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MACROECONOMIC PERFORMANCE AND STRUCTURAL SHOCKS: A NON-PARAMETRIC APPROACH

ABSTRACT: Recently, frontier techniques have been utilised in the measurement of countries' macroeconomic performance by constructing a "production set" where the outputs are some macroeconomic indicators, while the inputs collapse to a unit scalar. In the present study, a different approach is proposed. The trade-off between the variability of inflation and of the level of activity (often defined as the Taylor Curve) is posited as the relevant policy frontier. This frontier is estimated through non-parametric techniques on a sample of 19 OECD countries during the 1960-2009 period. There seems to be a definite role for structural shocks, especially oil shocks, in shifting the variability trade-off. Some supply-side characteristics also seem to matter.

1 - Introduction

One of the hallmarks of economics is the concept of a trade-off. This also applies within the field of monetary policy. During the 1960s and early 1970s, many economists and policymakers believed a central bank could achieve permanently lower unemployment by accepting permanently higher inflation. Attempts to exploit such a trade-off to gain the benefits of lower unemployment were, however, self-defeating. As unemployment fell and inflation rose, individuals began to expect that inflation would be higher. Workers demanded more rapidly rising money wages to compensate for expected price increases, and firms were willing to agree to these wage demands as they expected to be able to pass through their increased costs by raising prices. Rather than remaining stable at a new higher level, the inflation rate continued to increase as long as unemployment remained below the economy's natural rate. Thus, experience has convinced most policymakers that no such trade-off exists.

This does not mean, however, that central banks do not face unemployment-inflation trade-offs as they implement monetary policy. Recent research in macroeconomics has increasingly focused on the trade-off between *the variability* of the level of activity and of the variability of inflation (see for instance Taylor, 1996, p. 186). Attempts to keep inflation within a very narrow band are supposed to increase fluctuations in real GDP and employment. Conversely, attempts to smooth business cycle fluctuations are believed to lead to wider fluctuations in inflation. Still, the precise nature of this trade-off, and even its actual existence, is a subject of debate among economists.[1] This paper discusses how new evidence can be brought to bear upon this issue, conforming to the following structure: in Section 2 we examine an analytical derivation of the variability trade-off, called the Taylor curve after J.B. Taylor. Section 3 surveys the existing evidence on the Taylor curve, which is based on econometric simulations. Section 4 examines the promise of a largely new approach to this issue, based on the estimation of a cross-country cross-period non-parametric frontier. In Section 5, this approach is implemented, and its results are discussed. Section 6 contains some concluding remarks.

2 – Deriving the variability trade-off: the Taylor curve

Following Taylor (1994), consider three equations summing up the relations among real GDP, nominal rate of interest and rate of inflation:

(2.1) $y_t = -\beta\,(i_t - \surd_t - r^*) + u_t$

(2.2) $\pi_t = \pi_{t-1} + \alpha\, y_{t-1} + e_t$

(2.3) $i_t = \pi_t + g\gamma_t + h\,(\pi_t - \pi^*) + r^f + v_t$

where y_t is GDP measured as percentage deviation from its potential level; i_t is the short-term nominal rate of interest measured as a percentage; π_t the rate of inflation measured in percentage points; e_t, v_t, u_t are zero-mean shocks. The model parameters are π^*, r^t, r^*, α, β, g, h.

The first equation describes the inverse relationship between the real rate of interest and the deviations of real GDP vis-à-vis its potential level. These deviations depend on aggregate demand fluctuations: consumption, investment and net exports are assumed to depend negatively on the real rate of interest. Notice that for simplicity the actual, not the expected, rate of inflation is included in (2.1). The random variable u_t is a shift factor representing, among other things, changes in government purchases. When GDP equals its potential level ($y_t = 0$), the real rate of interest equals r^*, which is then defined as the equilibrium real rate of interest. The second equation describes price adjustment:

[1] See Walsh (1998 , p. 2).

inflation rises (falls) with a lag when GDP is above (below) its potential level. There are various rationales for this nominal rigidity. The random variable e_t represents price shocks. The third equation represents monetary policy in terms of the reaction of the central bank to deviations of inflation from π^* and to deviations of real GDP from its potential level. The policy instrument of the central bank is the short-term nominal rate of interest. Variable r^f is the implicit real rate of interest in the reaction function of the central bank. The random variable v_t represents monetary shocks.[2]

The long-run values of real GDP, inflation and nominal rate of interest are found by setting to zero the rate of inflation and the random shocks. We get:

(2.4) $y \;=\; 0$

(2.5) $i \;=\; r^* + \pi$

(2.6) $\pi \;=\; \pi^* + (\, r^* \text{Ӈ}\, r^f \,) / h$

Equation (2.4) makes it clear that in the present model there is no long-run trade-off between the rate of inflation and the deviations of GDP from its potential level. Keeping in mind Okun's law, this implies that no long-run trade-off exists between the rates of inflation and unemployment. While it is certainly possible for potential GDP (or for the natural rate of unemployment) to be dependent on the rate of inflation, there is some strong evidence to the contrary and the structure of our model is meant to capture the spirit of these results.

