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Abstract

This paper looks at the long term output effect of those monetary policies aimed at reducing inflation from its peak by the late seventies, in nine major OECD countries. The estimated effect depends on the way nominal shocks are identified. Alternatively to the cross-country regression analysis we estimate a Structural VAR model in output, inflation and unemployment. In this model some assumptions turn out to be of crucial importance: inflation is primarily, though not exclusively, a monetary phenomenon and neither permanent inflation nor the natural rate of unemployment are affected by productivity shocks. Under this identification scheme we find that permanent disinflations achieved by means of permanent reductions in money growth display a short-run Phillips curve pattern, but take most economies in our sample onto a higher level of steady state output.

Keywords: Disinflation, monetary shocks, stuctural VAR.
JEL classification: E31, E58, O4.

1. INTRODUCTION

After years of price stability in the industrialized world during most of the postwar era, by the early seventies inflation rates were on the rise. The mismanagement of monetary policies, due to an imperfect understanding of the mechanics of inflation (Clarida, Gali and Gertler, 1997) and the lose of confidence on the institutions of the international monetary system were at the root of these moderate inflationary episodes. After the first oil shock the monetary authorities did not react with tight monetary policies and things went from bad to worse: inflation rates reached by the late seventies historical levels while output growth rates fell and unemployment started to rise. In the last two decades, economic authorities all over the industrialized world have encouraged a major change in the way monetary policies are conducted and price stability has become the main aim of modern central banking. This process is by no means costless since a firm commitment to low and stable inflation reduces the room of manoeuvre of central banks to hinder the effect of some temporary shocks on unemployment. The conventional wisdom among monetary policy makers is that reducing inflation may generate a recession in the short run, but it pays-off in terms of higher output over the long run.

Sound monetary policies have been the key to reduce inflation to its current level. That the disinflation ***might be***, to some extent, responsible for the currently high level of unemployment in some countries can hardly be denied either. The question is whether the monetary policies followed during the nineties can also claim responsibility for higher output today. If they can, such monetary strategy can be considered successful, both on nominal and real grounds, at least from the perspective of agents with moderate discount rates. Otherwise, it would be difficult to justify tight monetary strategies as welfare improving policies.

The aim of this paper is to provide an answer for this question focusing on the disinflationary experience of nine countries (*C9* thereafter): United States, Canada, Japan, Italy, France, United Kingdom, Germany, Australia and Spain. Since our aim is to focus in the recent disinflation experience the sample period is 1972:2-

1996:3[1]; this is also the longest period for which homogeneous unemployment, GDP and inflation series are available for this group of countries. The task of encompassing, within a unified theoretical framework, the channels through which monetary policy operates in the short run and in the long run is beyond the scope of this paper and thus our approach is mostly empirical[2]. Our aim is to identify the nominal or monetary sources of permanent inflation and then look at how these affect output in the long run. This has been attempted by Bullard and Keating (1995), but our identification scheme differs from theirs as for the long-run determinants of inflation. We find that unemployment dynamics plays a crucial role as to separate out the nominal and real sources of inflation and output. To that end, we follow Blanchard and Quah (1989) and Shapiro and Watson (1988) and identify these shocks by imposing some long-run restrictions in a small structural vector autoregressive model (SVAR) including inflation, output and unemployment. This identification scheme is discussed in section 2, within the framework of a simple model. In section 3 we estimate the long-run effect on output and unemployment of a permanent nominal disinflation and provide an interpretation of the results. Section 4 concludes with some additional remarks.

2. IDENTIFYING THE LONG-RUN EFFECTS OF INFLATION: A SVAR APPROACH

2.1. The basic model

In the context of models of economic growth, even anticipated inflation may reduce the rate of return of capital because of the non-neutralities built-in most

[1] On the grounds of homogeneous data availability, we use data of West Germany (1972:2-1994:4) instead of Germany, and the sample period is also different for Spain and Italy (1976:3-1996:3 and 1972:2-1995:3, respectively).

[2] Actually, as recently stated by Solow (1997): "One major weakness in the core of macroeconomics... is the lack of real coupling between the short-run picture and the long-run picture".

industrialized countries tax systems (Jones and Manuelli (1995), Feldstein (1997)) or because the way bank regulations interact with monetary policies (Chari, Jones and Manuelli (1995))[3]. This is known as the *accumulation or investment effect* of inflation on growth. But inflation may also reduce the efficiency with which productive factors are used (*efficiency effect*). A high level of inflation induces frequent changes in prices which may be costly for firms (*menu costs*) and reduces the optimal level of cash-holdings by consumers (*shoe-leather costs*). It also leads to bigger forecast errors thus encouraging economic agents to spend more time and resources in gathering information, endangering the efficient allocation of resources.

The empirical relevance of these effects has been tested within the framework of cross-country convergence regressions augmented by the inflation rate. In his pioneering work, Barro (1995) estimates a negative long-run correlation between inflation and growth, using a large sample of countries. Although the author shows that this correlation survives when the prior colonial status of each country is used as instrument, still many authors claim that since both inflation and output are endogenous variables their correlation might be simply reflecting the incidence of non-monetary shocks, for instance technology shocks, affecting both variables in an opposite manner[4]. Barro (1996) and Gylfasson and Herbertsson (1996) find that controlling for random effects in cross-country regressions does not significantly alter the dynamic relationship among these two variables. Andrés and Hernando (1997) narrow their analysis to the OECD sample carefully looking at the issue of endogeneity in a number of ways[5]. They conclude that inflation causes income in the Granger sense and also that the negative correlation is robust to a number of

(3) See, for instance, Orphanides and Solow (1990) and De Gregorio (1993).

(4) See Kocherlakota (1996) and Sims (1996), among others.

(5) These authors also show that the estimated negative correlation among inflation and output is not explained by the presence of high inflation countries in the sample.

changes in the sample and of improvements in the econometric specification such as the possibility of idiosyncratic fixed effects[(6)].

No matter how elaborated they might be, cross-country convergence regressions do not fully settle the issue of endogeneity in the correlation among inflation and growth. This issue is of crucial importance to assess the beneficial effects of sound monetary policies. The argument goes as follows. Let us assume that output and inflation are non stationary variables whose unit roots can be explained by J orthogonal shocks $\{\varepsilon^j\}$,

$$\pi_t = \pi[b_1(L)\epsilon^1,\ b_2(L)\epsilon^2,\ b_3(L)\epsilon^3,\ldots.]$$

$$y_t = y[d_1(L)\epsilon^1,\ d_2(L)\epsilon^2,\ d_3(L)\epsilon^3,\ldots.]$$

If ε^1 represents money growth, the estimated long-run correlation among inflation and income is relevant for the monetary authority if,

$$Corr(\pi(b_1(1)\epsilon^1),\ y(d_1(1)\epsilon^1)) < 0$$

which, in turn, requires as a necessary condition that,

$$d_1(1)\epsilon^1 \neq 0$$

where ***b(1)*** and ***d(1)*** represent the long-run multipliers of ***d(L)*** and ***b(L)*** respectively. Alternatively, the critics' argument goes, the negative correlation estimated in convergence equations might be driven by other(s) non-monetary shock(s) ε^j,

$$Corr(\pi(b_j(1)\epsilon^j),\ y(d_j(1)\epsilon^j)) < 0$$

Thus the right way to proceed is to estimate the ultimate source of fluctuations $(\varepsilon' s)$ and to test the sign of $d_1(1)$. Since ε^1 is exogenous, the issue of causality is adequately handled.

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(6) These effects might be correlated with the regressors and are approximated by means of country-specific constants.

Bullard and Keating (1995) were among the first to approach the long-run effect of inflation in this way. They assume that the *J* set can be split in two groups: those shocks which exert a permanent effect on inflation (ϵ^P) and those with a purely temporary effect on it (ϵ^T). Thus, the long-run representation of the $\{\pi, y\}$ process is:

$$\Delta \pi_t = \gamma_{11}(1)\epsilon_t^P$$

$$\Delta y_t = \gamma_{21}(1)\epsilon_t^P + \gamma_{22}(1)\epsilon_t^T$$

Bullard and Keating invoke the *extreme monetarist assumption* of that *inflation is always and everywhere a monetary phenomenon*. Under this assumption, ϵ^P can be identified as the only shock behind the unit root of inflation which must be just the rate of growth of the monetary base, without contamination from supply side disturbances, to be found in ϵ^T. Thus, the interpretation of the estimated long run correlation among inflation and income boils down to a test of the sign of $\gamma_{21}(1)$. Bullard and Keating apply their model to several countries and find that the sign of $\gamma_{21}(1)$ is positive in most cases and significant in some of them, meaning that inflation is costless over the long run. If disinflations, as it is broadly accepted, are costly in the short-run the case for price stability is undermined. Thus, while cross-country regressions come up with a negative relationship between inflation and output, the SVAR approach, aimed at eliminating supply side influences on inflation, yields opposite results.

This is not the end of the story, though, for the *extreme monetarist* model can be misspecified, precisely for the same reasons as the conventional cross-country regression approach. If the *extreme monetarist* argument is right, then there would be no causality-based case against the convergence regressions results: i.e. correlations among thirty years averages of inflation and growth would reflect just the common effect of monetary shocks. To see this possible misspecification more formally let us assume that the monetarist claim is not true and that permanent inflation has a real component instead (ϵ^2). Thus, the long-run representation of the process is,

$$\Delta\pi = b_1(1)\epsilon^1 + b_2(1)\epsilon^2$$

$$\Delta y = d_1(1)\epsilon^1 + d_2(1)\epsilon^2 + d_3(1)\epsilon^3 + d_4(1)\epsilon^4 + \ldots$$

Under this assumption it is clear that the estimated ϵ^P in the *monetarist* model would not be an adequate estimate of the long run effect of monetary shocks, since it would be capturing two different (may be opposite) effects. For this to happen, it does not matter how small the contibution of ϵ^2 to the the long-run fluctuations of π is. As long as it is significant, what really matters is the size of $d_2(1)$; if this multiplier is positive and large, an estimated positive $\gamma_{21}(1)$ might be compatible with a negative influence of monetary shocks on output (i.e. a negative $d_1(1)$). Unfortunately, the additional source of long-run inflation cannot be handled in the bivariate system if we want to make use of long-run identification restrictions[7].

2.2. Identifying additional sources of fluctuations: The role of unemployment.

To identify additional sources of fluctuations of inflation, thus isolating the true nominal component, we need to enlarge the model to allow for a third variable. The unemployment rate is the natural candidate for that purpose. The enlarged model is specified as a three variables stationary vector in the first differences of the unemployment rate (u), inflation (π) and the log of output (y), driven by three orthogonal shocks: ϵ^N containing the nominal source of fluctuations and ϵ^Z and ϵ^* which are real and, that for reasons explained below, are called productivity and natural rate-velocity shocks respectively[8]. There are a number of advantages in bringing the unemployment rate into the VAR. First, unemployment has been during the last two decades very much a non-stationary variable that it is

[7] Notice that if $\gamma_{12}(1)$ is left free, there can be no zeroes impossed in the matrix of long-run multipliers since $\gamma_{21}(1)$ is our main hypothesis of interest. The model could be identidfied imposing short-run restrictions. We shall return to this later.

[8] Unit root tests for the variables are summarized in Appendix 1.

bound to contain useful information about the long-run features of the economies in our sample[9]. Secondly, most macroeconomic models come up with clear-cut predictions about the long-run determinants of unemployment (i.e. on the NAIRU), thus providing structural restrictions for identification purposes. Finally, but not least, a joint consideration of output and unemployment seems the natural approach to the costs of inflation since the SVAR approach permits a clear distinction among short run and long run responses to particular shocks. Disinflation is meant to impinge upon the economy some costs and to yield some benefits. The expected time pattern of these is one in which costs, in terms of higher unemployment and output foregone, come first whereas the eventual beneficial effects take much longer to show up. The presence of such pattern in the dynamics of our model might be taken as some sort of informal overidentifying restrictions.

