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The Transmission of Monetary Policy Shocks in Italy, 1967-1997

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Sintesi

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Il lavoro contribuisce alla letteratura empirica sugli effetti degli shock monetari, applicando la tecnica delle autoregressioni vettoriali (VAR) allo studio del caso italiano. Nella letteratura americana, questo approccio è utilizzato soprattutto per identificare i "fatti stilizzati" che si verificano dopo una restrizione monetaria, al fine di ricavare indicazioni sia sul meccanismo di trasmissione sottostante, sia su eventuali cambiamenti negli effetti della politica monetaria in periodi diversi.

Per l'Italia, le analisi di questo tipo si sono finora concentrate solo sugli anni più recenti, mentre il periodo analizzato dal presente lavoro va dal 1967 al 1997. L'utilizzo di un campione di stima che copre un lungo arco di tempo ha il vantaggio di permettere un confronto con i risultati ottenuti per altri paesi e di verificare la robustezza delle conclusioni a cambiamenti istituzionali.

Due sotto-periodi vengono identificati, mediante l'applicazione di criteri statistici: quello precedente e quello successivo al 1980. I risultati indicano che dal punto di vista qualitativo le risposte a uno shock di politica monetaria sono simili in entrambi i periodi: dopo una restrizione il prodotto diminuisce in misura significativa, in modo coerente con quanto indicato dai moltiplicatori del modello trimestrale della Banca d'Italia; tuttavia, la riduzione dei prezzi rispetto al profilo di riferimento è significativa, ampia e relativamente rapida, avendo luogo con un ritardo di 12-18 mesi (mentre il modello trimestrale, nella versione principale, in cui il cambio è mantenuto esogeno, prevede effetti della politica monetaria sui prezzi molto ridotti e estremamente lenti). La differenza dipende in parte dagli effetti mediante il canale del tasso di cambio, che si apprezza rapidamente dopo uno shock monetario; le sue variazioni si trasmettono con ritardi contenuti ai prezzi all'importazione e successivamente ai prezzi al consumo. Il ruolo importante del cambio suggerisce peraltro che il meccanismo di trasmissione potrebbe essersi modificato con l'ingresso dell'Italia nell'area dell'euro; è quindi necessario usare cautela nell'estendere i risultati ottenuti al contesto

attuale. Il salario reale aumenta dopo una restrizione; questo risultato contrasta con quelli ottenuti per gli Stati Uniti e indica una maggiore vischiosità dei salari nominali.

Il periodo precedente il 1980, rispetto al successivo, è caratterizzato da più ampie risposte dei prezzi e da un più forte aumento dei salari reali dopo uno shock monetario; questi risultati riflettono verosimilmente il diverso andamento del cambio e l'inerzia nei salari nominali introdotta dalle caratteristiche del meccanismo di indicizzazione. Le stime indicano anche che i fattori di costo (salari, prezzi delle importazioni, tasso di cambio) sono determinanti importanti dell'inflazione italiana; tuttavia, il loro ruolo nella propagazione dell'inflazione è diminuito dopo il 1980.

THE TRANSMISSION OF MONETARY POLICY SHOCKS IN ITALY, 1967-1997

by Eugenio Gaiotti*

Abstract

The paper studies the transmission of monetary policy shocks in Italy, by means of a structural VAR, using a long data sample; focusing on a long sample period permits a comparison between the Italian evidence and the international literature and makes it possible to test the robustness of the results in relation to structural and institutional changes. The interest rates on the refinancing operations of the Bank of Italy are used as measures of monetary policy; the identification of policy shocks is based on a reaction function that includes the exchange rate among its arguments. Under these identifying assumptions, the responses of output and prices to a monetary shock are consistent with the main findings in the international literature; however, the size of the estimated price response is large, leading to a divergence from existing structural models of the Italian economy, in which the effects of monetary policy on prices are limited. After a restriction, real wages increase (in contrast, in the US they decrease); the exchange rate appreciates; the fall in import prices precedes the decrease in consumer prices.

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1. Introduction[1]

In this paper, the transmission of monetary policy shocks to output and prices in the period 1967-1997 in Italy is addressed by means of a structural VAR. This technique has been extensively applied both to international and Italian macroeconomic data; however, in contrast with the US case, a full-fledged empirical study has not previously been conducted over a long sample period (although a few results for Italy have been included in some cross-country studies). Most investigations are limited to the 1990s and the second half of the 1980s, as the widespread changes in the monetary instruments and operating procedures that took place over the last thirty years have complicated the identification of a monetary indicator that is appropriate over a long period.

Focusing on a long sample period has several advantages: it permits a better comparison between the Italian evidence of the effects of monetary shocks and the consensus view that emerges in the copious international literature; it makes it possible to test the robustness of the results in relation to structural and institutional changes; moreover, it may shed some light on the changes that took place in policy transmission in Italy over the last thirty years: indeed, in many economists' view, monetary policy was a very effective tool in stabilising inflation between 1994 and 1996, while in the 1970s it had major effects on real activity but minor and slow effects on inflation. Differences in policy transmission are often attributed to changes in wage determination or to the exchange rate regime.

The exercise is mainly retrospective in character and has no direct implication for an assessment of policy transmission in the euro area economy. However, improving the understanding of monetary transmission in national economies may help to formulate educated guesses about the effects of the single monetary policy, the changes that it may generate and the differences in transmission in individual member states. To this end, a better understanding of the role of the exchange rate and of the role of wage stickiness is a topic for research.

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[1] The author thanks L. Buttiglione, F. Lippi and C. Monticelli for useful comments on previous versions of this paper. The usual disclaimer applies.

In order to identify and estimate the responses to monetary shocks, the first step is to look for a monetary policy indicator that is valid over a period of considerable changes in the operational procedures of monetary policy; it is argued that the interest rates on the operations of the Bank of Italy may serve this purpose. Monetary policy shocks are identified by estimating a policy reaction function that includes the exchange rate among its arguments. As the empirical literature has shown, the latter step is necessary to identify monetary policy when the exchange rate has an important role in policy transmission.

The paper is organised as follows. Section 2 briefly reviews the main interpretations of the process of transmission of Italian monetary policy to output and inflation in the last three decades; section 3 summarises the main features of the international VAR literature on monetary policy shocks. Section 4 discusses the model specification and the choice of the monetary policy indicator; section 5 deals with the identification strategy, while section 6 discusses the results.

2. The effects of monetary policy in Italy

Over the last three decades,[2] the views on the transmission mechanism of Italian monetary policy have changed, reflecting not only the evolution of monetary theory, but also the reforms introduced in the labour and financial markets, which changed the structure of the economy.