In order to derive the trade-off between the variability of GDP deviations and the variability of inflation, first substitute (2.3) into (2.1):

(7) $y_t \;=\; -\, c(\pi_t - \pi^*) - (c/h)(r^f - r^*) + (u_t - \beta v_t)/(1 + \beta g)$

where $c = \beta h/(1 + \beta g)$. This expression simplifies if $r^f = r^*$. Then substitute equation (7) into (2.2). This yields:

(8) $\pi_t - \pi* \;=\; (1 - \alpha c)\,(\pi_{t-1} - \pi^*) - (\alpha c/h)\,(r^f - r^*) + \alpha\,(u_{t-1} - \beta v_{t-1})/(1 + \beta g) + e_t$

The variance of the rate of inflation can easily be obtained from (2.8), and from this the variance of GDP deviations can be obtained using (2.7). Now, suppose the aim of the central bank is to minimise the following quadratic loss function:

(2.9) $L \;=\; E\,[\, \text{≕}(\pi_t - \pi^T)^2 + (y_t)^2 \,]$

where π^T is the (exogenously determined) target rate of inflation and the other variables have already been defined. Central bank policy can now be treated as the solution to a

[2] Equation (3) could also be interpreted as the result of a monetary policy with a fixed growth rate of the money supply.

control problem where the level of the short-term nominal rate of interest must be chosen in order to minimise (2.9). Formally, the optimal policy reaction function is found by minimising (2.9) subject to the constraints imposed by the structure of the economy as described by (2.1)-(2.3). For a given structure of the economy, and a given ≑ this yields a point characterised by the combination of the minimum variances of inflation (around a given target rate) and of GDP (around its potential value). Repeating the same minimisation exercise under different values of ≑ we are able to trace a locus of these minimum-variance points, the policy efficiency frontier.

To get a more intuitive grasp of this frontier, note that there are three kinds of disturbances hitting the economy; the demand shocks u_t[3] and v_t, and the cost shock e_t. The demand shocks move GDP (relative to its potential level) and inflation in the same direction, while the cost shock moves GDP and inflation in opposite directions. A policy relying on the short-term nominal rate of interest is akin to a demand shock inasmuch as it can only move GDP and inflation in the same direction. Given a quadratic loss function and a linear structure of the economy, optimal policy is also represented by linear rules. In this case, the optimal policy response to demand shocks is to offset them one-for-one, meaning that the variances of GDP and inflation on the policy frontier are not affected by the variance of demand shocks. The same cannot be said for cost shocks. By moving GDP and inflation in opposite directions, they force central bank to face a trade-off. As a consequence, the optimal policy response to a cost shock cannot be of a one-for-one nature, and the variances of GDP and inflation on the policy frontier are affected by the variance of cost shocks.

In our simple example, the policy frontier can be found positing to zero both u_t and v_t. A variability trade-off easily obtains varying *c*, which depends on the policy parameters *h* and *g*. Monetary policy determines $-(1 + \beta g)/\beta h$, the slope of equation (2.7), the aggregate demand curve, through parameters *g* and *h*. A lower h or a higher g make the curve steeper, and vice versa. If the aggregate demand curve is steeper, then GDP deviations following a price shock are relatively smaller; if the curve is flatter GDP deviations following a price shock are larger. Clearly the variance of GDP

[3] A surprising feature of this kind of literature is that, within this literature, u_t also represents shocks affecting the potential GDP level (such as TFP shocks). Indeed, the impact of these shocks on the GDP gap can be fully negated through demand management. Hence they cannot be considered as a frontier shifter: their variance can change indefinitely without affecting the optimal policy point.

deviations is lower when the aggregate demand curve is steeper, that is when *h* is small and *g* is large. Fig. 1 depicts the variability trade-off.

Fig. 1

The variance[4] of the rate of inflation is on the vertical axis, while the variance of GDP deviations is on the horizontal axis. As short-term interest rates respond more to inflation, (larger *h*) and less to GDP deviations (smaller *g*), the aggregate demand curve gets flatter. Hence, the variance of GDP deviations increases and the variance of inflation decreases.[5] It also follows from this discussion that a change in the variance of cost shocks would shift the trade-off frontier; an increase in the volatility of energy prices, for example, would lead to more inflation *and* GDP variability.[6]

Following a string of extremely influential works by J.B. Taylor, this variability trade-off represents the new policy benchmark for central bankers. For example, Taylor (1993) has suggested that recent Fed behaviour is characterised by a rule relating the federal funds rate to movements in inflation and the output gap:

(2.10) $i_t = \pi_t + g\gamma_t + h(\pi_t - \pi^*)$

Using this rule for determining the funds rate, for given values for *g* and *h* and a given structure of the economy, one can find a point characterised by the combination of the minimum variances of inflation and GDP. By then changing the values for *g* and *h*, a trade-off emerges between the variances of inflation and GDP along the above described lines. In a similar manner, the frontier associated with a different rule for adjusting the funds rate, such as one that responds to nominal income movements, can be derived. The GDP-inflation variability trade-off for two hypothetical policy rules is illustrated in Fig. 2.

Fig. 2

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[4] Taylor actually measures variability through the standard deviations of inflation and GDP. Svensson (2002) argues convincingly that formulating the trade-off in terms of variances is analytically more convenient.

[5] From Fig. 1 it may seem that the variance of inflation is not influenced by changes in *g* or *h*. This is not true, however, because the policy rule chosen has an impact on the variance of inflation by affecting the speed at which GDP returns to its potential level.

[6] Note that, while in the present model only the ratio between *g* and *h* affects the variance trade-off, the absolute magnitudes of these parameters are also of high policy relevance. For instance, raising both *g* and *h* very high would probably not be a good policy, as it could result in large fluctuations in the rates of the interest.

The rule that produces the dashed trade-off frontier can be described as inefficient; for any given GDP variance, the policy rule that produces the solid line results in lower inflation variance. Once the efficient trade-off frontier has been found, policymakers then must weigh the relative costs of GDP variability versus inflation variability in choosing a point on the frontier. If inflation variability is viewed as more costly than GDP variability, a point such as A might be optimal, while point B would be optimal if the costs of GDP variability are assessed more highly. This two-step approach, finding the efficient frontier and then deciding which point to pick, is useful in separating two distinct aspects of policy choice. On the one hand, the structure of the economy and the nature of economic disturbances that affect it will define the efficient frontier. On the other hand, the factors that determine which point on the frontier to choose depend on an assessment of the relative costs of different forms of economic variability.