The following simple structure will serve to rationalize our approach as well as the identifying strategy:

$$\pi_t = \Delta m_t + \Delta v_t - \Delta y_t \tag{1}$$

$$\Delta^2 v_t = \lambda_1(L)\epsilon_t^* + \lambda_2(L)\epsilon_t^N + \lambda_3(L)\epsilon_t^Z \tag{2}$$

$$\Delta^2 m_t = \chi_1(L)\epsilon_t^N + \chi_2(L)\epsilon_t^* + \chi_3(L)\epsilon_t^Z \tag{3}$$

$$y_t = a_t + \alpha k_t + (1-\alpha) l_t^s - (1-\alpha) u_t \tag{4}$$

$$\Delta y_t^P = \tau_1(L)\epsilon_t^* + \tau_2(L)\epsilon_t^N + \tau_3(L)\epsilon_t^Z \tag{5}$$

$$u_t = u_t^* - \beta(\pi_t - \pi_t^e) + \epsilon_t^Z \tag{6}$$

[9] See, for instance, King and Watson (1994), Alogouskofis and Manning (1988) and footnote 8 in the recent paper by Hall (1998).

$$\Delta u_t^* = \delta_1(L)\epsilon_t^* + \delta_2(L)\epsilon_t^N + \delta_3(L)\epsilon_t^Z \qquad (7)$$

The inflation process is represented in (1) by a simple quantitative theory equation, where m and v are logs of money supply and velocity respectively. (2) and (3) are structural unrestricted representations of Δv and Δm in terms of the structural innovations. Expressions (4) and (5) represent the determinants of current output, derived from a constant returns to scale production function, and potential (y^p) output; a, k and l^s represent the total factor productivity, the capital stock and the labour supply respectively. Equation (6) is a standard supply equation or *Phillips curve* in which deviations of unemployment from its *natural level* (u^*) depend on temporary nominal and real shocks. Finally, (7) represents the process of u^* as a function of the $\epsilon's$.

From (1)-(3) the process of inflation can be written as a function of the structural innovations as,

$$\Delta \pi_t = c_{21}(L)\epsilon_t^* + c_{22}(L)\epsilon_t^N + c_{23}(L)\epsilon_t^Z \qquad (8)$$

and taking first differences in (6),

$$\Delta u_t = \Delta u_t^* - \beta \left[c_{21}(0)(\epsilon_t^* - \epsilon_{t-1}^*) + c_{22}(0)(\epsilon_t^N - \epsilon_{t-1}^N) + (c_{23}(0) + 1)(\epsilon_t^Z - \epsilon_{t-1}^Z)\right] \qquad (9)$$

where $c_{1j}(0)$ are the associated short-run multipliers. Similarly, the output process (*Okun's Law*) can be written as follows:

$$\Delta y_t = \Delta y_t^P - (1-\alpha)(\Delta u_t - \Delta u_t^*) \qquad (10)$$

From (9) we see that the effect of any shock on unemployment is purely transitory, unless it affects u^* directly. Most theories of the *natural rate* predict that nominal shocks do not have a permanent effect on unemployment. Similarly, according to these theories the effect of purely productivity shocks on the supply and the demand for labour cancel out in the long run, so that these shocks have no effect upon u^*

either[10]. If we identify ϵ^Z as those real shocks with no permanent effect on u^*, the process (7) incorporates the following long-run restrictions: $\delta_2(1)=\delta_3(1)=0$. Thus the structural equation of unemployment is of the form:

$$\Delta u_t = c_{11}(L)\epsilon_t^* + c_{12}(L)\epsilon_t^N + c_{13}(L)\epsilon_t^Z \qquad (11)$$

where the long run multipliers $c_{12}(1)$ and $c_{13}(1)$ are both set to zero.

The process of y^P is not restricted. According to equation (10) the sources of long-run output fluctuations are those of potential output, i.e. those behind permanent changes in the savings rate, population growth and the total factor productivity. These variables are jointly driven by all shocks: ϵ^N, ϵ^Z and ϵ^*. Notice that both ϵ^Z and ϵ^* are *real* determinants of output, the difference among them being that the former does not exert a permanent influence upon unemployment. As regards the possibility of a nominal shock affecting investment and productivity, this is the effect that models of growth and inflation, as the ones mentioned above, are looking at. This is the channel through which monetary policies can have an effect beyond the medium term and is the hypothesis we are interested in. Thus, the structural output equation contains no long-run restrictions,

$$\Delta y_t = c_{31}(L)\epsilon_t^* + c_{32}(L)\epsilon_t^N + c_{33}(L)\epsilon_t^Z \qquad (12)$$

The model with the restrictions discussed so far can be put in matrix format as,

(10) This has been established by Layard, Nickell and Jackman (1991) as a consistent empirical feature of modem economies. The relevance of this fact in the design of consistent macroeconomic models of unemployment has been recently stressed by Blanchard and Katz (1997).

$$\begin{bmatrix} \Delta u \\ \Delta \pi \\ \Delta y \end{bmatrix} = \begin{bmatrix} c_{11}(1) & 0 & 0 \\ c_{21}(1) & c_{22}(1) & c_{23}(1) \\ c_{31}(1) & c_{32}(1) & c_{33}(1) \end{bmatrix} \begin{bmatrix} \epsilon^{*} \\ \epsilon^{N} \\ \epsilon^{Z} \end{bmatrix} \tag{13}$$

Equations (1) to (5) above are fairly general and do not impose restrictions, but (6) is not. In particular, in economies with hysteresis, the Phillips curve ought to be written as follows:

$$u_t = \rho u_{t-1} - \beta(\pi_t - \pi_t^e) + \epsilon_t^Z$$

such that if ρ would equal *1*, the unemployment process would be driven on the long run by all three shocks of the system, delivering no useful infoımation to identify each of them. The evidence suggests that the role of persistence, and thus the history of shocks, is crucial in explaining the high structural unemployment in the industrialized world. Thus, the superiority of the first difference stationary representation for the unemployment rate can hardly be disputed. The fact that unemployment has a non-stationary representation has been sometimes considered as a sign of *full hysteresis* and hence of a permanent trade-off among inflation and unemployment. But this does not have to be the case. A simple model of the labour market in Appendix 2 makes clear under what circumstances the unit root of the unemployment rate might have a nominal component. These conditions are rather demanding and, as Blanchard (1997) claims *"...whether ... channels* (behind hysteresis) *can explain large and long-lasting effects of disinflation on unemployment is far from established"*. Hence, although the degree of persistence in unemployment is very high in most countries, the assumption of full hysteresis is difficult to maintain and, thus, we chose to impose (6) on the data.

The restriction set in (13) helps to separate out $\{\epsilon^N, \epsilon^Z\}$ from ϵ^*, but does not isolate three orthogonal innovations. Neither the output nor the unemployment process can be restricted further. The later because there is only one source of permanent fluctuations left; the former because the standard model above suggests that all three shocks drive output. Thus, the additional restrictions must be found in the inflation process, and here is where the monetarist assumption is usefiıl.

The assumption that long-run inflation is only money $(i.e.\ \lambda_1(1) = \lambda_3(1) = \chi_2(1) = \chi_3(1) = 0)$ would provide with two additional restrictions so that the model would be overidentified: $c_{21}(1)=c_{23}(1)=0$. Table 1 shows that these overidentifying restrictions are largely rejected by the data. The reason for that rejection is clear: if money is the only source of inflation in the long-run but it does not affect unemployment at all, then unemployment and inflation should be long-run orthogonal (since ϵ^N and ϵ^* are so, by construction). What the rejection of the overidentifying restrictions indicate is precisely that this is not the case and that in all *C9* countries the unit root of inflation and unemployment must have a common component[(11)].

One alternative is to stick to the extreme monetarist assumption but allowing for a long run effect of money on unemployment (i.e. $\delta_2(1)$ and $c_{12}(1)$ non zero). But aside from relying in the *extreme monetarist assumption*, this approach has other shortcomings. The correlation among inflation and unemployment would be entirely accounted for by ϵ^N, meaning that money has not only a permanent but also a powerful effect upon unemployment over the long run. Furthermore, if there is full hysteresis productivity shocks might also affect unemployment rendering the model underidentified. Thus, the only way in which a long-run vertical Phillips curve might be imposed on the data, while still giving the correlation among inflation and unemployment a chance, requires allowing the possibility of more than one shock driving the inflation process in the long run. In such a case, the low frequency correlation among inflation and unemployment is due to real shocks[(12)]. This is what we look at next.

[(11)] See, for details on that evidence, King and Watson (1994) for the case of US.

[(12)] In the case of the US economy, this has been suggested by Evans (1994) in a similar setting.

2.3. Our identification scheme

If inflation has to have a second source of long-run fluctuation this must be real: since money growth is the only nominal root in the system, it cannot appear in more than one exogenous component if these are orthogonal each other. We allow for this possiblity by removing the restrictions $\lambda_1(1)=0$ and $\chi_2(1) = 0$ in (2), which in turn means that there is only a valid long-run restriction on the inflation process, namely $c_{23}(1)=0$. This makes clear the distinction among ϵ^{*} and ϵ^{z}; the later are those real shocks that affect neither unemployment nor velocity in the long run[13]. In what follows we first discuss some theoretically justifications for this assumption and then we shall discuss its empirical relevance.

Permanent differences in money growth account for most of the cross-country differences in permanent inflation; still, many authors argue that a, probably small but significant, influence of non-monetary factors cannot be denied. In particular, the literature of international trade suggests that relative inflation is partially explained by structural differences both on the demand and on the supply side of the economy[14]. The argument relies in the different pricing behaviour of firms in sectors exposed to the international competition as compared with that of firms specialized in the production of non-tradeable goods. Productivity growth in the tradeables sector leads to higher wages which spreads into other sectors in an economy with a unified labour market. Higher wage pressure in sectors with monopolistic power (non-tradeable goods) is translated into higher prices unless it is matched by a vigorous productivity growth. Thus, productivity growth differentials may result in permanent inflation. Similar effects can result from increases in public spending (Rogoff, 1992). Ball and Mankiw (1995) also show that menu costs may induce price level effetcs of real shocks if the distribution of relative prices presents

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(13) The identification of these two separate real roots of the system may not be very precise. However, it helps to isolate the nominal innovation and this is what we are interested in.

(14) See, among others, Balassa (1964), Samuelson (1964) or, more recently, De Gregorio, Giovannini and Wolf (1994) and Campillo and Miron (1997).

skewness. What these real theories of inflation have in common is that shocks which do not have a monetary origin might exert a lasting influence on the inflation rate, but they are not always explicit about the role played by monetary growth in the actual inflation process[15].

From an empirical point of view there are a number of reasons to allow for more than one source of long-run inflation movements. First, from an econometric perspective, the time horizon at which money can be considered fully accommodated, and thus the only source of inflation, may be very long. If this is the case, extreme monetarism is an infinite horizon property and it may not be wise to impose it as a long run restriction at finite horizons[16]. Second, removing one restriction in the inflation process allows for a proper test on the adequacy of such restriction. Third, recall that orthogonality ensures that only one of the shocks behind inflation contains the nominal component, the one whose effect we are interested in. If this shock is properly identified, its effect on output can be analyzed regardless of our ability to give a precise interpretation to the rest of the shocks in the model.

Thus, our identification scheme (*non-extreme-monetarist non-full-hysteresis*) allows for two sources of long-run inflation dynamics (ϵ^N and ϵ^*), and the matrix of the long-run multipliers looks as follows[17]:

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(15) One exception is Balke and Wynne (1996) that show how inflation may occur even without money growth, merely as a consequence of real shocks. Other economists would argue that persistent inflation always requires monetary accommodation (Ball, 1993).

(16) See Faust and Leeper (1994).

(17) Appendix 3 summarizes the results obtained under non monetarist identification schemes relying upon restrictions on the short run coefficients, $c_{ij}(L)$. Whereas short-run restrictions are less appealing than the long-run ones, these results confirm those obtained imposing (14).

$$\begin{bmatrix} \Delta u \\ \Delta \pi \\ \Delta y \end{bmatrix} = \begin{bmatrix} C_{11}(1) & 0 & 0 \\ C_{21}(1) & C_{22}(1) & 0 \\ C_{31}(1) & C_{32}(1) & C_{33}(1) \end{bmatrix} \begin{bmatrix} \epsilon^{*} \\ \epsilon^{N} \\ \epsilon^{Z} \end{bmatrix} \tag{14}$$

3. Results

The SVAR model under the set of restrictions summarized in the system (14) is estimated for our sample of nine countries. Figures 1-3 depict the response functions, for each country, of unemployment, output and inflation to each of the three shocks; the one year and the long-run forecast error variance decompositions are summarized in Tables 2 and 3. Although our primary aim is the identification of the nominal shock (ϵ^{N}), a first glance to Figures 1 and 2 and Tables 2-3 suggests that ϵ^{Z} and ϵ^{*} behave as it would be expected according to the simple model (1)-(7). In particular, the response of all three variables to an innovation in ϵ^{Z} suggests that it can be interpreted as a productivity or supply shock. A positive productivity shock has a strong but short-lived effect on unemployment, which might be caused by a slow process of labour reallocation. This shock hardly contributes to the forecast variance decomposition of inflation at any time horizon. Notwithstanding, the contribution of such a supply shock to explain the unit root of output is slightly low as compared with the contribution of ϵ^{*}.