The common view in the 1970s was that monetary tightening had major effects on output, but very small and slow effects on inflation. In this period, following wage pressures in 1969 and the two oil shocks in 1974 and 1979, inflation remained high, reaching peaks above 20 percent. The effect of monetary policy on inflation is thought to have been limited by nominal and real rigidities in wage determination, stemming from weak links between demand, unemployment and wages and from a limited role of price expectations in the price- and wage-setting process. In contrast, the main episodes of monetary restriction are held to

[2] For a detailed survey of Italian monetary policy from 1947 to 1979, see Fazio (1979); on monetary policy in the 1980s, Angeloni and Gaiotti (1990). A detailed discussion of the choice of instruments and intermediate targets in 1974-1983 can be found in Caranza and Fazio (1983).

have had a substantial impact on real output.[3] However, this view of the effects of monetary policy in this period is not uncontroversial. [4]

Disinflation took place in the following decade, according to many opinions at a lower real cost than before, due, among other things, to the changed labor market situation (Giavazzi and Spaventa, 1989). Several structural changes affected monetary policy: in 1979 the Italian lira joined the European Monetary System; in 1981, with the so-called 'divorce' between the Bank of Italy and the Treasury, the Bank was freed from the obligation to underscribe unsold Treasury bills at auction and granted greater independence in the use of its instruments.[5] The first period of disinflation, between 1981 and 1984, was prompted by monetary restriction in defence of the exchange rate and, after 1983, was made easier by the co-operative attitude of trade unions to the setting of wages.[6] The degree of wage indexation was reduced in 1985; the oil 'counter-shock' in 1986 further contributed to reduce inflation, which nonetheless remained around 5 percent. However, it is commonly held that, even in the 1980s, wage inertia, the wage indexation mechanism, a lack of competition in domestic markets and the expansionary fiscal stance to some extent impaired the effectiveness of monetary policy in further reducing inflation. [7] The question is, however, not settled: the consequences of a greater degree of wage indexation on the real effects of monetary policy are theoretically uncertain;[8] moreover, according to Ball (1994), in a number of countries sacrifice ratios (the output cost of disinflation) were actually lower in the 1970s than in the 1980s.

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[3] Among others, Onofri and Salituro (1985), Salvati (1985), Giavazzi and Spaventa (1989) stress that in the 70s, due to lack of wage flexibility, the link in transmission from aggregate demand to unemployment, to wages and prices was severed and monetary policy had little anti-inflationary effectiveness.

[4] A different view is that of Andreatta and D'Adda (1985) who maintain that in the 70s a tighter monetary policy would have reduced inflation without substantial output losses.

[5] For a full account of these institutional developments, see Passacantando (1996).

[6] Cooperation was based on a temporary decrease in the degree of wage indexation and a planned rate of inflation. See Guiso and Magnani (1985).

[7] See Visco (1995) and Barca and Visco (1992). The standard version of the Bank of Italy quarterly model does indeed suggest a very small or nil effect of interest rate changes on prices, as in Galli, Terlizzese and Visco (1989).

[8] See Fischer (1977). In the index of wage flexibility used by Ball (1994), indexation clauses are assumed to *increase* flexibility.

Wage indexation was completely abolished in 1992, when wage bargaining was linked to the Government's inflation target; as a consequence, the inflation target acquired a greater role in shaping expectations; between 1995 and 1997, this role was further enhanced by an annual statement by the Governor of the Bank of Italy, announcing the level beyond which inflation would not be tolerated and monetary policy tightened.[9] Innovations in financial markets contributed to the effectiveness of monetary policy: during the first half of the 1990s, the development of an efficient secondary market for public securities and the removal of restrictions on international capital movements allowed the market judgement of monetary policy intentions to be readily reflected in long-term interest rates and in the exchange rate; a more direct "expectations" channel was activated.

Monetary policy effectively counteracted the inflationary pressures arising from the exit of the lira from the exchange rate mechanism of the EMS in 1992 and the depreciation shock in 1995. This period of monetary restriction, lasting from 1994 to 1996, succeeded in reverting the trend in the exchange rate and promoting price stability. The structural factors that limited the anti-inflationary effectiveness of policy were de-emphasized in the policy debate.[10]

3. Monetary policy shocks and the structural VAR approach

An empirical analysis of the effects of monetary policy shocks over an extended period of time is warranted by the range of opinions prevailing over the past decades; in addition, such an exercise allows a comparison of the Italian case with the results in the international literature which, using structural VARs estimated over long sample periods, has identified a few "stylized facts" that occur after a benchmark monetary policy shock. [11] As it has been

[9] See the Governor's *Concluding remarks* in the Bank of Italy's *Annual Report* for the years 1994, 1995, 1996.

[10] Spaventa (1995) argues that a model of monetary policy "impotence" is no longer supported by the facts and that the transmission channel of monetary policy may work again. Gaiotti, Gavosto and Grande (1998) find evidence of an important "expectations" channel of monetary transmission in 1986-1996, i. e. they found evidence of an effect of monetary policy on price expectations and of price expectations on actual prices.

[11] For a summary of the main findings in the US VAR-based literature see also Sims (1996), Sims and Zha (1996), Leeper, Sims and Zha (1996).

widely discussed, the VAR approach does not give an answer to the question of the overall role of monetary policy (which includes both its systematic and unsystematic components); however, it may help shed light on the features of the model of transmission of policy shocks to output and prices.

Christiano, Eichenbaum and Evans (1997b) and (1997c) review the main results in the literature on the effects of monetary policy shocks. They conclude that a few robust regularities emerge in the US; among these, they quote the following stylized facts observed after a restrictive shock.

Output falls: after a delay of about six months, there is a sustained decline in GDP; the response function is hump-shaped, with a maximum fall after about twelve-eighteen months. Prices move initially very little: the GDP deflator is flat for about a year, then it starts to decline. Real wages do not move, or decrease a little, as the response of nominal wages is similar to that of prices. Moreover, after a monetary shock there is a persistent rise in the federal funds rate and a decrease in monetary aggregates. Christiano, Eichenbaum and Evans argue that these facts help to discriminate between competing models of the monetary transmission mechanism; in particular, they argue that these facts are not consistent either with models that stress the role of sticky nominal wages in monetary transmission - according to which real wages should rise after a restriction - or with models based on imperfect information and noisy price signals – which imply an immediate change in the price level after a shock. In their view, models featuring price stickiness (where firms do not immediately adjust prices and output falls) or liquidity effects stemming from limited participation in the financial markets (where a restrictive shock causes banks' reserves and loanable funds to decrease and interest rates to rise) are a more promising direction for research.

The main feature of a VAR is the focus on cross-correlations among a limited number of macroeconomic variables, avoiding strong identifying assumptions and imposing only a parsimonious set of restrictions to interpret the results:

(1) $$\mathbf{C(L)y}_t = \mathbf{u}_t$$

In (1), C(L) is a matrix-polynomial in the lag operator (with C_0=I), y_t is the vector of endogenous variables and u_t is the vector of reduced-form errors, with cov(u_t)=Σ. Equation (1) is the reduced form of the structural model:

(2) $$\mathbf{A}_0\mathbf{y}_t = \sum_{i=1}^{n} \mathbf{A}_i \mathbf{y}_{t-i} + \varepsilon_t$$

where

(3) $$\varepsilon_t \equiv \mathbf{A}_0 \, \mathbf{u}_t$$

From (1) and (3), it is possible to derive the moving average representation:

(4) $$\mathbf{y}_t = [\mathbf{A}_0\mathbf{C}(\mathbf{L})]^{-1}\varepsilon_t$$

The coefficients of (4), the "impulse-response" functions, show the dynamic response of each endogenous variable to a shock on a structural equation, ε; in particular, they describe the response to an exogenous change in monetary policy. Isolating the exogenous component of monetary policy from its endogenous response to the economy is crucial to estimate its effects, since the empirical correlation between monetary policy, output and prices may be due to reverse causation. While the impulse responses are not an estimate of the total effects of monetary policy (they do not measure the effect of the systematic component of monetary policy), they allow us to test the implications of assumptions concerning monetary transmission mechanisms.