3 – Measuring the variability trade-off: the existing evidence

Much of our knowledge of variability trade-offs comes from simulations of models designed to mimic the behaviour of the major industrialised economies. These models incorporate realistic inflation and GDP adjustment so that they can be used to study the variability trade-off implied by different rules for conducting monetary policy. Fuhrer (1997), Ball (1999), Batini and Haldane (1999), Rudebusch and Svensson (1999) provide examples of this type of research, employing models of the US and of the UK economy. The evidence from simulations can be used to determine the nature of the volatility trade-off that arises under a particular policy rule and to evaluate alternative policy rules.

Now, the notion that focusing more on limiting fluctuations in real GDP will lead to more inflation variability is fairly intuitive. But does such a variability trade-off actually exist? Simulations of economic models reveal such a trade-off, but economists disagree about which model best captures the true behaviour of the economy, and these disagreements mean that there is no consensus about the true trade-off faced by policymakers. It is also difficult to find evidence of the trade-off in the data from actual economies. There are several reasons why the empirical evidence is inconclusive. The chief problem is that each point on the trade-off frontier is associated with a specific way of conducting monetary policy. If policy has been conducted in a stable and efficient fashion over several years, then the observed volatility of GDP and inflation would provide an observation on a single point on the trade-off frontier. Evidence on just a single point does not provide information on the entire trade-off frontier.

Among these studies, we will consider with particular attention the studies carried out by Cecchetti and his associates (Cecchetti, 1998; Cecchetti et al., 1999; Cecchetti and Ehrmann, 2000; Cecchetti et al., 2001) because of their simple and elegant structure and because of their (to some extent, deceptive) similarity with the endeavour here undertaken. Basically we will describe the analysis in Cecchetti et al. (2001), with some occasional references to the other works. In Cecchetti et al. (2001) a sample of 23 industrialised countries is taken into account for the 1980s and the 1990s. There has been a marked improvement in the macroeconomic conditions across these periods, in particular as far as inflation is concerned. From a mean rate of 10.82% in the 1980s these economies progressed in the 1990s to 3.41%.

The main aim of the analysis is to consider this change in macroeconomic performance and to attempt its decomposition in shifts of the policy frontier (associated to a change in the variance of cost shocks) and in efficiency changes (shifts vis-à-vis the frontier). To do so we start from the quadratic loss function already seen in Section 2:

(3.1) $L = E\,[\,\lambda(\pi_t - \pi^T)^2 + (1 - \lambda)\,(y_t)^2\,]$

Indeed, to measure macroeconomic performance we must compute the loss associated to a given performance point on the frontier, and to do so we need an estimate of the parameter λ. The following procedure is adopted in order to get it:

Fig. 3

To any given performance point, we associate the optimal GDP and inflation variances found at the intersection of the policy frontier with a ray going from the origin to the performance point itself. We thus assume that the parameter λ characterising any given performance point is the slope of the policy frontier in correspondence of this intersection. Now macroeconomic performance P_i is given by the observed GDP and inflation variances weighted by this particular λ, denoted λ_i:

(3.2) $P_i = E\,[\,\lambda_i(\pi_t - \pi^T)^2 + (1 - \lambda_i)\,(y_t)^2\,]$

Subsequently, the variation in macroeconomic performance, ΔP_{it}, is defined as P_{it}.- P_{it-1}. Obviously, $\Delta P_{it} > 0$ stands for an improvement in macroeconomic performance. This improvement can be brought about either by a shift toward the frontier, or by a shift of the frontier, or by a combination of both these movements. Shifts of the frontier, that are one and the same thing as cost shocks, are given by:

$$(3.3)\ S_i = E\,[\lambda(\pi^*_t - \pi^T)^2 + (1-\lambda)\,(y^*_t)^2\,]$$

where π^*_t and y^*_t denote the values of inflation and GDP subsequent to the cost shocks. Hence, $\Delta S_{it} = S_{it}$.- S_{it-1} is the measure used to quantify the variations of cost shocks.

Now, the country's macroeconomic efficiency can be defined comparing actual performance with the optimal variance point. Indeed, macroeconomic *in*efficiency is defined as:

$$(3.4)\ I_i = P_i - S_i$$

Naturally, $\Delta I_{it} = I_{it} - I_{it-1}$ measures the variations of inefficiency; if $\Delta I_{it}>0$ the country's macroeconomic efficiency improves, and vice versa. The proportion in the changes in performance that can be accounted for by changes in policy can now be written as:

$$(3.5)\ Q_{it} = \Delta I_{it} / \Delta P_{it}$$

A value of $Q_{it} > 0$ stands for an improvement in policy efficiency and vice versa..

In order to implement these measures, a small macro dynamic model is estimated over the two periods 1982-89 and 1990-97. This model comprises an aggregate demand and an aggregate supply curve, which are estimated through OLS country by country. Using these estimates and an unrestricted policy reaction function (with the rate of interest as the policy instrument) a performance point and an optimal frontier point can be singled for each country in a given period.

More formally, we suppose that the central bank selects the rate of interest i_t that minimises the loss function (3.1), subject to the structure of the economy as described by:

$$(3.6)\ Y_t = BY_{t-1} + ci_{t-1} + DX_{t-1} + v_t$$

The quadratic nature of the problem ensures the linearity of the solution:

(3.7) i_t = ì Y_t Ǵ ŋ

where ì is the vector of the coefficiencts representing the reaction of the monetary authority to changes in GDP and inflation, while ŋ is a constant term depending on B, c, D and the target values of inflation (and eventually GDP). The control problem is solved finding ì from:

(3.8) ìTHFc HcfHM c HB ,

H= λGFBGcìf HFBGcìf

Following this procedure for a given ≑ yields an optimal variance point. By varying ≑ a whole policy frontier can be traced, and measures P_i, S_i and I_i obtained along the above described lines.

The empirical results reveal that all countries, with the exception of Germany, Austria and Sweden, had significant improvements in economic performance. Also, in 20 out of the 23 countries under examination, policy efficiency has improved (see Table 3.1). The results indeed suggest that a higher efficiency has been more important than the reduced variance of cost shocks in order to achieve macroeconomic performance.