The monetary root of inflation can only be in either ϵ^{N} or ϵ^{*}, but not in both since these shocks are, by construction, orthogonal. There are several reasons to argue that the monetary component of inflation has to be in ϵ^{N}, whereas ϵ^{*} is a non-nominal source of permanent inflation. First, the forecast variance decomposition of the model indicates that ϵ^{*} explains most of the short and long-run path of unemployment and a great deal of those of output too, which is not what could be expected from a nominal shock. Second, in most countries ϵ^{N} might be characterized as a *nominal demand shock*. It is demand since the short run correlation with unemployment displays a Phillips curve pattern: the increase in inflation leads to a rapid fall in unemployment in the short run. As inflation reaches its steady-state level, unemployment subsides slowly returning to its previous level. On the other hand, ϵ^N must be nominal since it accounts for most of the variance of the forecast error of inflation over the long run, whereas its contribution to the forecast variance decomposition of output and unemployment is virtually nil (Tables 2 and 3). These results are consistent with the widespread consensus among economists that the long run behaviour of real variables is basically driven by real shocks.

As regards the *long-run elasticity* of output with respect to nominal innovations, it is negative in six out of the nine cases. Actually, a permanent increase in inflation due to a nominal shock has a positive effect on output in France and Italy and negative in Japan, Spain, United States, Australia, The United Kingdom and Canada (although in the later the effect is just weakly significant)[(18)]. This effect is non significant in the case of Germany. Finally, when the sample period is restricted to 1974:2-1996:3, 1976:3-1996:3 and 1980:1-1996:3 the negative response to innovations in ϵ^N becomes stronger and more significant in all cases. This is the main hypothesis we are interested in. This means that disinflations achieved through a permanent fall in monetary growth might have significant short run unemployment costs, but end up having net beneficial permanent effects on output. Figures 3.1, 3.2 and 3.3 also show that, for some countries, the path of output following a change in ϵ^N is consistent with the central banker's view of disinflations: the main cost of disinflation comes first, in terms of higher unemployment and lower output; in the medium and longer term, unemployment gets back to its unchanged natural rate and output increases to achieve its new long run level. Again, these results are consistent with the dynamics of the simple model sketched in the previous section. If the shock ϵ^N is predominantly associated with permanent changes in the rate of growth of money, and since its long-run effect on unemployment is restricted to zero, the only way in which it can exert a permanent effect upon output is through its incidence on the accumulation of productive factors and/or on the level of total

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[(18)] When the model includes a time trend, results are very similar, but the negative effect of nominal shocks in Canada becomes strongly significant.

factor productivity. This is precisely what the literature on inflation and growth is about and our results confirm that the negative correlation among inflation and output found in some of these studies cannot be explained solely on the basis of endogeneity[19].

France and Italy are the only countries in the sample whose behaviour is at odds with these negative long-run elasticity results. A closer inspection of these cases reveals that perhaps the nominal component of inflation is not well identified in these two countries under neither scheme. First, notice that in these two cases the short-run response of unemployment and output to ϵ^N does not exhibit the *Phillips curve* pattern common to all other countries. Also, whereas the average contribution of ϵ^* to the long-run forecast error variance of inflation, excluding France and Italy, ranges from 12 to 22 per cent, this value reaches a low 5 per cent in France and a high 34 per cent in Italy. This makes, for our purposes, the identification of the nominal shock in these two countries slightly less reliable than in the rest of the countries. In France the identification is not satisfactory since the nominal shock explains a large proportion of the output variance (9%), far larger than in other countries (excluding Italy). On the other hand, this is the only country for which inflation is almost fully explained by ϵ^N, so it is not surprising that the results are close to those obtained under the *extreme monetarist* identification[20]. But that scheme has the unpleasant feature that the nominal shock explains a great proportion of the forecast error variance of output (up to 10 per cent 10 years ahead). The identified ϵ^N shock also explains an extremely high proportion of long-run output in Italy: 30 percent. In this country, inflation is also explained almost in similar proportions by ϵ^N and ϵ^*, whereas the later shock explains almost nothing of output in the long run.

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(19) Since output is stationary in first differences in our sample, the effect of inflation is an effect upon the steady state level of output. This is consistent with the findings in the literature on growth empirics. See Andrés and Hernando (1997) for a detailed discussion on this issue.

(20) The *p-value* of the overidentifying restrictions is close to the level of non rejection (Table 1).

Finally, a common feature of the results obtained is the shape of the response of both inflation and output to innovations in ϵ^*, the other source of long-run inflation dynamics. A negative innovation in ϵ^* generates a permanent fall in inflation associated with a permanent fall in output. This confirms our previous surmise of a misspecification bias in the *extreme monetarist* identifying scheme[21]. The long-run response of output, unemployment and inflation to innovations in ϵ^* also permits to draw some additional policy implications of the model. The main purpose of the paper was to investigate the long-run implications of those monetary policies aimed at achieving a permanent disinflation. But the unit root of inflation has also a non negligible real component. Our results show that the way disinflation is pursued matters. In particular, when the disinflation is achieved by means of changes in ϵ^*, the short-run unemployment and output costs extend over the long run generating a permanent cost. In this case the unemployment effects of disinflation are long-lasting and outweigh the efficiency gains leading to a permanently lower steady state output.

4. Conclusions

In this paper we have analyzed the dynamic response of unemployment and output following a monetary policy shock aimed at reducing the steady state level of inflation. We focus in the recent disinflation experience witnessed in several of the most advanced economies in the world. For that purpose, we estimate a VAR model on these three variables and chose to identify the shocks on the basis of their long-run expected impact, as suggested by a broad class of macroeconomic models. Two identification restrictions turn out to be of crucial importance: the first one, is the *extreme monetarist* claim ***that inflation is just a monetary phenomenon in the long-run***; the second one is common to most theories of the business cycle and

[21] If our scheme is correct the nominal shock estimated under the monetarist scheme is a composite of ϵ^N and ϵ^*. Even if the contribution of ϵ^* to inflation is small, a powerful long-run positive impact of ϵ^* on output generates the positive impulse response estimated under that scheme.

simply argues that *monetary shocks do not generate a long-run trade-off between inflation and unemployment*.The *first result* of our exercise is that these theoretically appealing restrictions are clearly at odds with the recent experience in the countries in our sample. This is not surprising because one can hardly expect the existing long-run non-zero correlation between inflation and unemployment being explained by models in which the sources of the unit roots behind these series are orthogonal.

In order to reconcile the model with the facts either of these assumptions has to be removed. The model under the *extreme monetarist* restriction might be inadequate for our purposes, since it puts too much structure on the process driving inflation. The risk of the nominal shock identified under this assumption being contaminated by a, small but non-negligible, real component is simple too big. We choose to stick to the predictions of business cycle theory and allow for more than one source of long-run inflation while imposing that money does not exert a permanent influence upon the natural rate. This implies that unit roots of inflation and unemployment have something in common which is real instead of nominal. Our *second result* is that the dynamic relationship among nominal shocks, output and unemployment, estimated under this scheme, very much confirms the widespread view of the disinflation literature: a process of permanent disinflation, engineered by the monetary authority, might lead to a temporary increase in unemployment (along a short-run Phillips curve trade-off); once unemployment is back to its natural rate, the economy reaches a new long run equilibrium with both higher productivity and output.

The *third result* is that whereas nominal disinflations lead to long run output gains, disinflations achieved by other (real) means might impinge upon the economy not only a temporary but also a permanent cost. The cause is that although both disinflation strategies do rise productivity, the rise in unemployment associated to the a 'real' disinflation leads to a net output loss. This last component is what *extreme monetarist* identification scheme fails to pick up properly, thus misrepresenting the long-run effect of monetary policies.

A proper evaluation of the costs and benefits of disinflation requires an explicit loss function for the monetary authority. Since the output gain of monetary disinflations is permanent, its present value outweighs that of the increased unemployment at a zero discount rate. If the central bank has both unemployment (probably approximating distributional issues) and output among the arguments of its objective function, the present value of a disinflation will depend on the discount rate.

APPENDIX 1: UNIVARIATE ANALYSIS OF THE VARIABLES

Variables Definition: OECD DATA. Output (Y) defined as GDP expressed in 1986 prices and GDP implicit price deflator (P) are from Quarterly National Accounts. Annual inflation rate is defined as $\pi_t=\Delta_4 \log P_t$. Unemployment (u) is defined as the total unemployment rate. Investment (I) is defined as Gross Fixed Capital Formation at 1990 prices. We estimate all the VAR models including four lags, a constant term and seasonal dummies. The results are extremely robust to use inflation defined as CPI annual rate. The sample period covers from 1972:2 to 1996:3 excepts for Italy (1972:2-1995:3), Spain (1976:3-1996:3) and Germany (1972:2-1994:4). On the grounds of homogeneous data availability we use data of West Germany instead of Germany.

UNIT ROOT TESTS

$$\Delta x_T = \alpha_0 + \alpha x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \epsilon_t \qquad (p=4)$$

	OUTPUT		INFLATION	
	DF	PP	DF	PP
AUSTRALIA	0.90	1.49	-1.63	-1.42
CANADA	-0.73	-0.84	-1.07	-1.11
SPAIN	-0.12	0.71	-2.85	-2.52
FRANCE	-0.16	-0.28	-0.91	-0.92
ITALY	-0.69	-0.54	-0.84	-1.47
JAPAN	-0.61	0.32	-4.79	-1.88
UK	-0.07	0.63	-1.37	-1.67
USA	-0.09	0.46	-1.95	-1.64
GERMANY	0.37	0.44	-1.70	-1.22

Nota: DF: T-statistics Dickey-Fuller tests, and PP: T-statistics Phillips-Perron tests.

UNIT ROOT TESTS

$$\Delta x_T = \alpha_0 + \alpha x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \epsilon_t \quad (p=4)$$

	INVESTMENT		UNEMPLOYMENT	
	DF	PP	DF	PP
AUSTRALIA	1.00	1.50	-2.30	-2.36
CANADA	1.88	1.99	-2.50	-2.18
SPAIN	0.64	1.34	-2.80	-2.40
FRANCE	0.72	1.28	-1.24	-1.25
ITALY	0.65	0.80	-1.20	-0.54
JAPAN	2.72	3.44	-1.83	-1.45
UK	0.67	1.20	-2.50	-2.02
USA	1.64	2.55	-2.46	-2.38
GERMANY	0.38	0.43	-2.15	1.11

Nota: DF: T-statistics Dickey-Fuller tests, and PP: T-statistics Phillips-Perron tests.

APPENDIX 2: A STYLIZED MODEL OF THE LABOR MARKET

Let us consider the following simple version of the *insiders-outsiders* model of the labour market. The expressions for the supply (n^s) and demand (n^d) for labour are:

$$n_t^s = g_0 + g_1(w_t - p_t) \tag{2.1}$$

$$n_t^d = g_2 - g_3(w_t - p_t - a_t) \tag{2.2}$$

where all *g's* are positive, *w-p* and *a* represent the real wage and total factor productivity. Workers set the nominal wage before the realization of current variables is known, as to achieve the highest real wage compatible with a given employment target (n^I):

$$w_t^I = p_t^e + a_t + \frac{g_2}{g_3} - \frac{n_t^I}{g_3} \tag{2.3}$$

Thus, the unemployment rate behaves according to:

$$u_t \approx n_t^s - n_t^d = (n_{t-1}^s - n_t^I) - g_3(p_t - p_t^e) + \Delta n_t^s \tag{2.4}$$

Let us assume the following general expression for n^I:

$$n_t^I = (1-\gamma)n_t^s + \gamma n_{t-1} - Z_t \tag{2.5}$$

The employment target of the insiders is a weighted average of the current labour supply and past employment. Also this employment target is lower the higher the distortions induced by some labour market institutions captured by *Z* (unemployment benefit duration, minimum wages, etc.). The parameter γ (which lies between *0* and *1*) captures the power of *insiders* (employment protection legislation, hiring and firing costs and the like), such that the higher that power the higher γ. Thus, the Phillips curve can be written (adding and subtracting p_{t-1}) as:

$$u_t = \gamma u_{t-1} - g_3(\pi_t - \pi_t^e) + \lambda Z_t + \gamma \Delta n_t^s \qquad (2.6)$$

Notice that when γ is strictly lower than 1 the unit root of unemployment is purely real and should be explained by the presence of non stationary components in Z.