To derive (4), A_0 must be identified, given the estimation of C(L), u_t and Σ from (1). To this end, some restrictions must be imposed; a standard set of restrictions is that the covariance matrix of the structural disturbances (ε) is an identity matrix:[12]

(5) $$E(\varepsilon_t \varepsilon_t^{\,T}) = \mathbf{A}_0 E(\mathbf{u}_t \mathbf{u}_t^{\,T})\mathbf{A}_0^T = \mathbf{A}_0 \Sigma \mathbf{A}_0^T = \mathbf{I}$$

The remaining restrictions needed to identify the model may be imposed by constraining the links of simultaneous causality among the endogenous variables, i. e. setting

[12] Leeper, Sims and Zha (1996) justify this assumption arguing that a well-specified model should account for all the correlations among the variables, so that the disturbances have a diagonal covariance matrix.

some of the elements of A_0 to zero. As Christiano, Eichenbaum and Evans (1997b) show, this strategy to identify monetary policy shocks involves making enough assumptions to estimate the monetary policy rule. A common assumption is that at each time the nonpolicy variables do not respond to contemporaneous monetary policy shocks (A_0 is block-recursive); alternatively, if one adopts an identification scheme in which a policy shock has a contemporaneous impact on some nonpolicy variable, a broader set of restrictions must be identified, following the approach adopted by Bernanke (1986).

In the literature on monetary policy shocks, a number of empirical 'puzzles' have been shown to depend on the choice of inappropriate identifying assumptions:[13] a *liquidity puzzle* (monetary expansions are associated with increases rather than decreases in interest rates: Leeper and Gordon 1992), a *price puzzle* (monetary tightening is associated with a persistent increase in the price level rather than a decrease: Eichenbaum 1992), an *exchange rate puzzle* (monetary contractions in open economies are associated with an impact depreciation of their currency: Grilli and Roubini 1995). The liquidity puzzle disappears when the policy instrument is measured by a short term interest rate or by a reserve aggregate, rather than by a broader monetary aggregate (Bernanke and Blinder 1992); the price puzzle disappears when current and lagged values of commodity prices (which represent information about future inflation) are included among the arguments of the policy rule (Sims 1992); the exchange rate puzzle has been addressed by assuming that the central bank looks at contemporaneous values of the exchange rate when setting its short term rate (Kim and Roubini 1995).

4. Specification of the model: a measure of monetary policy

We estimate a 6-variable VAR, including: GDP, reported monthly by the Chow-Lin method using industrial production; the cost-of-living-index; contractual wages; the effective exchange rate of the lira; import prices; an interest rate measuring monetary policy. All series

[13] See the discussion in Kim and Roubini.

are monthly, from 1965 to 1997 (Fig. 1 and Fig. 2; see Appendix 1 for a full description of the data). The first five series are taken in logs. Seasonal dummies are used.

The choice of the variables and their behavior needs to be discussed. The inclusion of the exchange rate rests on research that has shown that in open economies this variable has to be taken into consideration to obtain estimates of monetary shocks and their effects;[14] this is certainly true in Italy, where the external constraint has always been the main factor considered in monetary policy decisions. In Fig. 2, the behavior of the effective exchange rate is characterized by the two major depreciations in the 1970s (in 1973 and again in 1976, when the currency market was closed for forty days) and by the two main depreciations in the 1990s (in 1992 when the lira was forced out of the EMS, and in 1995, following both the international repercussions of the Mexican crisis and domestic political factors).

Wages and import prices are the 'cost-push' factors that have traditionally been considered important determinants of domestic price dynamics by most analyses of Italian inflation (e.g., Visco, 1995). Import prices have a twofold role here: their exogenous component measures shocks to international prices, and they also endogenously react to the effective exchange rate, the speed affecting the transmission of currency shocks to domestic inflation (pass-through). Inspection of Fig. 2 reveals the effect of the two oil shocks in 1974 and 1979, when import prices reached annual rates of increase of about 60 and 30 percent respectively, and the counter-shock in 1986, marked by a twelve-month rate of decrease of about 30 percent. The sharp increase in (lira-denominated) import prices in 1976 was linked to exchange rate depreciation; in contrast, a loose comparison with the behaviour of the exchange rate also suggests a lower pass-through of exchange rate depreciation to import prices in the 1990s, when twelve-month depreciation rates of the order of 20 percent were only partially reflected in import prices (the extent and determinants of 'pass-through' were an issue in the monetary policy debate in 1995). From an econometric standpoint, the inclusion of wages and import prices was found necessary to avoid a "price puzzle", as discussed in more detail below.

[14] E.g. Kim and Roubini (1995), Smets (1997a), Smets (1997b).

Most of the recent VAR literature on the Italian case uses short-term market rates as policy indicators; [15] this option is not feasible over a long period, since in the 60s and part of the 70s short-term markets did not exist or were heavily regulated.[16] We focus on the yield on two refinancing instruments used by the Bank of Italy: the effective 'fixed-term advances' (FTA) rate from 1967 to 1984 and the auction rate on repo operations with the banking system from 1985 to 1997. Thus, we follow the approach by Bernanke and Blinder (1992), using an interest rate, rather than a reserve aggregate, as a policy measure. [17]

The choice is based on the monetary policy operating procedures followed by the Bank of Italy. After conducting monetary policy in the 1950s and 1960s mainly by directly or indirectly regulating banks' liquidity,[18] the use of interest rates was reactivated in 1967. In 1967 the instrument of 'fixed-term advances' (FTA: short-term collateralized loans granted to banks' upon request, at the discretion of the Bank of Italy) was created; since 1969 (and until 1991) the interest rate on FTA was set equal to the discount rate plus a variable spread, which increased with the frequency of borrowing (for the explicit purpose of making it more reactive to market conditions). A restriction in the supply of reserves through open market operations forced an increased recourse to borrowing and was readily reflected in an increase in the FTA rate. In the 1970s, fixed term advances represented a major source of central bank financing to the banking system.

In 1981, open market repurchase agreements on Treasury securities were introduced; they have rapidly become the most important source of liquidity for the banking system. Interest rates on repos were determined at variable-rate auctions; by defining the supply of repos, the Bank of Italy aimed to affect the repo rate and, indirectly, market rates: the T-bill

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[15] See the multi-country studies by Gerlach and Smets (1995), Smets (1997b), Kim and Roubini (1995). Kim (1994) estimates a VAR over a longer period using a long-term interest rate as a monetary policy indicator. See also, among others, Bagliano and Favero (1996), Buttiglione and Ferri (1994), Gaiotti, Gavosto and Grande (1998).

[16] A complete development of effective market mechanisms for the indirect transmission of monetary policy was completed at the beginning of the 1990s (see Gaiotti, 1992).

[17] The issue of using a reserve measure rather than an interest rate is left as a topic for further research. However, no explicit decision to target reserves was ever taken by the Bank of Italy in the period considered, unlike the Fed. Recently, De Arcangelis and Di Giorgio (1998) have shown that interest rates should be preferred to reserves in the 90s.