4 – Measuring the variability trade-off: a new tack?

One way around the estimation problem illustrated in the previous section is to look at the experiences of many different countries. If countries have similar economic structures, have faced similar disturbances, and have operated on the efficient frontier, but have differed in the choices policymakers have made between GDP and inflation stability, then historical patterns of different countries would provide evidence on the GDP and inflation variability trade-off. Unfortunately, actual economies have different economic structures, have experienced different disturbances, and have conducted policy in different ways. Thus, it is difficult to identify a variability trade-off using the historical experiences of a cross-section of countries.

Yet, consider the following research strategy. In recent years, some attention has been paid to the utilisation of frontier techniques to the measurement of countries' macroeconomic performance throughout a given period. In all these works (see for instance Lovell, 1995; or Lovell *et al*., 1995), performance is assessed by constructing a "production set", where the outputs are basically some indicators of growth (or GDP per capita), price stability, employment, and trade balance, while the inputs are the services provided by the countries' helmsmen (implying under some simple assumptions that the input vector collapses to a scalar of value one for every country in every year). Then, efficiency measures are computed through some non-parametric techniques such as FDH or DEA. Some obvious improvements on this kind of analysis would be basing the choice of outputs on a proper economic model, and relying on a more articulate inputs-set than the simple representation given above of the helmsman's services. There are some reasons to believe that applying frontier analysis to the estimation of the Taylor curve seems to be able to provide the required improvements. The trade-off involves two well-defined magnitudes that are positive by definition (and thus amenable to the province of production analysis). There is a lively ongoing debate suggesting plenty of articulate specifications of the helmsman's services. In order to supersede the simple representation of inputs as the services provided by the countries' helmsmen, one could rely on the indicators of governance suggested by the recent theoretical and empirical literatures on the labour market (Layard *et al.*, 1991; Layard and Nickell, 1999; Blanchard and Wolfers, 2000). Furthermore, it seems that frontier are ideally suited to answer to the following kind of questions that have been recently asked within the debate on the Taylor curve (Cecchetti *et al.*, 2001) : is there an improvement in the trade-off? Has the frontier shifted or has monetary policy become more efficient?

More precisely, the empirical strategy proposed here is that in order to gauge the existence of a cross-country Taylor curve, frontier analysis is applied to a production set where the variability of inflation and the level of activity are taken as inputs (they are "bads"), and various indicators of cost-shocks, supply-side structures, and policy stance are considered as outputs (perhaps it would be better to say shifters). The policy frontier is to be estimated through non-parametric techniques: these techniques easily allow to deal with a multi-input multi-output set-up, do not incur in any simultaneity problems, and do not make any restrictive assumption about functional form (and then on the eventual interactions between the target variables and their exogenous determinants). Also, the non-parametric approach, easily allows for high behavioural heterogeneity (that is, in the trade-off) across time and countries. The main drawback of the approach is that it is difficult to allow for the stochastic noise in the data. Within the non-parametric approach, DEA is to be preferred,[7] since we are highly interested in calculating shadow prices. Indeed, these shadow prices allow to assess empirically which is the relative weight policymakers put upon the variability of inflation and of the level of activity. A graphical illustration of the DEA approach is provided in Fig. 4.

[7] A very recent and complete introduction to DEA is given in Cooper *et al.* (2000).

Formally, the postulates utilised to build the production possibility set $Z_{BCC}(Z^\circ)$ are:

1. strong free input and output disposal;
2. convexity:

$$\forall (\mathbf{x}_i, \mathbf{y}_i) \text{ e } (\mathbf{x}_j, \mathbf{y}_j) \in Z_{BCC}(Z^\circ),$$

$$\forall\ 0 \le \lambda \le 1, \quad \begin{pmatrix} \mathbf{x} \\ \mathbf{y} \end{pmatrix} = \lambda \begin{pmatrix} \mathbf{x}_i \\ \mathbf{y}_i \end{pmatrix} + (1-\lambda) \begin{pmatrix} \mathbf{x}_j \\ \mathbf{y}_j \end{pmatrix} \in Z_{BCC}(Z^\circ)$$

3. the vector $\mathbf{0} \in Z_{BCC}(Z^\circ)$.

The production possibility set is defined by:

$$\hat{Z}_{DEA-V}(Z^\circ) = \{(x,y) \in R^{N+M} :$$
$$y \le \sum_{j=1}^{N} \gamma_j y_j ;\ x \ge \sum_{j=1}^{N} \gamma_j x_j ;\ \sum_{j=1}^{N} \gamma_j = 1;\ \gamma_j \ge 0,\ j = 1,\ldots,N \}$$

and its frontier is characterised by variable returns to scale. The *input-saving* efficiency measure DF_I of the i-th observation, λ_i, is obtained from the *input-oriented* model BCC_P-I):[8]

BCC_P-I (x_i, y_i):

$$\min_{\lambda_i,\, \gamma_j} \lambda_i$$

s.t.

$$y_{mi} \le \sum_j \gamma_j\, y_{mj}, \qquad m = 1, ..., M$$

$$\lambda_i x_{ki} \ge \sum_j \gamma_j\, x_{kj}, \qquad k = 1, ..., K$$

$$\lambda_i \ge 0, \quad \sum_j \gamma_j = 1, \quad j = 1, ..., N$$

Usually, observations are dominated by convex combinations of efficient observations situated on the frontier. The identification problem has been above formulated in its *envelopment form*. The dual expression, the *multiplier form*, is:

[8] Formally, an output-oriented model can be set up, and output-increasing efficiency measures obtained. However, in the present context we need be interested only in the input-oriented model.

$$
\begin{aligned}
& BCC_D^I\,(x_i\,, y_i\,): \\
& \max_{\mu_i, \nu_i, \omega_i} \; \mu_i y_i - \omega_i \\
& \nu_i x_i = 1 \\
& \mu_i y_i - \nu_i x_i - \omega_i \leq 0 \\
& \mu_i \geq 0, \nu_i \geq 0
\end{aligned}
$$

providing information on the shadow prices ν and μ, the ratios among the latter are the input and output marginal rates of substitution.

