | 0.88 | 0.74 | 0.95 |
| UK | 0.26 | 0.71 | 0.24 | 1.21 | 0.92 | 0.75 | 0.86 | 0.94 |
| Average | 0.73 | 2.03 | 0.65 | 1.22 | 0.93 | 0.82 | 0.87 | 0.91 |
| Non-IT | trade-off ratio | | policy ratio | | persistence $\pi$ | | persistence $r$ | |
| Austria | 1.05 | 1.28 | 0.85 | 1.02 | 0.95 | 0.90 | 0.91 | 0.95 |
| Belgium | 0.35 | 2.42 | 0.85 | 1.18 | 0.95 | 0.78 | 0.92 | 0.91 |
| France | 0.15 | 2.36 | 0.47 | 2.03 | 0.98 | 0.89 | 0.94 | 0.91 |
| Italy | 0.41 | 1.10 | 0.58 | 4.15 | 0.94 | 0.94 | 0.88 | 0.97 |
| Japan | 0.23 | 4.78 | 0.32 | 0.23 | 0.93 | 0.76 | 0.89 | 0.89 |
| Netherlands | 1.00 | 2.65 | 1.93 | 1.23 | 0.97 | 0.91 | 0.90 | 0.94 |
| Spain | 0.73 | 0.86 | 1.29 | 2.23 | 0.96 | 0.87 | 0.79 | 0.96 |
| US | 2.14 | 9.21 | 2.27 | 6.85 | 0.97 | 0.93 | 0.88 | 0.96 |
| Average | 0.76 | 3.08 | 1.07 | 2.36 | 0.96 | 0.87 | 0.89 | 0.94 |

Table 6: Trade-off, policy ratios and persistence

| Country | pre-IT | IT | pre-IT | IT |
|---|---|---|---|---|
| *IT* | trade-off ratio | | policy ratio | |
| Australia | 0.46 | 0.58 | 1.28 | 0.28 |
| Canada | 0.94 | 3.85 | 1.11 | 4.36 |
| Finland | 1.11 | 6.55 | 0.44 | 2.49 |
| New Zealand | 1.03 | 2.58 | 0.83 | 1.80 |
| Sweden | 2.31 | 2.81 | 0.91 | 1.77 |
| UK | 0.34 | 1.06 | 0.26 | 1.74 |
| Average | 1.03 | 2.9 | 0.8 | 2.07 |
| Non-IT | trade-off ratio | | policy ratio | |
| Austria | 1.38 | 2.67 | 1.23 | 1.57 |
| Belgium | 0.42 | 4.18 | 0.83 | 1.80 |
| France | 0.28 | 2.79 | 0.58 | 4.31 |
| Italy | 4.35 | 7.35 | 1.35 | 8.37 |
| Japan | 0.29 | 6.58 | 0.33 | 0.35 |
| Netherlands | 1.89 | 3.66 | 1.69 | 1.25 |
| Spain | 0.68 | 1.06 | 0.81 | 4.00 |
| US | 3.37 | 8.04 | 2.25 | 10.2 |
| Average | 1.58 | 4.54 | 1.14 | 3.98 |

Table 7: trade-off and policy ratios / supply shock

| Country | pre-IT | IT | pre-IT | IT |
|---|---|---|---|---|
| *IT* | trade-off ratio | | policy ratio | |
| Australia | 0.41 | 0.40 | 1.13 | 0.17 |
| Canada | 0.73 | 3.65 | 0.97 | 2.36 |
| New Zealand | 0.61 | 2.31 | 0.64 | 1.41 |
| Sweden | 1.82 | 1.47 | 0.79 | 0.87 |
| UK | 0.21 | 0.75 | 0.20 | 1.66 |
| Average | 0.76 | 1.51 | 0.54 | 1.32 |
| *non-IT* | trade-off ratio | | policy ratio | |
| Austria | 1.06 | 1.42 | 0.99 | 0.94 |
| Belgium | 0.33 | 2.11 | 0.91 | 1.25 |
| France | 0.23 | 2.30 | 0.60 | 1.86 |
| Italy | 0.40 | 1.61 | 0.59 | 4.37 |
| Japan | 0.23 | 4.37 | 0.35 | 0.23 |
| Netherlands | 0.87 | 2.79 | 1.60 | 1.33 |
| Spain | 1.06 | 0.95 | 1.26 | 1.83 |
| US | 3.37 | 7.58 | 2.38 | 6.69 |
| Average | 0.84 | 2.89 | 1.08 | 2.31 |