[18] The instruments used are discussed by Fazio (1969) and Fazio (1979).

rate, as discussed by Caranza and Fazio (1983), and the overnight rate, as shown by Buttiglione, Del Giovane and Gaiotti (1997). [19]

Throughout the whole period, the discount rate, changed in discrete steps by the monetary authorities, also had a signalling effect for the private sector; however, it had limited relevance as a cost to banks (almost no funds were actually supplied at this rate). The official rate is compared with the FTA and the repo rate in Fig. 3. Their movements track the starting dates of the main restrictions, obtained from narrative accounts of the last 30 years by Fazio (1979), Caranza and Fazio (1983), Angeloni and Gaiotti (1990). The figure includes two major restrictions in the 60s (September 1963, summer 1969); two in the 70s (March 1974, 1976); one at the beginning of the 1980s; three tightening episodes in that decade (fall 1984, the end of 1985 and fall 1987); two major episodes in the 1990s, June-September 1992, when monetary policy was tightened during the exchange rate crisis, and 1994-1995, when monetary policy was tightened in reaction to inflationary pressures and a depreciating exchange rate.

5. Estimation and identification: the role of the exchange rate

There are many possible breaks in our sample: the end of the Bretton Woods system in 1973; the joining of the EMS in 1979 and the restriction at the beginning of the 1980s; the exit from the EMS in 1992. Following an Akaike criterion (Tab. 2), we split the sample in 1981, estimating two VARs: 1967-1980 and 1981-1997. The parsimonious choice of break-points is due to the dimensions of the VARs, which would otherwise run into degrees-of-freedom problems; within these periods, the results of recursive Chow tests were somehow more mixed than those of information criteria, but did not rule out completely the hypothesis of stability, as Fig. 4 shows[20].

[19] From 1973 to 1983 direct credit controls were also used (ceilings on bank lending and constraints on the composition of banks' portfolios); their role in policy implementation was by no means minor, but they were a complement, not a substitute, for indirect monetary instruments and interest rate policy. For a discussion, see Cotula and Rossi (1989) and Fazio (1979).

[20] Structural instability is a common finding in VARs estimated over long periods. Sims (1996) argues that an information criterion (Akaike or Schwartz) is a consistent decision procedure to check whether the VAR

The VAR includes lags 1, 2, 3, 6, 9, 12 and 13. The inclusion of 13 lags was necessary to obtain non auto-correlated residuals; the exclusion of some of the intermediate lags aims at gaining degrees of freedom. Autocorrelation and normality tests are satisfactory once a few outliers are accounted for with point dummies (Tab. 1). Although we did not explicitly consider cointegration relations, a Johanssen rank test showed the existence of at least two cointegration vectors.

Identification is obtained by means of restrictions on the simultaneous causality between the variables. We start from a recursive structure for the A_0 matrix in equation (3) above, with variables ordered as GDP(y), wages (w), consumer prices (p), the exchange rate (e), import prices (p*), the monetary indicator (r); i. e., we assume that the private sector variables (excluding the exchange rate) do not immediately react to monetary policy shocks, while the monetary authority takes into account all current-period information on output, wages and prices in deciding its behaviour; this assumption looks reasonable given the monthly frequency of the data.

We depart from the recursiveness assumption only to allow simultaneous causality between the exchange rate and the interest rate: this is necessary since it has been shown that the use of a recursive ordering in systems that include the exchange rate may give rise to an "exchange rate puzzle", i. e. a depreciation after a monetary restriction (see the discussion in Christiano, Eichenbaum and Evans (1997b).

$$(6) \qquad y_t = \begin{pmatrix} y \\ w \\ p \\ e \\ p^* \\ r \end{pmatrix} \qquad A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ -a_{21} & 1 & 0 & 0 & 0 & 0 \\ -a_{31} & -a_{32} & 1 & 0 & 0 & 0 \\ -a_{41} & -a_{42} & -a_{43} & 1 & 0 & -a_{46} \\ -a_{51} & -a_{52} & -a_{53} & -a_{54} & 1 & 0 \\ -a_{61} & -a_{62} & -a_{63} & -a_{64} & -a_{65} & 1 \end{bmatrix}$$

Model (6) is then under-identified. The solution generally envisaged in the literature is to find variables that are pre-determined with respect to the monetary shock and represent

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should be estimated over sub-samples, viewing "time-invariance as always more or less good approximation." An example of the alternative approach is Bagliano and Favero (1997) .

valid instruments for the exchange rate in the policy reaction function. The relations that link the reduced-form residuals (u) to the structural disturbances (ε) are:

$$u_r = a_{64}\ u_e + a_{65}\ u_{p^*} + [\ a_{61}\ u_y + a_{62}\ u_w + a_{63}\ u_p\ ] + \varepsilon_r \tag{7}$$

$$u_e = a_{46}\ u_r + [\ a_{41}\ u_y + a_{42}\ u_w + a_{43}\ u_p\ ] + \varepsilon_e \tag{8}$$

$$u_{p^*} = a_{56}\ u_e + [\ a_{51}\ u_y + a_{52}\ u_w + a_{53}\ u_p\ ] + \varepsilon_{p^*} \tag{9}$$

where (7), (8) and (9) are derived from (6) and (3) above (the variables in square brackets are predetermined). Equation (7) is the policy reaction function, written in the form of residuals, stating that monetary conditions are tightened when the exchange rate depreciates (a_{64} is expected to be negative) and that they may react to import prices p* (a_{65} is either zero or positive); equation (8) states that the exchange rate appreciates when monetary conditions are tightened (a_{46} is expected to be positive). Equation (9) describes the contemporaneous impact of the exchange rate on import prices (that are lira-denominated); allowing for incomplete pass-through in the short run, a_{56} is expected to be between zero and one.

Following the approach in Smets (1997b), we use shocks to the German interest rate, the dollar/DM rate and world raw material prices[21] as instruments for u_e and u_{p^*} in equation (7);[22] the underlying assumption is that these variables have a direct impact on the exchange rate and import prices, but beyond that they have no direct effect on the policy rate. The identification of (7) allows us to recover the policy shocks, estimate equations (8) and (9) and recover the matrix A_0.

The resulting estimates are shown in Tab. 3 (with t-statistics in brackets); in the final estimate of the reaction function, the coefficient for u_{p^*} was set equal to zero, after testing the restriction. The signs are as expected: the policy rate is decreased in reaction to an appreciation (15 and 30 basis points, respectively in the two sample periods, for each

[21] These shocks are constructed as innovations from an auto-regressive model of these variables.

[22] Smets (1997b) uses residuals of both an international interest rate and of the dollar/DM exchange rate as instruments to estimate the equivalent of equations (7) and (8). Kim and Roubini (1995) and Smets (1997a) augment the VAR by including an international interest rate and imposing the identifying assumption on the A_0 matrix.

percentage point of appreciation); in turn, the estimate of a_{46} implies that a one percentage point increase in policy rates induces a contemporaneous appreciation of around 40 basis points: there is no "exchange rate puzzle". The simultaneous effect of the exchange rate on import prices (p*) is positive but less than one (about 0.3), implying an incomplete pass-through in the short run.

6. The transmission of monetary shocks

Fig.5 reports the estimated monetary shocks and their six-month moving average (a smoothed measure of the non-systematic stringency of monetary policy). Comparing the estimated shocks with the dates of the main restrictions, the latter coincide or are immediately followed by a period of unusual monetary tightness.

Over both sample periods, the properties of the model are consistent with both theoretical priors and the benchmark results of the VAR literature (Fig. 6 and Fig. 7); in addition, they match many anecdotal features of Italian inflation.

The role of shocks to wages and to the exchange rate in affecting the pattern of Italian inflation is confirmed. The price level increases after a shock to wages and to import prices; it decreases after a positive shock on the exchange rate.