5 – The empirical analysis

We first describe our data-set, then the way in which DEA has been adapted to this rather unusual field of application. Finally we provide a description of our results.

5.a) The data and the estimation strategy

To repeat, in order to gauge the existence of a cross-country Taylor curve, frontier analysis is applied to a production set where the variability of inflation and the level of activity are taken as inputs (they are "bads"), and various indicators of cost-shocks, supply-side structures, and policy stance are considered as outputs (perhaps it would be better to say shifters). The empirical application here provided relates to the measurement of macroeconomic performance during the 1960-2009 period in a sample of 19 OECD countries (data are mainly taken from the OECD database).

As said above, usual methods provide evidence on just a single point of the entire trade-off frontier. One way around this problem is to look at the experiences of many different countries controlling for their different economic structures and disturbances. Accordingly, the "production set" should be conditioned on all these factors. Furthermore, as we want to rely on a DEA non-parametric approach, a battery of Banker tests can be used to assess their relative significance of the conditioning factors (Banker, 1996).

Series for the variance of inflation (CPI and GDP deflator) and of the level of activity (Hodrick-Prescott output gap and rate of unemployment) are taken from the OECD database for 19 OECD countries over the 1960-2009 period. Series for the cost-shocks are provided by the variance of the real oil prices weighted by oil import shares, and of the labour demand shift indicator suggested in Blanchard and Wolfers (2000). Variances are calculated on annual data over eight sub-samples, each one of them five-year long. Indicators of supply-side structure, taken from various sources, are available over the same sub-samples. We use a pooled sample: we must pool together the eight sub-samples, to reach a number of observations (allowing for some missing values, equal to 137), that makes inference reasonably sound. Hence, no dynamic (Malmquist) analysis will be possible, but changes in the "state of technology" can be tested through the significance of time (either pulse or shift) dummies.

5.b) The results

We take a baseline specification (variance of *inflation* and of *GDP gap* as inputs, the variance of the *real oil prices* and of the *labour demand shift* as shifters). The significance of various other shifters (indicators of supply-side structure) is assessed against this baseline model.

Table 5.1

There is a clear role for cost-shocks, and for some supply-side characteristics in shifting the variability trade-off; systematic policy stance is much less of an influence.

It turns out that the preferred specification includes as shifters (beside the variance of real oil prices and of the labour demand shift), the Employment Protection Index and an index of ownership occupation (both variables are believed to be related with the persistence of shocks). What about having some further information on the performance of single countries? Consider Tab. 5.2, where we give the average efficiency scores throughout the whole period:

Table 5.2

From Tab. 5.2, it can be clearly seen that the policy performance of countries such as Ireland, Italy and Spain, which perform very badly as far as EPI and labour mobility are concerned, improves a lot once full allowance is made for this handicap.

Once proper allowance is made for cost-shocks and for supply-side characteristics in shifting the variability trade-off, measures for the following indicators are provided:

λ the relative shadow prices of inflation variance

Δ TE = percentage changes of efficiency scores

Δ P = percentage changes of macro performance, measured as

$$P = -\left[\lambda \, \mathrm{var}(\pi_t) + \mathrm{var}(y_t)\right]$$

TC = the frontier shifts, measured as Δ P - Δ TE.

Median values for these indicators are shown in Tab. 5.3.

Table 5.3

Throughout the period under consideration, countries appear to have become slightly more efficient (on average), but their performance on the whole has worsened, because the frontier has shifted upwards. The latter phenomenon is easily explained through Tab. 5.4, where we provide mean values for the cost-shock variances. Also, the (median) relative shadow price of the var. of inflation has risen vis-à-vis the values taken in the 1970s, well in agreement with various kinds of evidence on the matter.

Table 5.4

Now, what about assessing the recent move of some countries to Inflation Targeting, as well as the inception of the EMU? About the role of the EMU, consider in Tab. 5.5 the medians of the percentage changes in efficiency scores and λ for EMU and non-EMU countries (from 1980-85 onwards):

Table 5.5

It turns out that countries within and outside the EMU have shown similar preferences for inflation vis-à-vis GDP variance. Yet, their macro policy efficiency has been remarkably better. Further research will try to elucidate whether the source of this better performance mainly lies in more accurate demand management or in the insulation from demand shocks.

About Inflation Targeting, consider in Tab. 5.6 the medians of the percentage changes in efficiency scores and ≓for targeting and non-targeting countries (from 1985-90 onwards):

Table 5.6

Here, a behavioural difference emerges: Inflation Targeting countries have stuck more solidly to the shift in preferences (toward more stable inflation) materialising at the outset of the 1980s. Yet, their macro policy efficiency has not significantly been affected by this move. On the other hand, it seems that non-Targeting countries have taken advantage of their greater freedom, achieving a better policy performance. On this matter too, further research is needed.

6 – Concluding remarks

The trade-off between the variability of inflation and of the level of activity (often defined as the Taylor Curve) is posited in the present paper as the relevant policy frontier. This frontier is estimated through non-parametric techniques on a sample of 19 OECD countries during the 1960-2009 period. A definite role emerges for cost-shocks, as well as for some supply-side characteristics, in shifting the variability trade-off. Also, the relative shadow price of the variance of inflation is higher in recent years, well in agreement with various kinds of evidence. Countries appear to have become slightly more efficient on average, but their performance has worsened, because the frontier has shifted upwards.

Evaluating alternative policies in terms of their implications for the trade-off between GDP volatility and inflation volatility offers useful insights into some recent monetary policy debates. For example, the widely held consensus that monetary policy cannot have permanent effects on the level of the unemployment rate or the rate of real economic growth has led some to advocate that central banks focus only on maintaining low inflation. Now, many economists would argue that a single-minded focus on maintaining inflation within a very narrow band may lead to undesired real economic fluctuations. And conversely, attempts to smooth real fluctuations too actively will lead to excessively volatile inflation.