When γ is equal to 1, the nominal surprise enters in the unit root of unemployment (along with other real components):

$$u_t = u_{t-1} - g_3(\pi_t - \pi_t^e) + \lambda Z_t + \Delta n_t^s \qquad (2.6')$$

APPENDIX 3: ALTERNATIVE IDENTIFICATION SCHEMES

It might be argued that the unit root of unemployment is a sampling feature and that therefore it cannot be used to draw inferences about the long run path of the economy. If unemployment cannot be brought into our VAR model, the only way in which the *extreme monetarist* assumption can be relaxed is by invoking restrictions in the short run coefficients $c_{ij}(0)$. This is most clear if we consider the bivariate model in inflation and output, driven by two shocks (nominal and real). If real shocks are allowed to have a long-run effect on inflation, the only way in which the output effect of nominal shocks can be tested is by imposing restrictions in the short run dynamics. This is also true even if a third variable, other than the unemployment rate, is used to enlarge the model unless some theoretical restriction can be imposed on the long-run determinants of such variable.

In this section the long-run effect of monetary policies is estimated in three different models, all of them identified resorting to one or more restrictions on the matrix of contemporaneous coefficients. Since models identified under short-run restrictions are somewhat less reliable, we have chosen to present several alternatives to asses the robustness of the results. The first model substitutes unemployment by the log of investment (i) into the VAR and is estimated under the restrictions: $c_{13}(1)=c_{21}(0)=c_{31}(0)=0$:

$$\begin{bmatrix}\Delta\pi\\ \Delta y\\ \Delta i\end{bmatrix} = \begin{bmatrix}c_{11}(L) & c_{12}(L) & c_{13}(L)\\ c_{21}(L) & c_{22}(L) & c_{23}(L)\\ c_{31}(L) & c_{32}(L) & c_{33}(L)\end{bmatrix}\begin{bmatrix}\epsilon^{N}\\ \epsilon^{z}\\ \epsilon^{i}\end{bmatrix} \qquad (3.1)$$

One of the channels through which inflation is meant to affect output in market economies is by reducing the saving and accumulation effort. Then investment is a natural candidate to assess the long-run effect of disinflations. Investment is non-stationary but, unfortunately, there are no plausible theoretical restrictions to impose on its long-run determinants. Thus the model can only be identified invoking two additional short run restrictions (over and above $c_{13}(1)=0$ which implies that we only try to isolate two sources of long-run inflation). Among these we chose to impose that the nominal shock has no current effect on output and investment.

The second model is a VAR in output and inflation in which nominal shocks are assumed not to have current impact on output: $c_{21}(0)=0$.

$$\begin{bmatrix} \Delta\pi \\ \Delta y \end{bmatrix} = \begin{bmatrix} c_{11}(L) & c_{12}(L) \\ c_{21}(L) & c_{22}(L) \end{bmatrix} \begin{bmatrix} \epsilon^N \\ \epsilon^Z \end{bmatrix} \qquad (3.2)$$

The third model simply substitutes output by investment in the previous one:

$$\begin{bmatrix} \Delta\pi \\ \Delta i \end{bmatrix} = \begin{bmatrix} c_{11}(L) & c_{12}(L) \\ c_{21}(L) & c_{22}(L) \end{bmatrix} \begin{bmatrix} \epsilon^N \\ \epsilon^i \end{bmatrix} \qquad (3.3)$$

The rationale of these short-run restrictions is weaker than that of the long-run ones. Admittedly, nominal shocks might have an immediate impact on real variables invalidating the restrictions imposed on $c_{21}(0)$ and $c_{31}(0)$. Nonetheless, these restrictions simply set the contemporaneous response of real variables to nominal shocks to zero. This is most natural since the long-run effect of money on output that we are trying to identify operates through the response of potential output nor through the output gap. The response of potential output is expected to be slow requiring some time lag to show up.

The results obtained in all three models are very robust. In all cases, the nominal shock is well identified according to the estimated forecast error variance decompositions (Tables A3-1 to A3-3) as well as the impulse-response functions (Figures A3-1 to A3-3)[22]. The variance decompositions show that the shock ϵ^N explains most of inflation fluctuations, and very little of output ones. As regards the long-run effect of these shocks, the impulse-response functions depicted in Figures A3-1 to A3-3 share a common pattern: the response of investment and output to nominal shocks is always negative and significant for all 9 countries in the sample[23].

[22] The real sources of fluctuations are not well disentangled in model (3.1).

[23] The only exception is the response of investment to nominal shocks in Canada (models (3.1) and (3.3)).

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TABLE 1: Test of the Overidentifying restriction

	Chi-Squared(1 DF)	Significance Level
USA	14.87	0.000
CANADA	15.21	0.000
JAPAN	23.04	0.000
UNITED KINGDOM	20.88	0.000
FRANCE	4.77	0.029
GERMANY	26.61	0.000
ITALY	34.62	0.000
AUSTRALIA	12.13	0.000
SPAIN	23.67	0.000

TABLE 2. One-Year Forecast Error Variance Decomposition

		ε^*	ε^N	ε^Z
USA	Unemployment	90(2)	6(2)	4(1)
	Inflation	2(1)	98(1)	0(0)
	Output	86(3)	4(1)	10(2)
CANADA	Unemployment	94(1)	3(1)	3(1)
	Inflation	2(3)	96(3)	2(1)
	Output	62(7)	1(2)	37(7)
JAPAN	Unemployment	76(4)	5(1)	19(3)
	Inflation	17(13)	71(11)	12(3)
	Output	69(9)	1(1)	30(8)
UNITED KINGDOM	Unemployment	90(2)	9(2)	1(0)
	Inflation	21(9)	78(9)	1(0)
	Output	63(8)	1(1)	36(5)
FRANCE	Unemployment	85(3)	0(0)	14(3)
	Inflation	2(3)	95(3)	3(1)
	Output	57(8)	13(5)	30(7)
GERMANY	Unemployment	94(1)	5(1)	1(0)
	Inflation	9(6)	90(6)	1(0)
	Output	68(7)	8(3)	24(5)
ITALY	Unemployment	91(2)	6(1)	4(1)
	Inflation	22(8)	55(7)	23(5)
	Output	17(9)	34(9)	49(9)
AUSTRALIA	Unemployment	93(1)	1(0)	5(1)
	Inflation	1(2)	97(2)	1(0)
	Output	75(5)	1(1)	24(5)
SPAIN	Unemployment	81(4)	2(1)	17(3)
	Inflation	2(5)	97(5)	1(0)
	Output	82(5)	1(2)	17(4)

NOTE: Standard Errors in brackets.

TABLE 3. Long-Run (Ten Years) Forecast Error Variance Decomposition

		ε^{*}	ε^{N}	ε^{Z}
USA	Unemployment	99(0)	1(0)	0(0)
	Inflation	14(7)	86(7)	0(0)
	Output	83(3)	1(1)	16(3)
CANADA	Unemployment	99(0)	0(0)	0(0)
	Inflation	15(7)	84(7)	1(0)
	Output	31(8)	1(1)	68(8)
JAPAN	Unemployment	99(0)	0(0)	1(0)
	Inflation	20(6)	78(6)	2(0)
	Output	80(8)	2(1)	18(7)
UNITED KINGDOM	Unemployment	100(0)	0(0)	0(0)
	Inflation	21(8)	79(8)	0(0)
	Output	77(5)	2(1)	21(5)
FRANCE	Unemployment	99(0)	0(0)	1(0)
	Inflation	5(4)	94(4)	0(0)
	Output	51(9)	9(4)	40(9)
GERMANY	Unemployment	100(0)	0(0)	0(0)
	Inflation	23(7)	77(7)	0(0)
	Output	90(2)	1(0)	9(2)
ITALY	Unemployment	99(0)	1(0)	0(0)
	Inflation	34(10)	62(9)	4(1)
	Output	3(3)	30(10)	67(9)
AUSTRALIA	Unemployment	99(0)	0(0)	0(0)
	Inflation	12(7)	87(7)	0(0)
	Output	64(7)	2(2)	34(7)
SPAIN	Unemployment	100(0)	0(0)	0(0)
	Inflation	22(9)	77(9)	0(0)
	Output	90(3)	1(1)	9(2)

NOTE: Standard Errors in brackets.

TABLE A3-1. Long-Run Forecast Error Variance Decomposition (model (3.1))

		ε^{*}	ε^{N}	ε^{Z}
USA	Inflation	48(9)	0(10)	52(13)
	Output	22(4)	7(21)	71(20)
	Investment	37(16)	5(16)	58(16)
UK	Inflation	92(6)	1(3)	7(6)
	Output	12(3)	17(32)	71(31)
	Investment	5(1)	0(31)	95(31)
FRANCE	Inflation	66(9)	0(6)	33(11)
	Output	6(2)	25(27)	69(27)
	Investment	8(2)	1(20)	91(20)
CANADA	Inflation	77(10)	1(5)	22(11)
	Output	4(1)	80(27)	16(27)
	Investment	1(0)	7(30)	92(30)
ITALY	Inflation	42(8)	1(6)	57(10)
	Output	7(2)	4(16)	89(16)
	Investment	2(1)	57(26)	41(26)
JAPAN	Inflation	53(8)	3(6)	44(10)
	Output	6(2)	69(27)	25(26)
	Investment	5(1)	16(21)	80(21)
AUSTRALIA	Inflation	90(7)	0(3)	10(7)
	Output	4(1)	54(32)	42(32)
	Investment	7(2)	6(32)	87(31)
SPAIN	Inflation	81(4)	1(6)	18(10)
	Output	1(0)	48(35)	51(35)
	Investment	2(1)	18(35)	80(35)
GERMANY	Inflation	86(7)	0(4)	14(8)
	Output	5(1)	2(27)	93(28)
	Investment	3(1)	10(29)	87(29)

NOTE: Standard Errors in brackets.

TABLE A3-2. Long-Run Forecast Error Variance Decomposition (model (3.2))

		ε^P	ε^T
USA	Inflation	52(9)	48(9)
	Output	23(5)	77(5)
UK	Inflation	96(4)	4(4)
	Output	9(2)	91(2)
CANADA	Inflation	86(7)	14(7)
	Output	2(1)	98(1)
FRANCE	Inflation	82(7)	18(7)
	Output	3(1)	97(1)
ITALY	Inflation	48(8)	52(8)
	Output	6(1)	94(1)
JAPAN	Inflation	80(7)	20(7)
	Output	7(2)	93(2)
AUSTRALIA	Inflation	93(5)	7(5)
	Output	8(3)	92(3)
GERMANY	Inflation	89(6)	11(6)
	Output	4(1)	96(1)
SPAIN	Inflation	86(10)	14(10)
	Output	0(0)	100(0)

NOTE: Standard Errors in brackets.

TABLE A3-3. Long-Run Forecast Error Variance Decomposition (model (3.3))

		ε^P	ε^T
USA	Inflation	45(10)	55(10)
	Investment	38(6)	62(6)
UK	Inflation	90(5)	10(5)
	Investment	7(3)	93(3)
CANADA	Inflation	79(7)	21(7)
	Investment	2(0)	98(0)
FRANCE	Inflation	66(9)	34(9)
	Investment	9(2)	91(2)
ITALY	Inflation	64(7)	36(7)
	Investment	2(0)	98(0)
JAPAN	Inflation	62(11)	38(11)
	Investment	8(2)	92(2)
AUSTRALIA	Inflation	90(7)	10(7)
	Investment	6(2)	94(2)
GERMANY	Inflation	87(8)	13(8)
	Investment	5(1)	95(1)
SPAIN	Inflation	81(9)	19(9)
	Investment	2(0)	98(0)

NOTE: Standard Errors in brackets.