In addition, monetary policy matters throughout the whole period. The effects on output show up after 6-12 months, peak after 18 months and then fade out; the dynamics are similar to those discussed by Christiano, Eichenbaum and Evans (1997b). The effects are substantial: if a one-percent interest rate shock is maintained for one year, the effect on output is between 1 and 0.5 percentage points below baseline.

The effects of monetary disturbances on prices are significant and permanent, but they build slowly, reaching their full effect after about three years. The response functions do not display a "price puzzle", which is common in the VAR literature, i. e. a positive effect of a monetary restriction on prices; as mentioned, the price puzzle is usually attributed to omitted variables and solved by considering the effect of exogenous changes in commodity prices on consumer prices. The inclusion of wages and import prices in our VAR was found necessary to avoid the puzzle: once the effect of exogenous shocks to these variables is accounted for, a

significant negative monetary effect emerges. In contrast, a price puzzle appears in all specifications in which wages and import prices are omitted from the set of variables (Fig. 8). The exogenous components of import prices and wages play the role assigned to international commodity prices in most of the VAR literature: they signal future increases in prices (Christiano, Eichenbaum and Evans 1997b).

Real and nominal effects of monetary policy are significant in both sample periods; however, before 1980, the response of inflation is larger. Eighteen months after a one-standard-deviation shock, the price level is respectively 0.5 percent and 0.1 percent below baseline in the first and second periods; the confidence bands do not overlap (Tab. 4 and Fig. 9); the response of output also decreases, but just above the one-standard deviation band. A different shape of responses to monetary shocks in different periods is also found by Christiano, Eichenbaum and Evans (1997b) for the US, who find smaller response functions in the period 1989-1995 than in 1965-1995; however, they attribute this result to the different size of a standard monetary shock, concluding that in the US the post-1989 period is characterized by smaller shocks but similar responses to a given shock. This is not the case here; the different shape of responses holds also comparing the effects of unit (one percent), rather than one-standard-deviation, interest rate shocks (Tab. 4). It could be argued that the pegging of the exchange rate in the 1980s may have decreased the size and duration of the effects of nominal shocks on prices; the same effect could be expected as a consequence of the orientation of monetary policy to price stability, representing a stronger nominal anchor.[23] In any case a weaker response of prices to monetary policy shocks in the 1970s is not found.

The variance decomposition in Tab. 5 also shows a lower contribution of monetary shocks to output and price variance after 1980; in neither period are monetary shocks the main source of fluctuations in real activity, as they account for about 10 per cent of output variance, a result consistent with most international findings for the post-war period. The contribution of monetary shocks to price variance is somewhat higher (22 and 11 percent).

[23] The fact that the output response to a monetary shock does depend on the policy rule is discussed by Cochrane (1997).

All in all, the VAR model leads to different conclusions from existing structural models of the Italian economy, which usually feature strong monetary effects on output and minor effects on prices; an example of the latter result is Nicoletti Altimari et al. (1995), where the effects of monetary policy on prices takes up to 6 years to materialise. The difference between VARs and structural model estimates was discussed by Gaiotti, Gavosto and Grande (1998), limited to the last ten years (1986-1996); it is noteworthy to find that it also holds in a much longer sample. The different results in VARs and in the Bank of Italy quarterly model may partly depend on the fact that, in the main version of the model, an exogenous exchange rate is assumed; Nicoletti Altimari et al. (1995) and Gaiotti and Nicoletti Altimari (1996) show that if this assumption is removed a stronger effect of monetary policy on prices is found.

As far as wages are concerned, the pattern of their response to a monetary shock is broadly similar to that of prices (Fig. 9). As a consequence, after a restrictive shock, initially the real wage does not move much (Fig. 10); however, after about one year it increases temporarily. The increase is particularly relevant in the pre-1980 period. The increase in the real wage - albeit modest - does not match the finding of Christiano, Eichenbaum and Evans (1997b) for the US, i. e. a slight decline in the real wage in response to a monetary shock; in the Italian case, wage stickiness may play a larger role in explaining the real effects of monetary policy.

The exchange rate appreciates immediately after a monetary shock, it then starts to depreciate slowly (Fig. 10); it is back to baseline after one and a half - two years. This response is consistent with a standard model in which the exchange rate ‘overshoots’, featuring an immediate appreciation and a subsequent depreciation to compensate for the temporarily higher domestic rate. Import prices also fall rapidly, although not instantaneously, implying an incomplete pass-through. The fall in import prices leads the fall in consumer prices by several months; the exchange rate is an important channel of monetary transmission to prices and may indeed account for the large price response. A major role for the exchange rate implies that considerable caution should be used when extending the results obtained for domestic economies to the transmission of the single monetary policy after 1998.

The effects on prices of shocks to the wage and to the exchange rate equation are also smaller after 1980 (Fig. 11); the same holds for the response of wages to price shocks. A variance decomposition (Tab. 5) also shows that the share of price fluctuations accounted for by external shocks is higher before 1980 than afterwards (respectively, 13 and 2 percent of price variance is accounted for by exchange rate shocks, 41 and 13 percent by import price shocks). The dampening of 'cost push' effects on prices during the 1980s and the 1990s may be due to the gradual removal of indexation, as well as to the commitment of monetary policy to price stability and to the pegging of the exchange rate in the 1980s. Before 1980, an adverse price shock had no effect on the real exchange rate (Fig. 12),[24] as the higher price level was rapidly followed by a nominal devaluation; after 1980, an adverse price shock led to a real appreciation. This behaviour is suggestive of the different policy regime: the negative feedback of a price shock on demand through the real appreciaton, was a key factor in the 1980s disinflation according to Gressani, Guiso and Visco (1988).

An important issue in evaluating the results is the appropriateness of the monetary indicator that we employ. Two objections could be raised: we use an interest rate whose behaviour is partly market-determined and subject to considerable volatility, which may bias the estimate; from this standpoint, it may be argued that the official discount rate, which is a variable under the control of the Bank of Italy, may yield significantly different results. Moreover, the extensive use of credit ceilings between 1973 and 1983 may also bias the results, although the sign of the effect is theoretically indeterminate.[25]

We address both issues with a robustness check. Fig. 13 compares the responses to a monetary shock with those obtained using the discount rate as a monetary policy measure. They are broadly similar; the effects on output are somewhat stronger when the official rate is used. This may reflect the stronger signalling effect of this rate and a faster transmission to bank rates, as shown by Buttiglione, Del Giovane and Gaiotti (1997). To consider the existence of direct controls on bank lending in 1973-1983, we also re-estimated the VAR

[24] The real exchange rate is constructed as the difference of the responses of the nominal exchange rate and of the price level.

[25] Marano (1996) shows that the effect of the existence of credit ceilings on the estimate of the effect of changes in policy rates is ambiguous.

controlling for the quantity of bank loans; two lags of the log of bank loans were introduced as an exogenous variable. The results are also shown in Fig. 13; in this case, too, the response functions are not very sensitive to the introduction of the new variable.

7. Conclusions

The objective of this paper was to estimate the effects of monetary policy shocks in Italy using a structural VAR over a long data sample, filling a gap in the empirical literature.

The interest rates on the main refinancing operations of the Bank of Italy (fixed-term advances in the 1970s, repurchase agreements since the 1980s) are appropriate measures of monetary policy, yielding plausible responses of the main macroeconomic variables from the standpoint of economic theory.