The variability trade-off is also important for those countries that have moved to an inflation targeting policy regime since it is critical for determining the appropriate width of the inflation target. New Zealand, for example, initially defined its inflation target as 0 - 2% inflation. In 1997, however, this was widened to 0 - 3%. The Bank of England has a target inflation band of plus or minus 1% around its target of 2.5% inflation. The output-inflation variability trade-off is one of the key factors in determining the effects of changing the width of the inflation band. If the trade-off frontier is steep, for example, then reducing the variability of inflation causes little increase in GDP variability. In this case, a narrow target inflation band would be appropriate. A recognition of the variability trade-off shifts the focus from the level of inflation (which should be low) to questions of how wide the target band should be.

In future work, more recent data are to be constructed and used: this relates to other indicators of supply-side structure and of policy stance, as well as of nominal inertia. A deeper assessment of the recent move of some countries to inflation targeting, as well as of the inception of the EMU, is also highly needed.

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Fig. 1 - The GDP-inflation variability trade-off

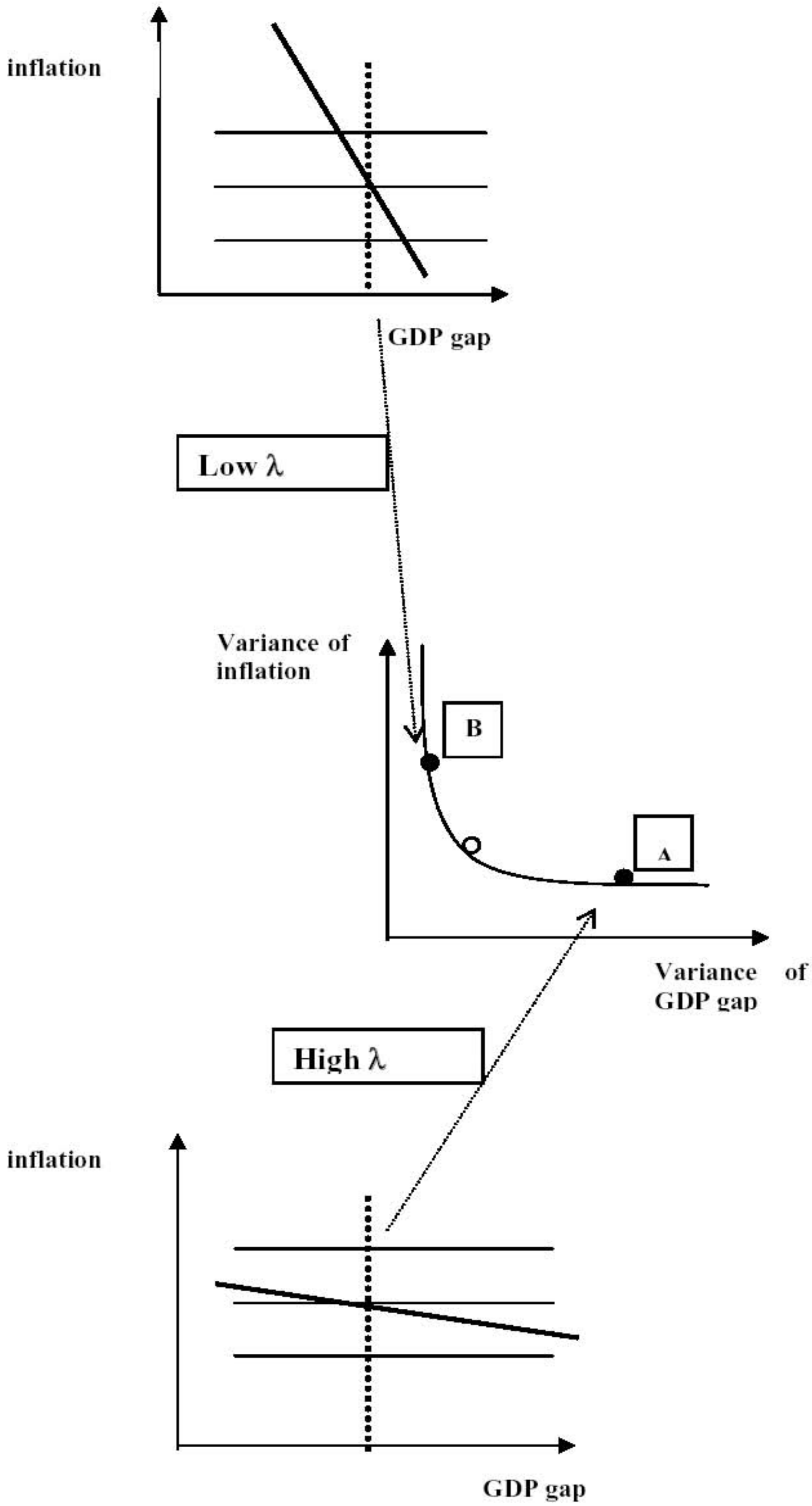


Fig. 2 - The variability trade-off for two hypothetical policy rules

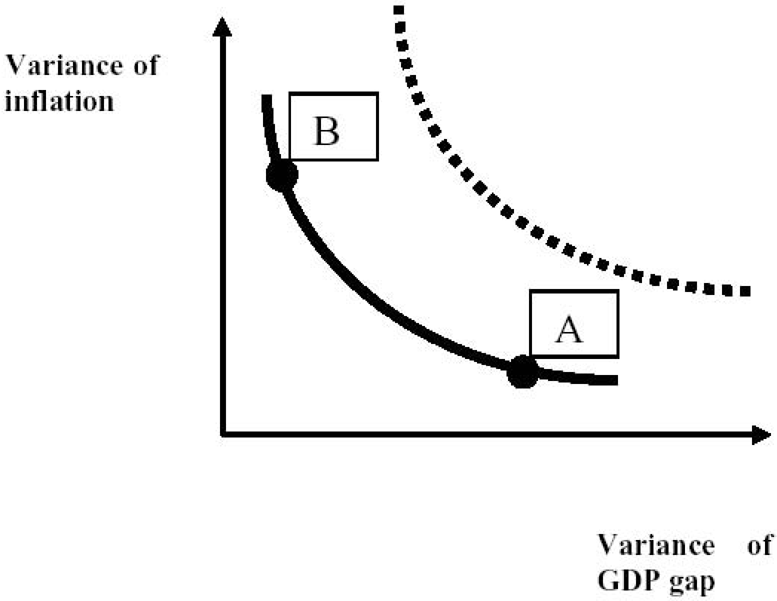


Fig. 3 - Estimating the parameter λ from revealed preferences

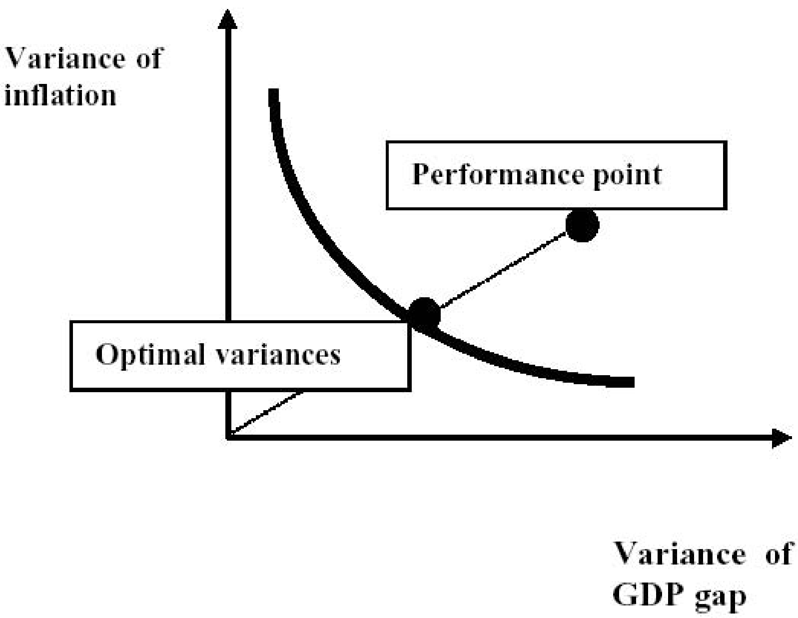
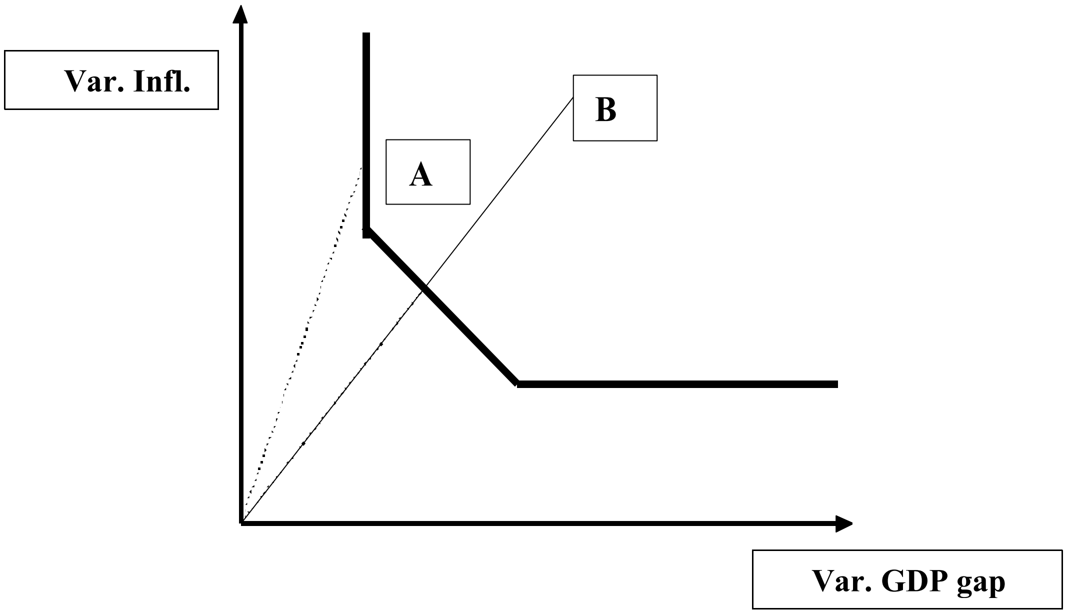