FIGURE 1.1 RESPONSES TO ε^*

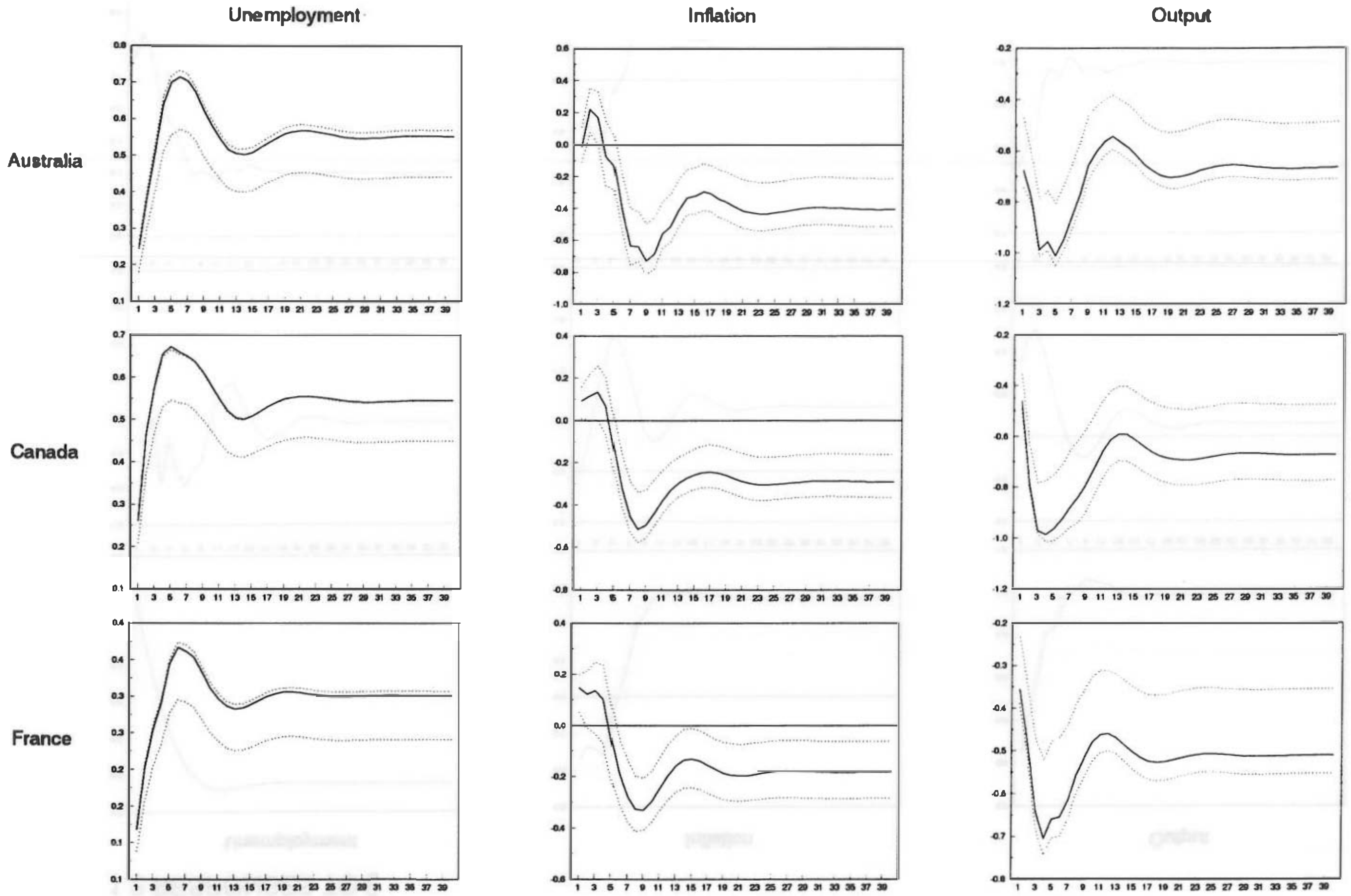


FIGURE 1.2 RESPONSES TO ε^*

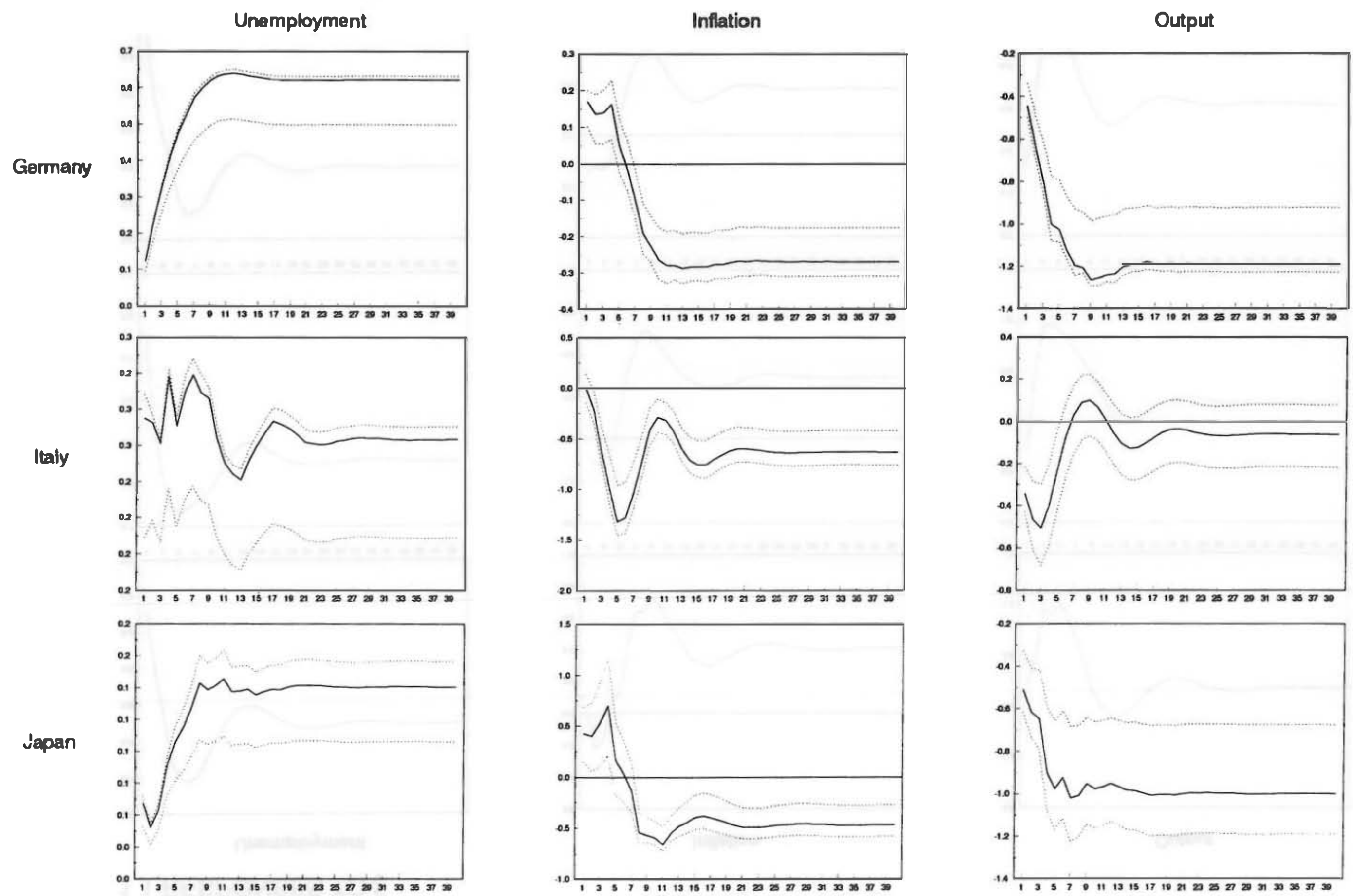
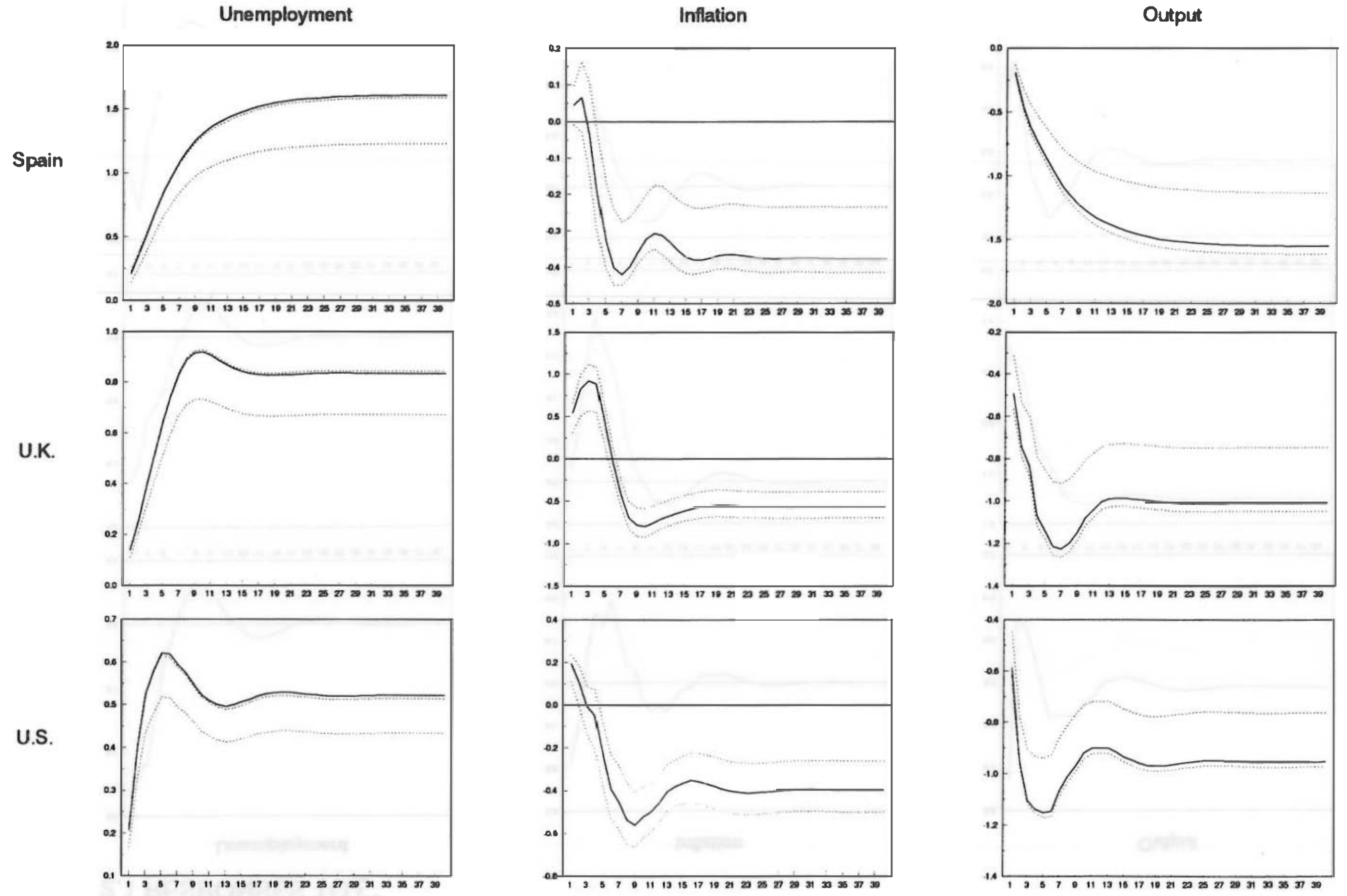