Table 8: trade-off and policy ratios / inflation expectations

# Figures

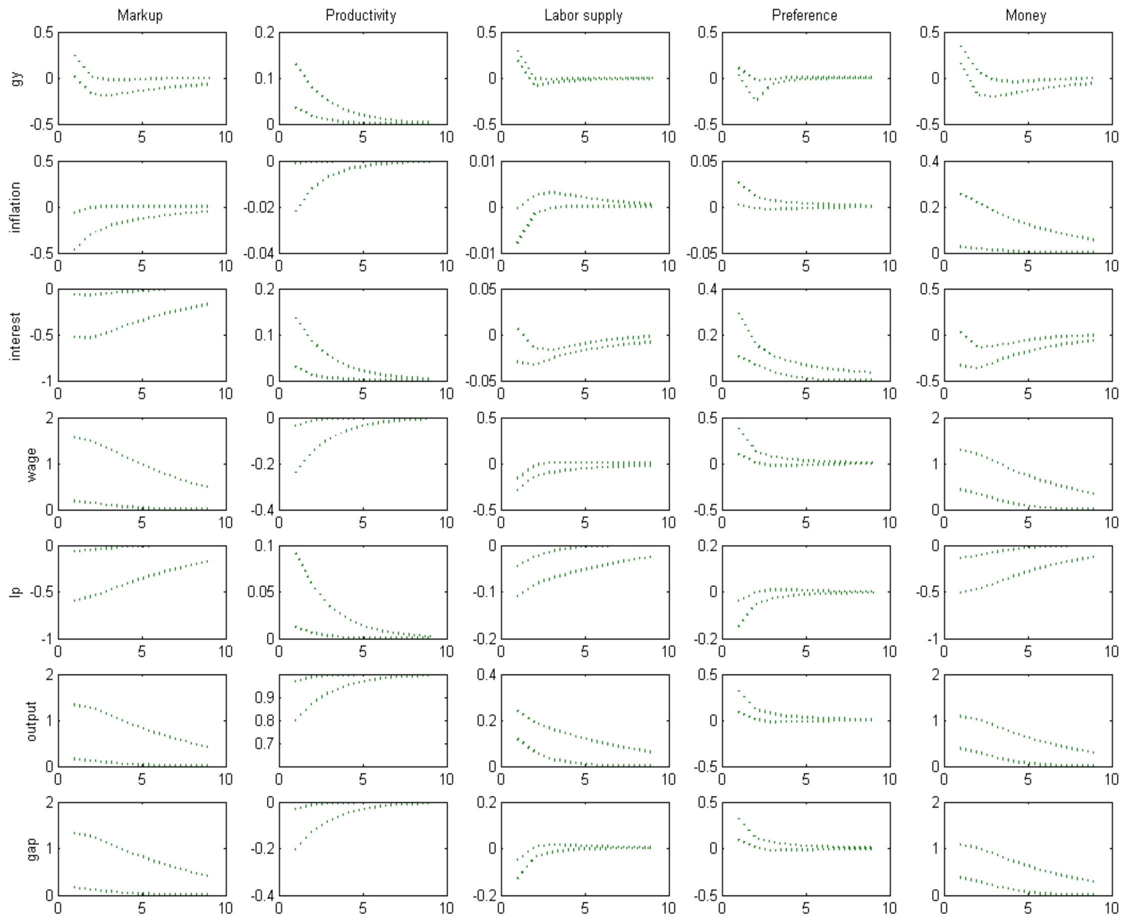


Figure 1: 68-percent confidence bands for the responses of the variables in response to markup (first column), a productivity (second column), a labor supply (third column), a preference (forth column) and a monetary policy shock (last column).