Monetary policy matters; the responses of output and prices to a restrictive monetary shock are consistent with the main findings in the literature. Output decreases substantially, prices decrease more slowly. However, unlike the results obtained for the US, real wages increase moderately; this may indicate that wage stickiness has a larger role in explaining the real effects of monetary policy in Italy than in the US, particularly before 1980; this could be a factor to consider in assessing differences in transmission among euro area countries. The exchange rate appreciates immediately, then depreciates slowly, consistently with an "overshooting" behaviour. Import prices decrease rapidly; they precede by several months the response of consumer prices, suggesting that the exchange rate is an important channel of monetary transmission to prices. The role of the exchange rate in the transmission of monetary shocks suggests that considerable caution must be used when extending the results of exercises of this kind to the working of EMU post-1998.

The size of the estimated price responses is large. This is a major divergence from existing structural models of the Italian economy, which usually include strong effects of monetary policy shocks on output but fairly limited effects on prices. Notably, we found that monetary policy had a strong effect on inflation especially before 1980. Afterwards, the weaker response of prices may reflect the gradual weakening, and eventually the removal, of wage indexation, which took place from the early 1980s; it may also reflect the pegging of

the exchange rate until 1992 and, more generally, the stabilizing effects of a strategy of monetary policy aimed at controlling inflation.

Cost factors (i. e., wages, international prices, the exchange rate) are important determinants of Italian inflation; however, their role in the propagation of inflation also appears to have diminished post-1980, following the changes in monetary policy and in wage bargaining that took place during the 1980s and the 1990s.

Tables and figures

Tab. 1

DIAGNOSTIC TESTS (1)

	1967-1980	1980-1996
Vector AR - LM(4)	CHISQ(36) = 31.636, [68%]	CHISQ(36) = 49.431 [7%]
Vector normality	CHISQ(12) = 17.354 [14%]	CHISQ(12) = 14.415 [28%]

(1) The test statistics are computed using CATS. To obtain normality, five point dummies are included in the first sub-sample (70:1, 71:3, 72:12, 76:2 and 76:3) and three in the second sub-sample (92:9, 92:10 and 95:3).

Tab. 2

INFORMATION CRITERIA

Sample split:	Akaike criterion	Schwartz criterion
1974:1	- 46.9123	- 39.9460
1980:12	- 47.3503	- 40.3841
1992:10	- 31.5293	- 24.5630
whole sample(1)	- 47.1528	- 43.6625

(1) 1967:1-1997:12.

Tab. 3

STRUCTURAL IDENTIFICATION (1)

Sample	Equation
1967-1980	$u_r = -0.14\ u_e + 0.0\ u_{p^*} + [0.15\ u_y - 0.08\ u_w + 0.20\ u_p] + \varepsilon_r$ (1.2) (restr.) (1.4) (1.9) (1.3) restriction test: F(1,163)= 0.032 [86%] $u_e = 0.40\ u_r + [0.36\ u_y + 0.06\ u_w - 0.35\ u_p] + \varepsilon_e$ (2.9) (2.1) (0.8) (1.2) $u_{p^*} = -0.36\ u_e + [-0.47\ u_y - 0.10\ u_w + 0.99\ u_p] + \varepsilon_{p^*}$ (2.5) (1.4) (0.7) (1.9)
1981-1997	$u_r = -0.28\ u_e + 0.0\ u_{p^*} + [0.11\ u_y - 0.40\ u_w + 0.49\ u_p] + \varepsilon_r$ (0.6) (restr.) (0.6) (2.1) (1.1) restriction test: F(1,189)= 0.32 [57%] $u_e = 0.41\ u_r + [0.08\ u_y - 0.14\ u_w - 0.44\ u_p] + \varepsilon_e$ (4.8) (0.3) (0.8) (0.9) $u_{p^*} = -0.21\ u_e + [-0.04\ u_y + 0.49\ u_w - 0.35\ u_p] + \varepsilon_{p^*}$ (2.4) (0.1) (2.3) (0.6)

(1) - IV estimation. Instruments used in the u_r equation: u_y, u_w, u_p, shocks to the DM/dollar exchange rate, to the German interbank rate and to world raw material prices; u_e equation: u_y, u_w, u_p and the estimated ε_r; u_{p^*} equation: u_y, u_w, u_p and the estimated ε_e.

Tab. 4

RESPONSES TO A MONETARY SHOCK (1)
(standard deviation in parenthesis)

One standard deviation shock

	Output	Prices
a)1967-1980	-0.345	-0.464
	(0.184)	(0.162)
b)1981-1997	-0.103	-0.125
	(0.062)	(0.073)

One percentage point shock

	Output	Prices
a)1967-1980	-0.587	-0.834
	(0.335)	(0.289)
b)1981-1997	-0.132	-0.143
	(0.077)	(0.088)

(1) Responses after 18 months.

Tab. 5

VARIANCE DECOMPOSITION (1)

1967-1980

Shock to:	Output	Wages	Prices	Exchange rate	Import prices	Monetary shock
Variance of:						
Output	33.1	11.6	6.1	30.1	3.7	14.6
Prices	0.52	12.7	10.4	13.0	41.1	22.2

1981-1997

Shock to:	Output	Wages	Prices	Exchange rate	Import prices	Monetary shock
Variance of:						
Output	65.2	7.0	2.1	11.5	4.5	7.8
Prices	0.95	31.0	40.3	2.1	13.0	11.7

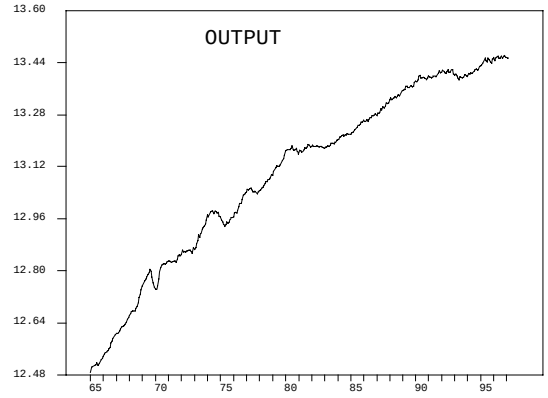
(1) Decomposition of 24-month ahead forecast variance.