FIGURE 1.3 RESPONSES TO ε^*



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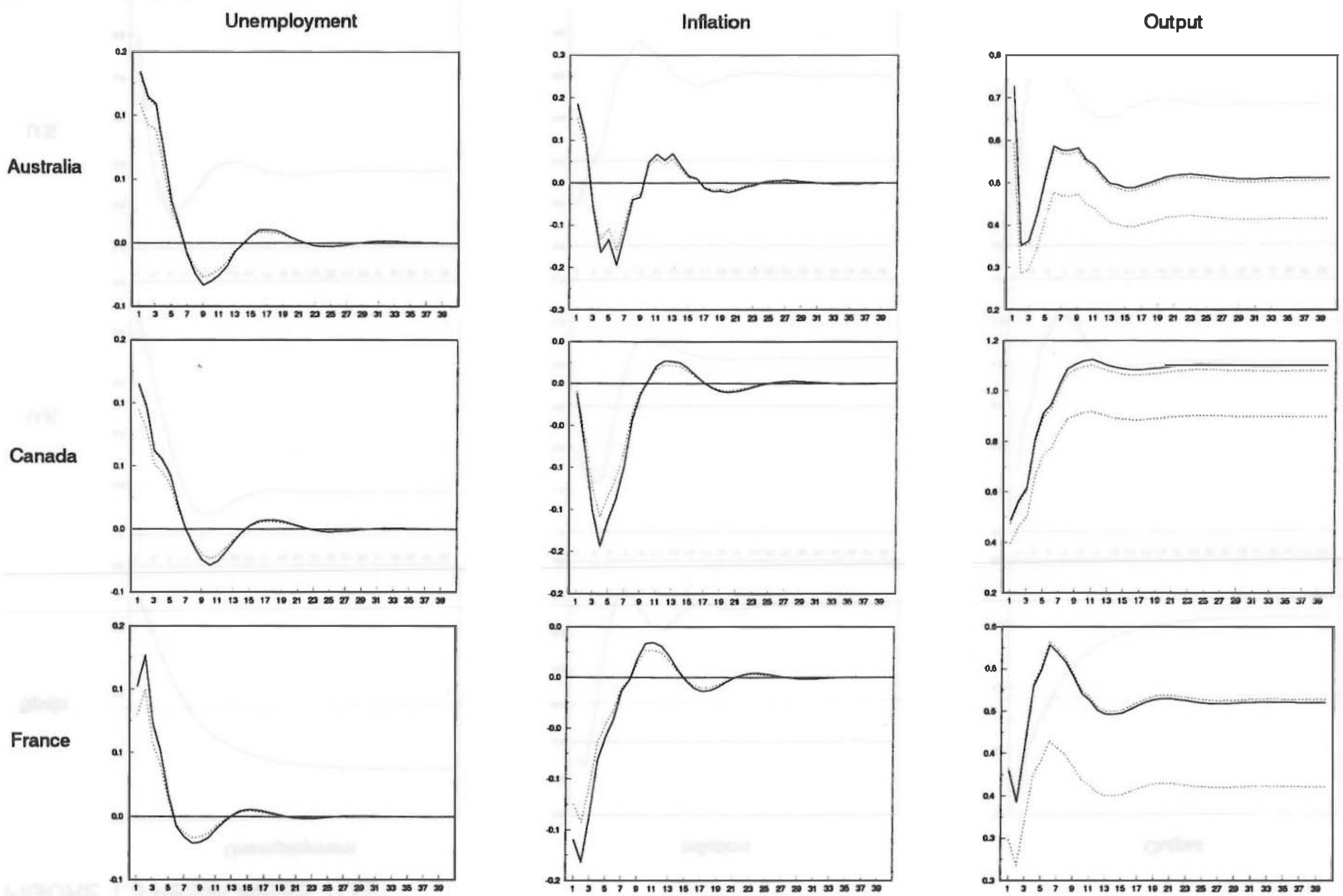