Fig. 4


Var. Infl.
B
A
Var. GDP gap

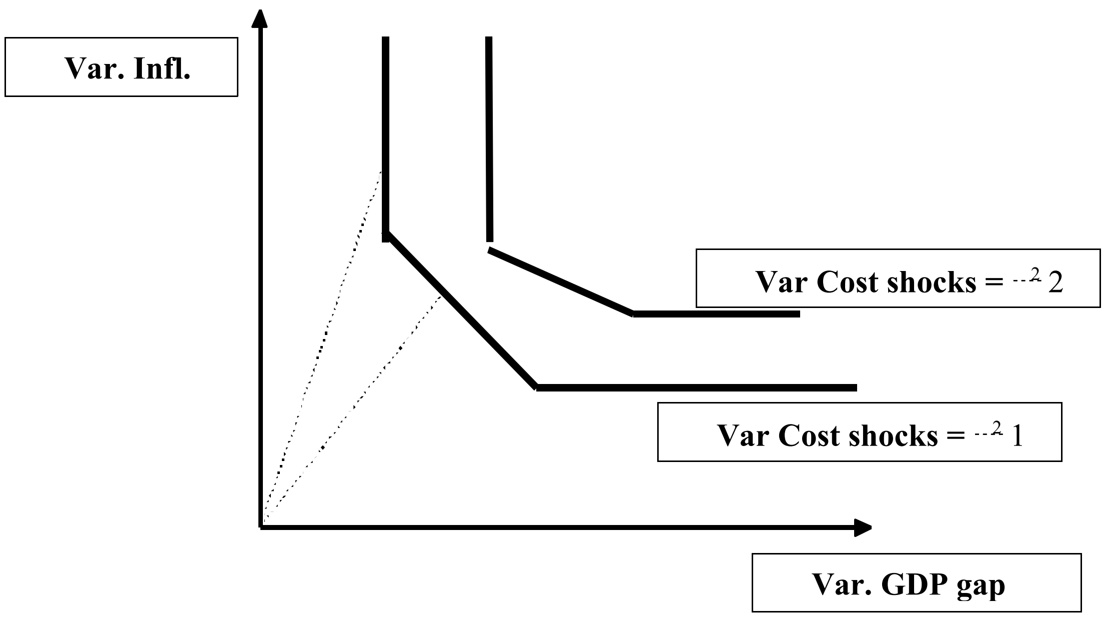

Var. Infl.
Var Cost shocks = --^{2} 2
Var Cost shocks = --^{2} 1
Var. GDP gap

TABLE 3.1

Paesi	àE	àP	àS	Q = àE / |àP|
A: paesi con miglioramenti della performance				
Corea	0.1055	0.0766	0.0289	**1.377**
Portogallo	0.5162	0.4753	0.0410	**1.086**
Canada	0.0883	0.0844	0.0039	**1.047**
Cile	0.8772	0.9574	-0.0802	**0.916**
Australia	0.3140	0.3439	-0.0300	**0.913**
Olanda	0.0329	0.0373	-0.0044	**0.882**
Spagna	0.4185	0.4907	-0.0722	**0.853**
Israele	12.8470	15.1654	-2.3183	**0.847**
Belgio	0.1028	0.1235	-0.0280	**0.832**
Messico	5.3632	6.4874	-1.1242	**0.827**
Francia	0.2511	0.3241	-0.0730	**0.775**
Danimarca	0.1327	0.1747	-0.0420	**0.760**
Irlanda	0.2626	0.3572	-0.0946	**0.735**
Nuova Zelanda	0.4646	0.7331	-0.2685	**0.634**
Italia	0.3788	0.6593	-0.2806	**0.574**
Stati Uniti	0.0166	0.0323	-0.0156	**0.516**
Regno Unito	0.0125	0.0259	-0.0133	**0.484**
Finlandia	0.0448	0.2140	-0.1692	**0.209**
Svizzera	-0.0190	0.0337	-0.0526	**-0.564**
Giappone	-0.0254	0.0032	-0.0286	**-7.813**
B: paesi con perdita della performance				
Svezia	0.1535	-0.0013	0.1548	**119.870**
Austria	0.0058	-0.0088	0.0146	**0.665**
Germania	-0.0180	-0.0232	0.0052	**-0.777**

Q= contributo della politica al cambiamento della performance

TABLE 5.1

RESTRICTED MODEL	UNRESTRICTED MODEL	***K-S Test (P-value)***
Baseline	Baseline+shocks	***0.000***
Baseline+shocks	B+s+Central Bank Independence (*Franzese*)	*0.318*
Baseline+shocks	B+s+Central Bank Independence (*Cukierman*)	*0.153*
Baseline+shocks	B+s+Employer-Union Coordination (*Nickell*)	***0.018***
Baseline+shocks	B+s+Corporatism (*Tarantelli*)	*0.256*
Baseline+shocks	B+s+Employment Protection index (*OECD*)	*0.318*
Baseline+shocks	B+s+Union Density (*Nickell*)	*0.153*
Baseline+shocks	B+s+Ownership Occupation (*Oswald*)	***0.028***
Baseline+shocks	B+s+Wage Rigidity(*Nickell*)	*0.380*

TABLE 5.2

Production set	**Baseline**	**Baseline plus shocks**
Av. Eff. Scores	**0.42**	**0.63**
Australia	0.37	0.64
Austria	0.55	0.66
Belgium	0.45	0.59
Canada	0.30	0.37
Denmark	0.48	0.52
Finland	0.29	0.36
France	0.56	0.63
Germany	0.59	0.67
Ireland	0.12	0.79
Italy	0.27	0.88
Japan	0.49	0.64
Netherlands	0.52	0.65
Norway	0.57	0.71
New Zealand	0.52	0.73
Spain	0.26	0.92
Sweden	0.28	0.52
Switzerland	0.68	0.68
UK	0.27	0.31
USA	0.58	0.72

TABLE 5.3

	àεã (median)	εC (median)	àP (median)
1960-65	0.00	-0.08	-0.08
1965-70	-0.05	0.38	0.33
1970-75	0.54	-0.93	-0.39
1975-80	-0.60	0.01	-0.59
1980-85	0.19	0.27	0.46
1985-90	-0.11	-1.13	-1.24
1990-95	0.08	1.00	1.08
SUM	0.05	-0.47	-0.42

TABLE 5.4

	variance Oil prices	variance Labour demand shift	λ (median)
1960	0.16	0.99	3.06
1965	0.27	2.28	0.85
1970	176.11	2.89	0.08
1975	221.68	2.73	0.25
1980	124.01	2.25	0.84
1985	78.50	2.51	2.92
1990	23.21	2.63	3.44
1995	10.38	2.04	2.32

TABLE 5.5

	à TE	à lambda
EMU	**0.11**	**-0.11**
Non-EMU	**-0.08**	**-0.08**

TABLE 5.6

	à TE	à lambda
Targeting	**0.00**	**-0.04**
Non-targeting	**0.20**	**-0.22**