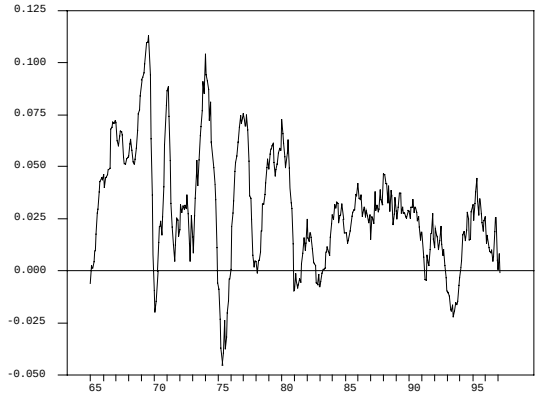
Fig. 1

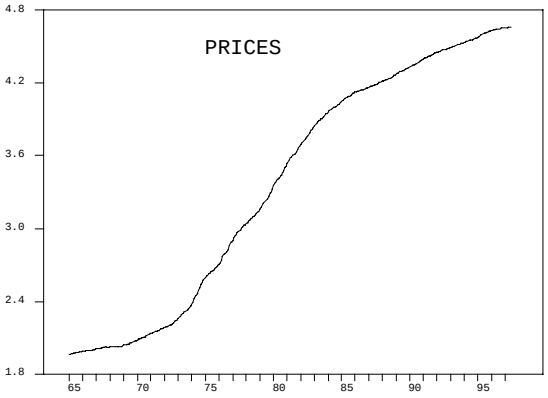
THE VARIABLES

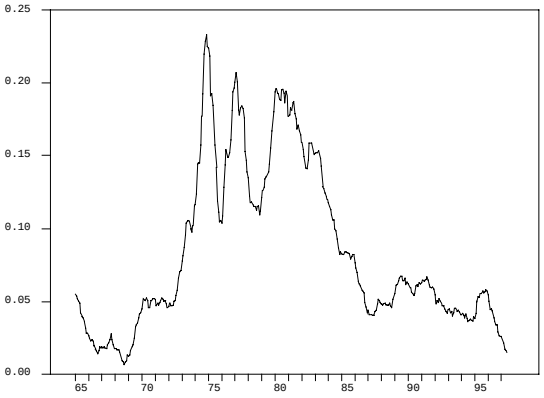
log-level

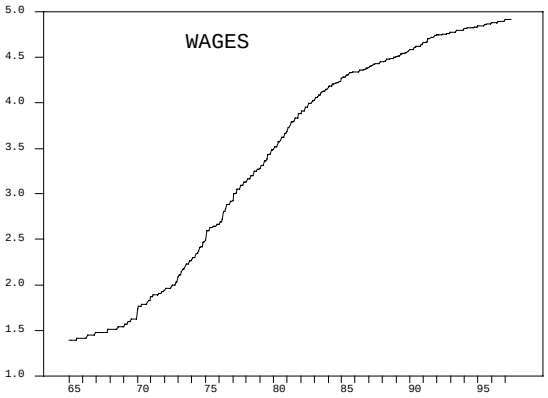
12-month log-difference











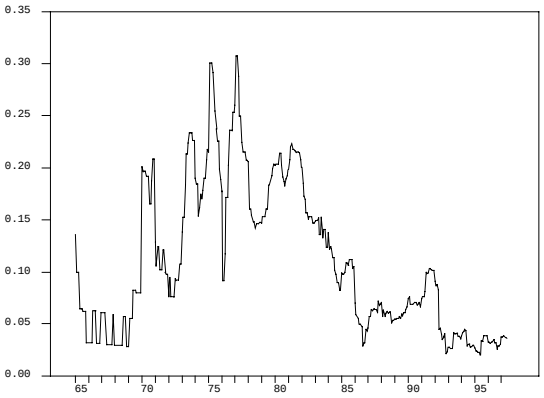


Fig. 2

THE VARIABLES

log-level 12-month log-difference

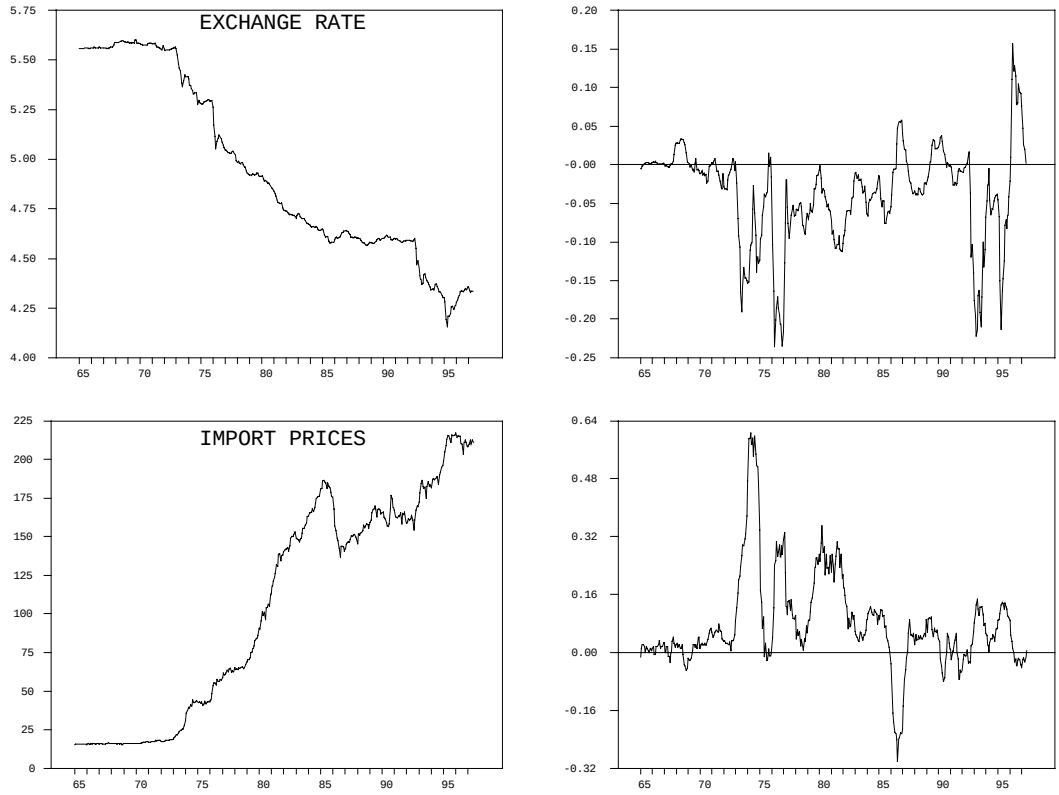
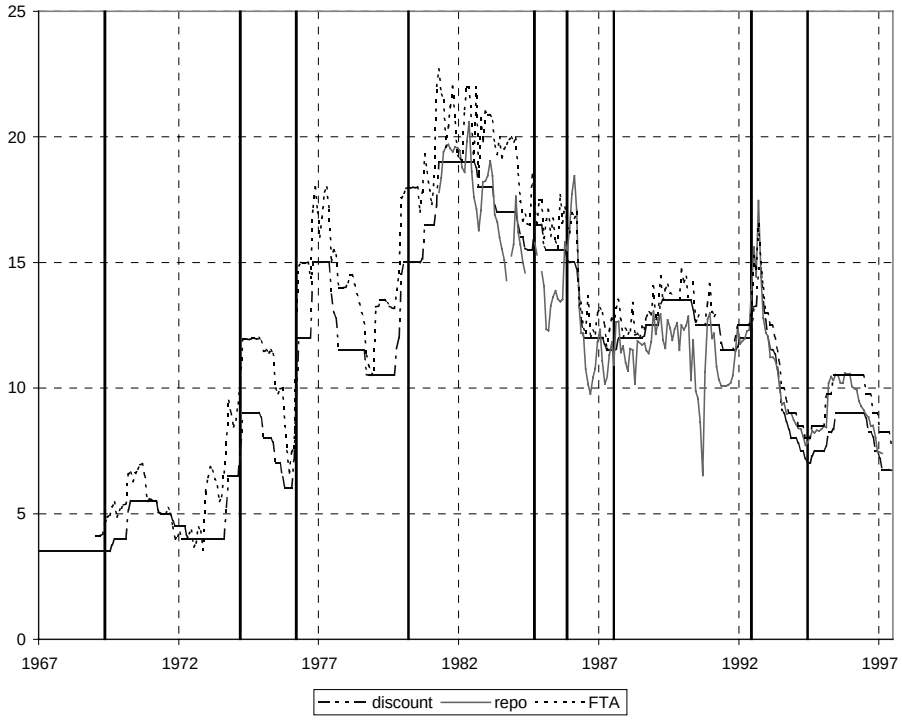