FIGURE 2.2 RESPONSES TO ε^z

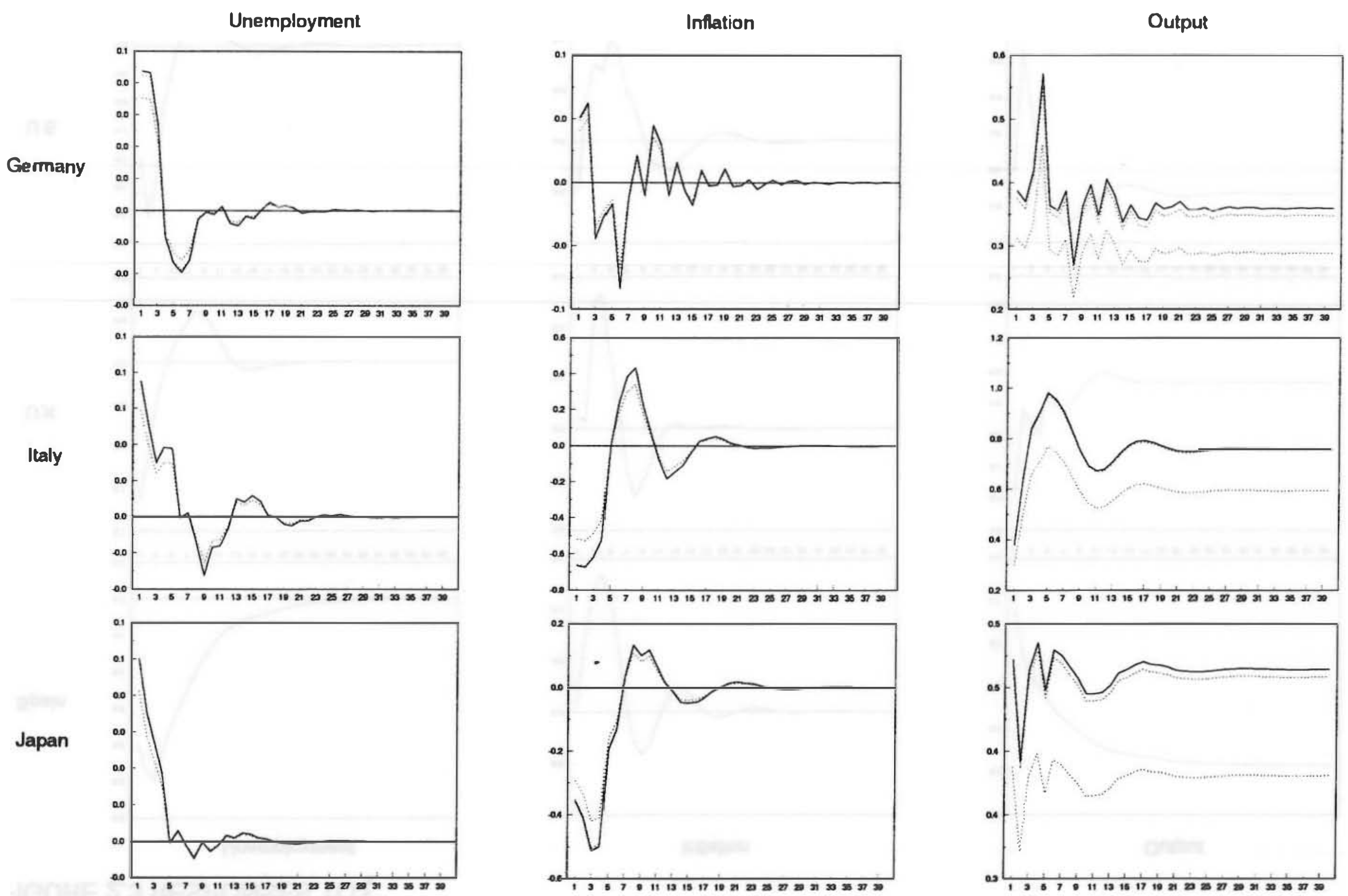


FIGURE 2.3 RESPONSES TO ε^{z}

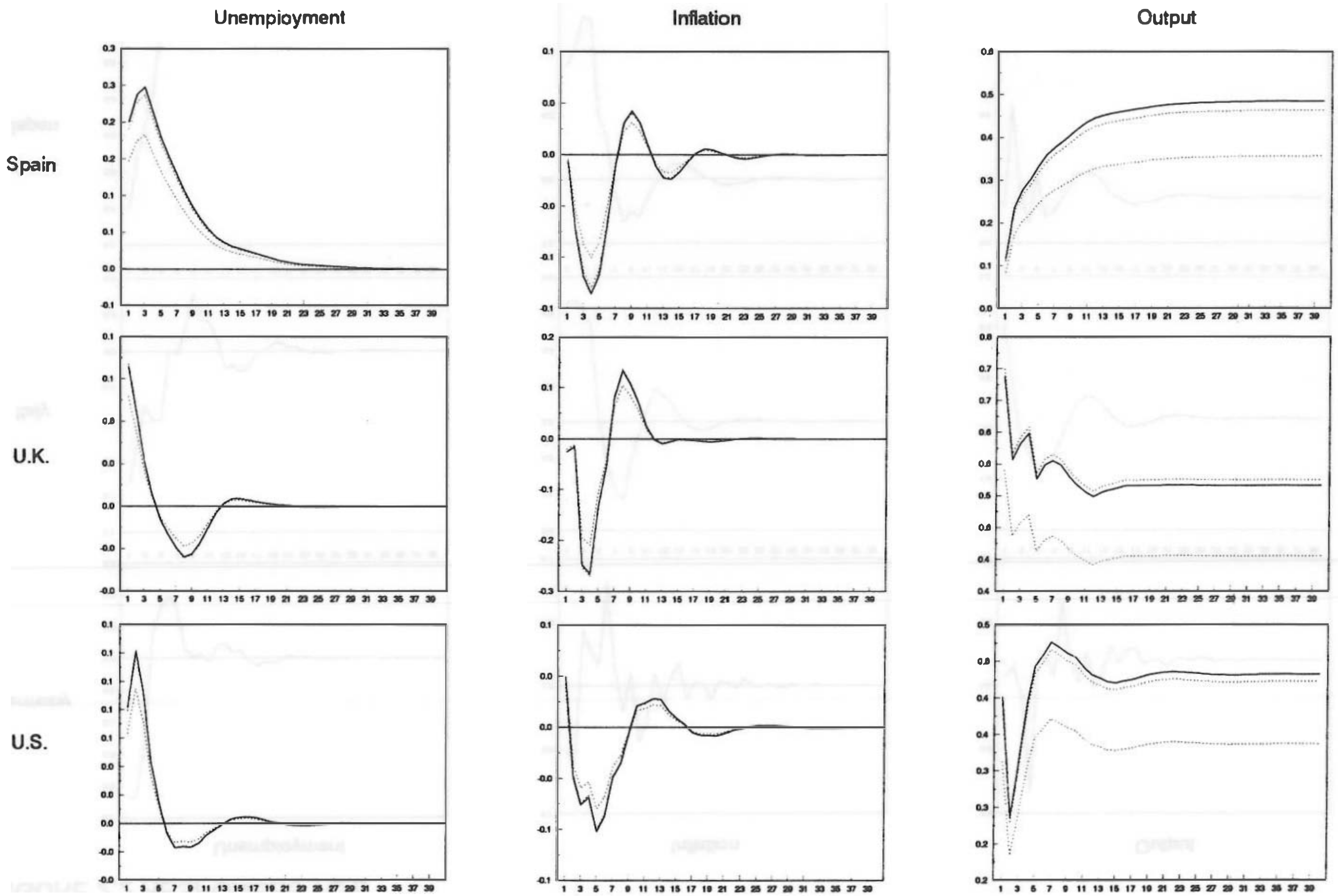


FIGURE 3.1 RESPONSES TO ε^N

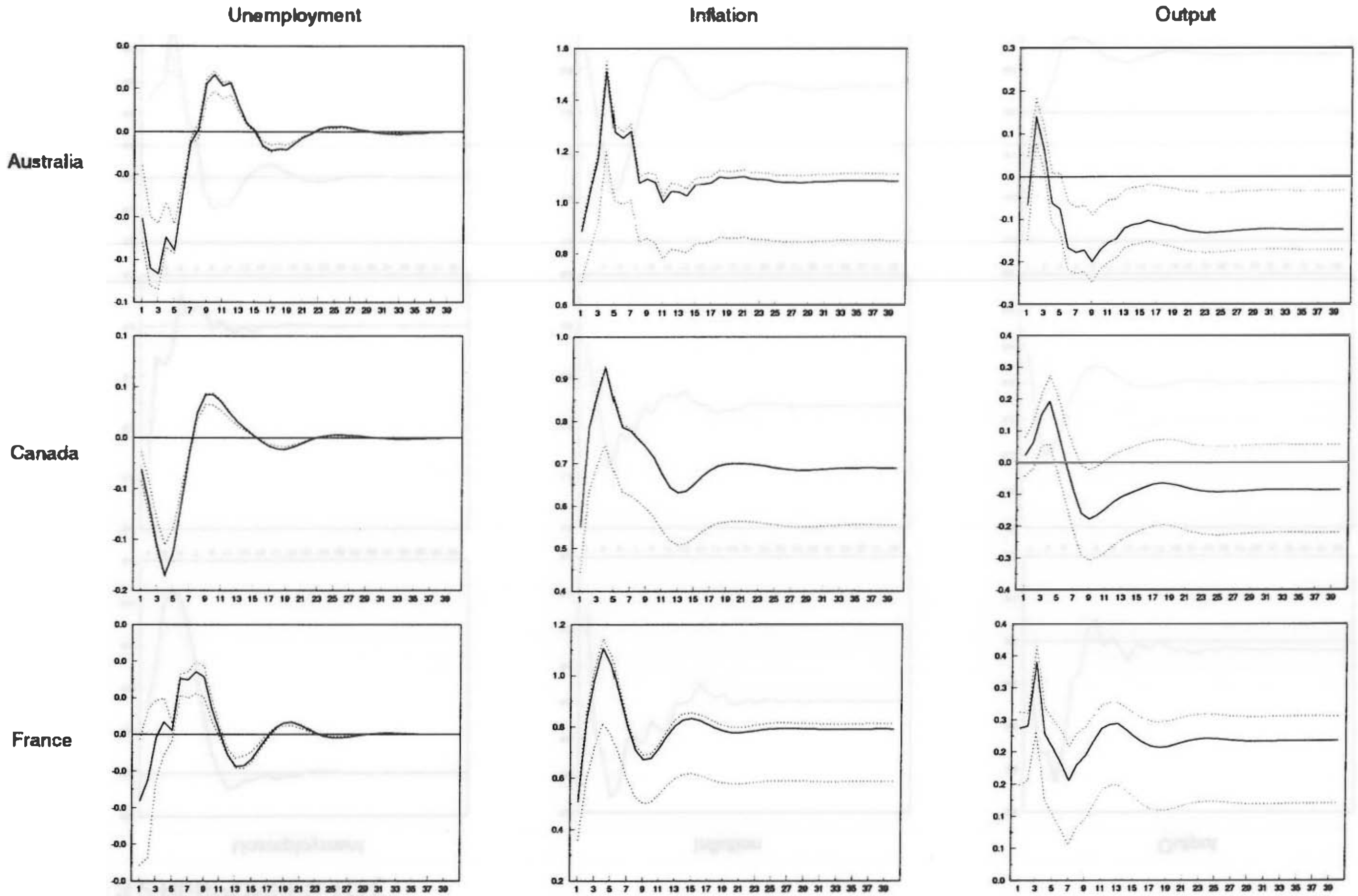


FIGURE 3.2 RESPONSES TO ε^{N}

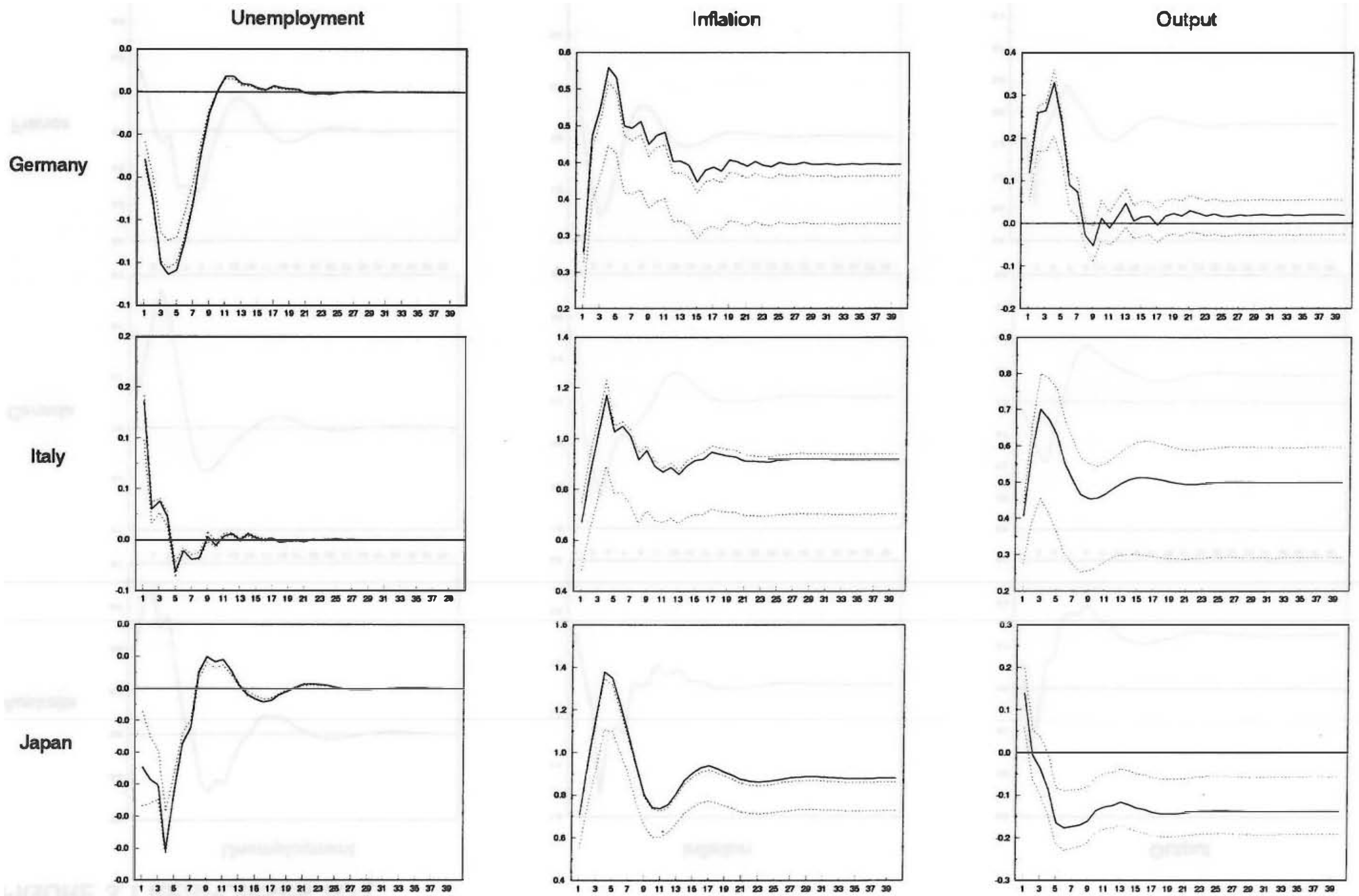


FIGURE 3.3 RESPONSES TO ε^N

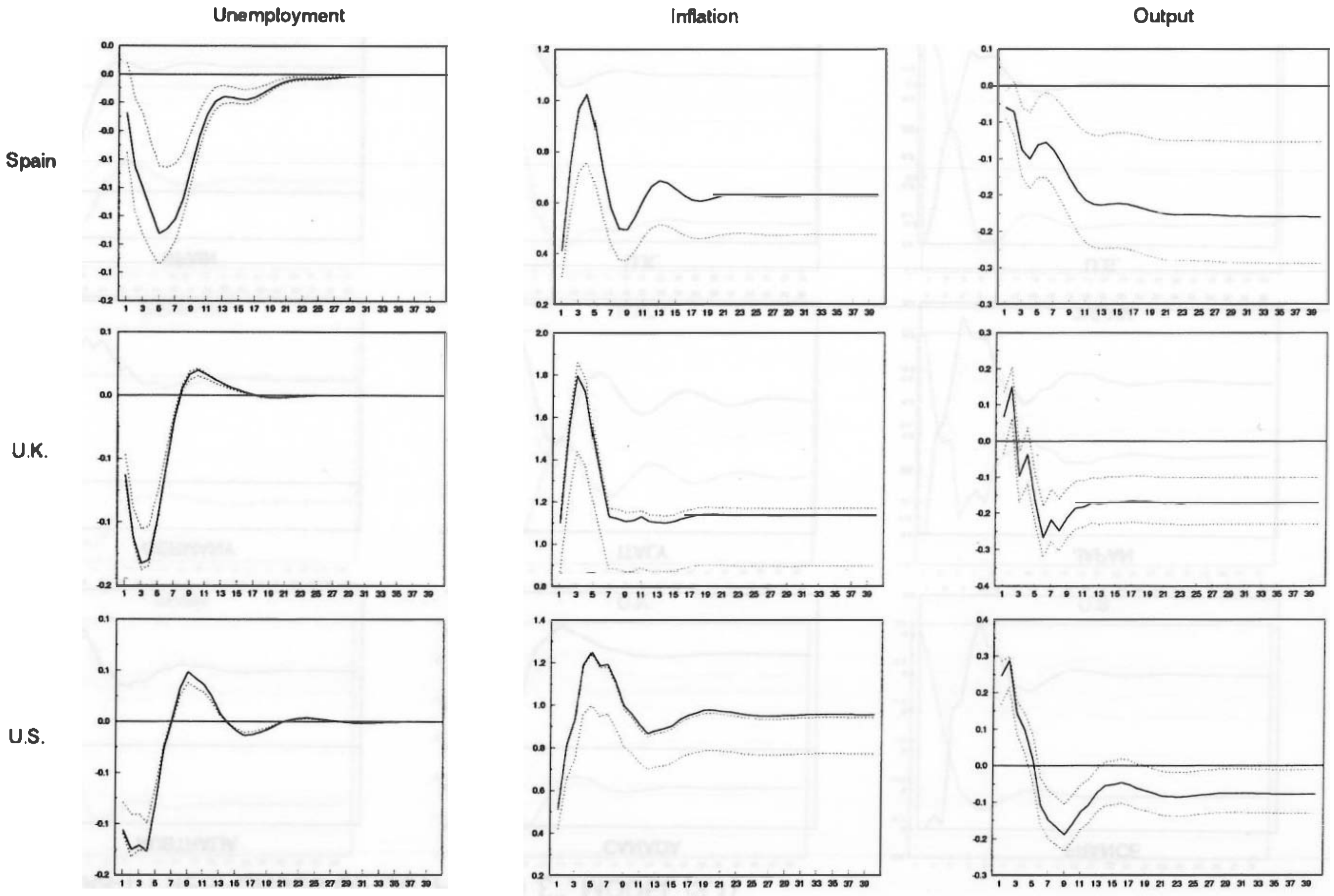


FIGURE A3-1.1 RESPONSES OF OUTPUT TO ε^N. MODEL (3.1)

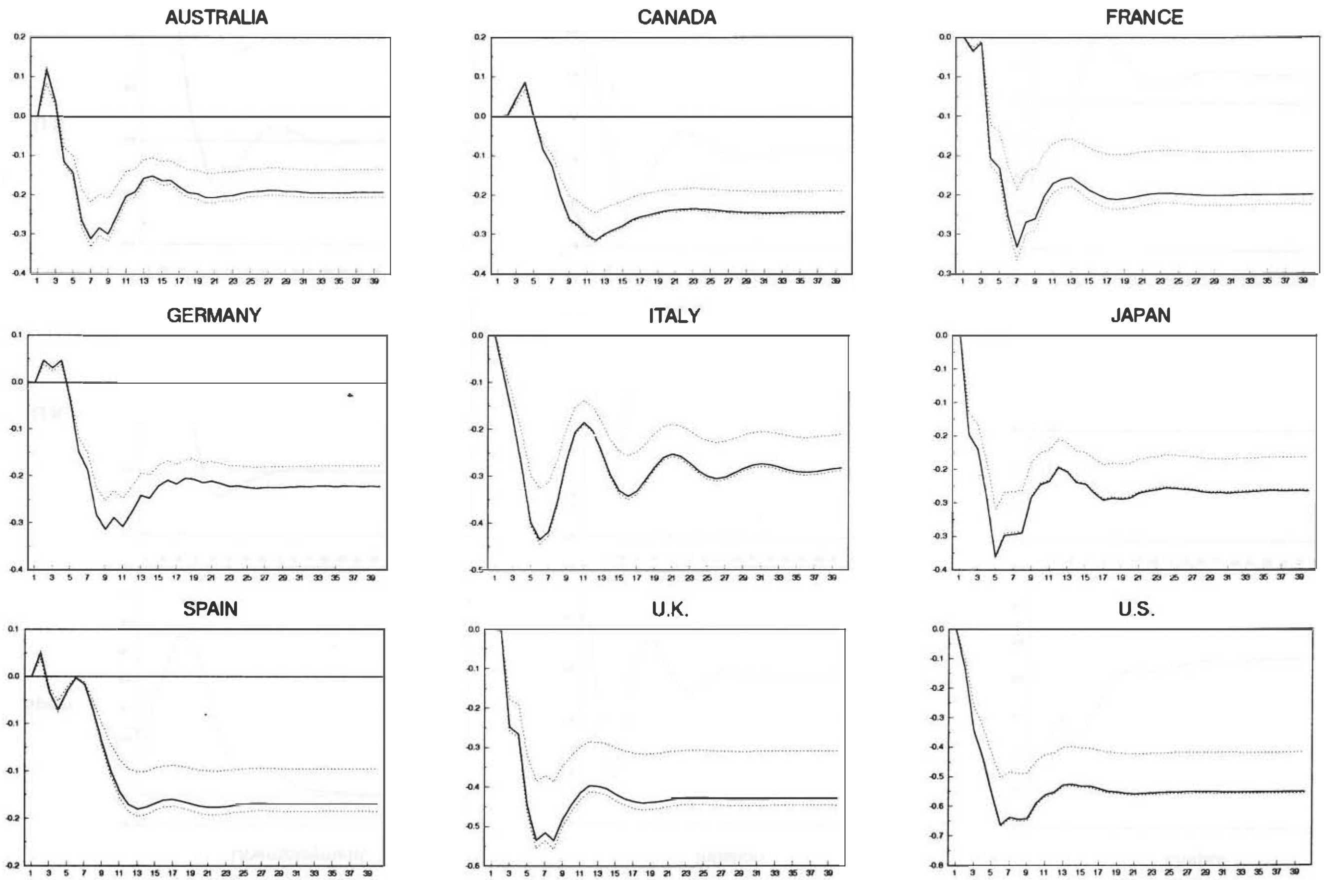


FIGURE A3-1.2 RESPONSES OF INVESTMENT TO ε^N. MODEL (3.1)

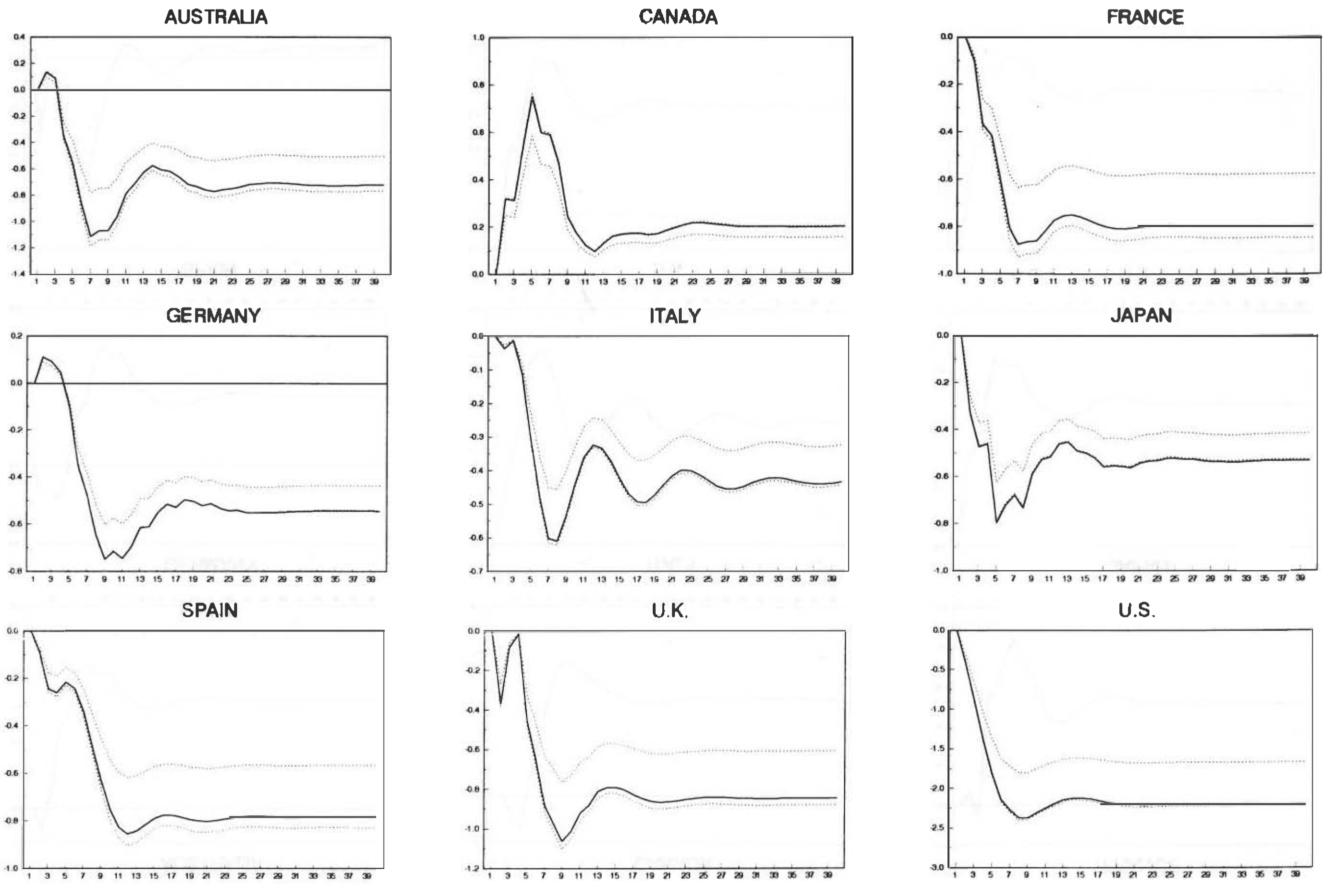


FIGURE A3-2 RESPONSES OF OUTPUT TO ε^{N}. MODEL (3.2)

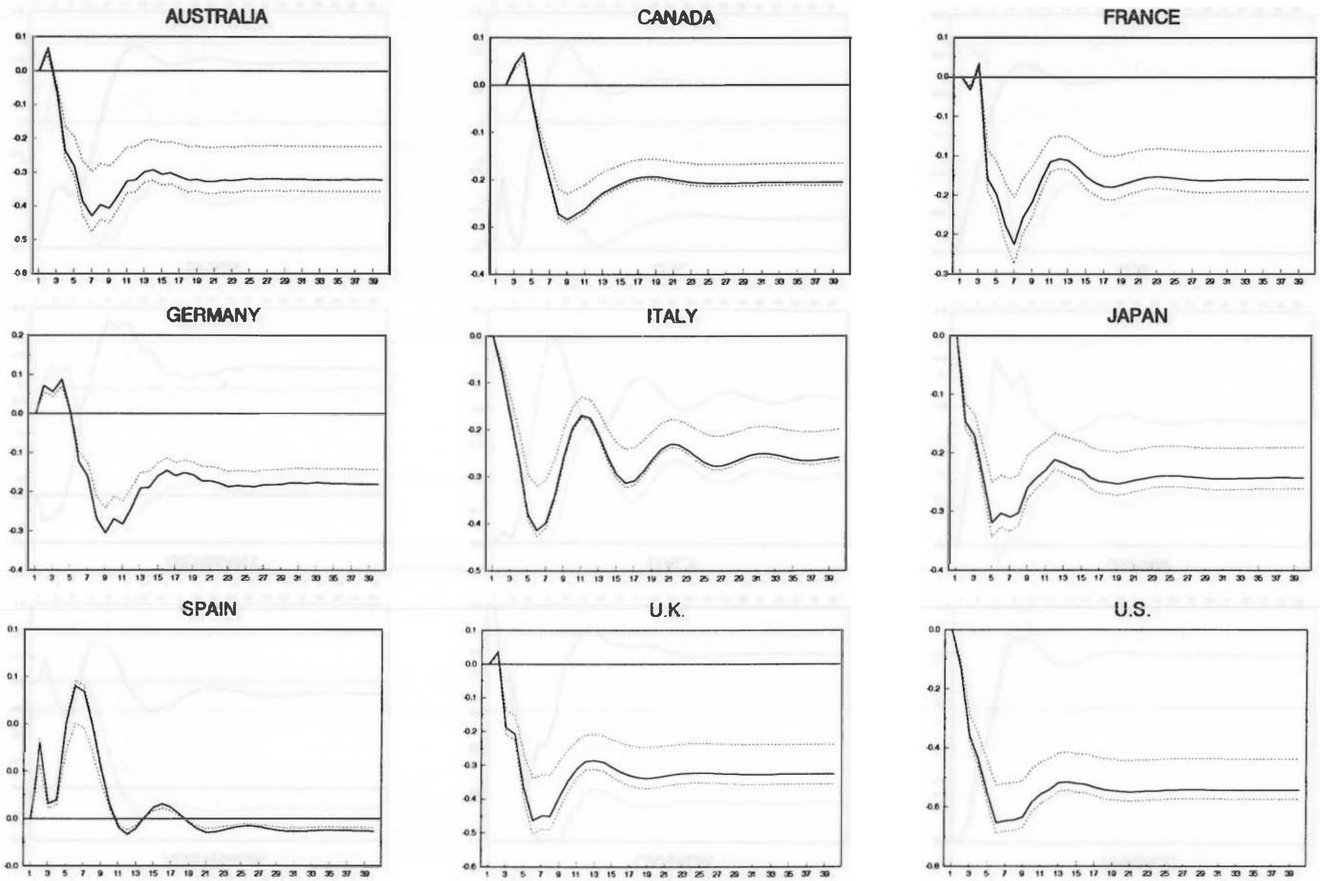
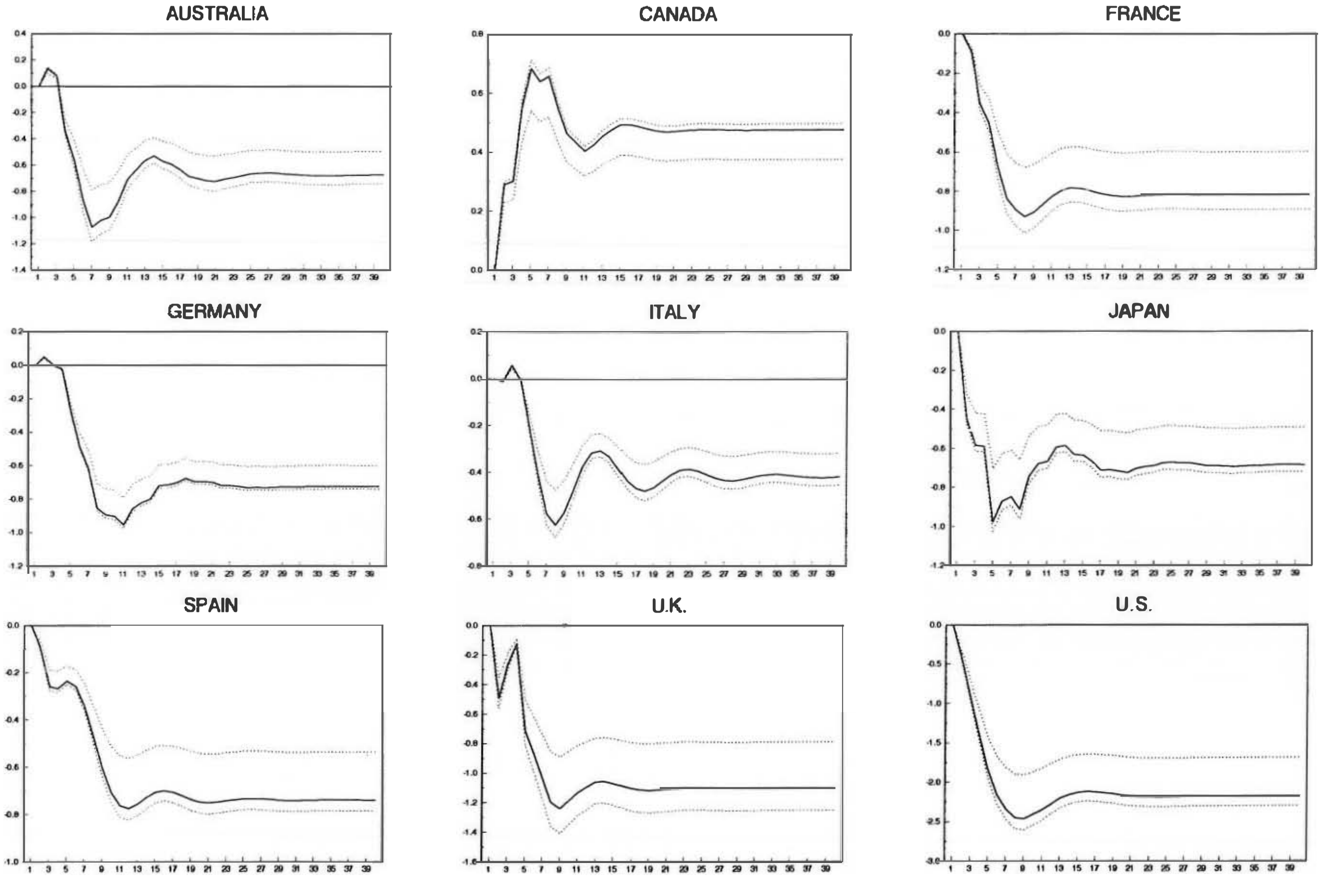


FIGURE A3-3 RESPONSES OF INVESTMENT TO ε^N. MODEL (3.3)



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