Fig. 3

INTEREST RATES (1)

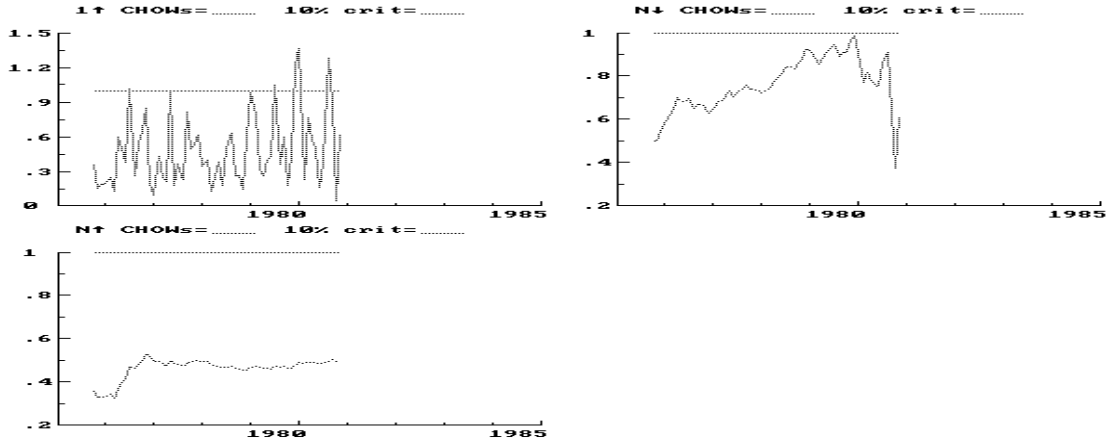


(1) The vertical lines indicate episodes of monetary restriction (see text).

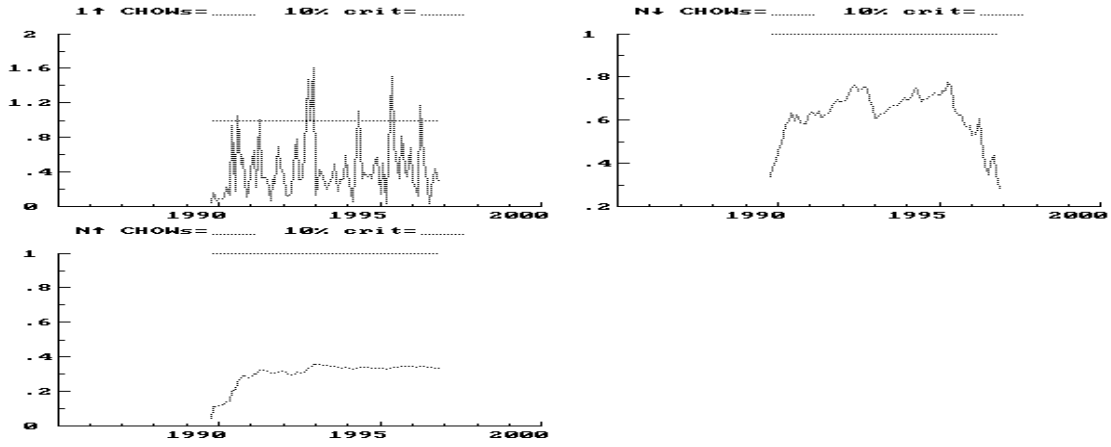
Fig. 4

RECURSIVE STABILITY TESTS (1)

1967-1980



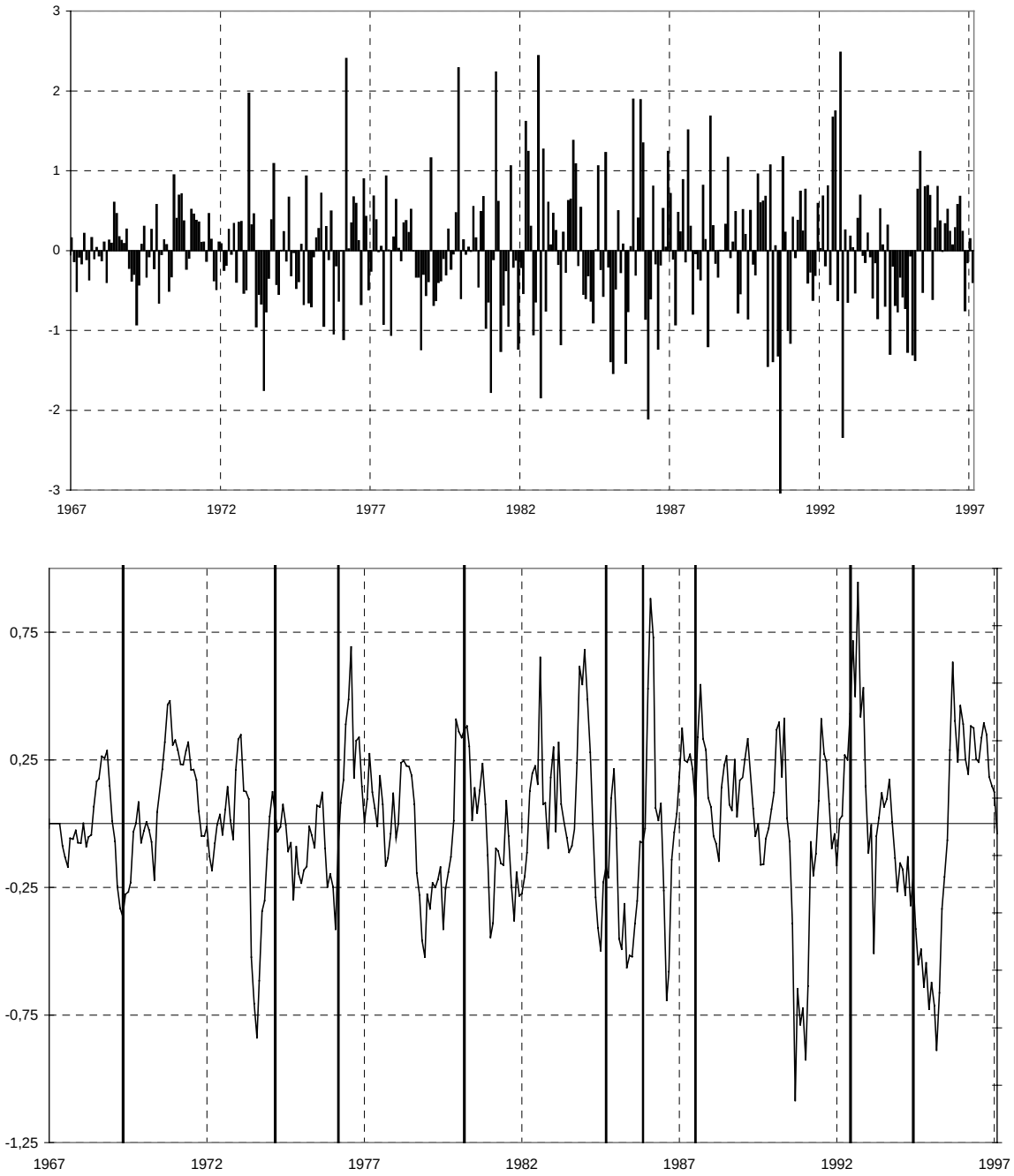
1981-1997



(1) The test statistics are computed using PC-FIML. See Doornik - Hendry (1994).

Fig.5

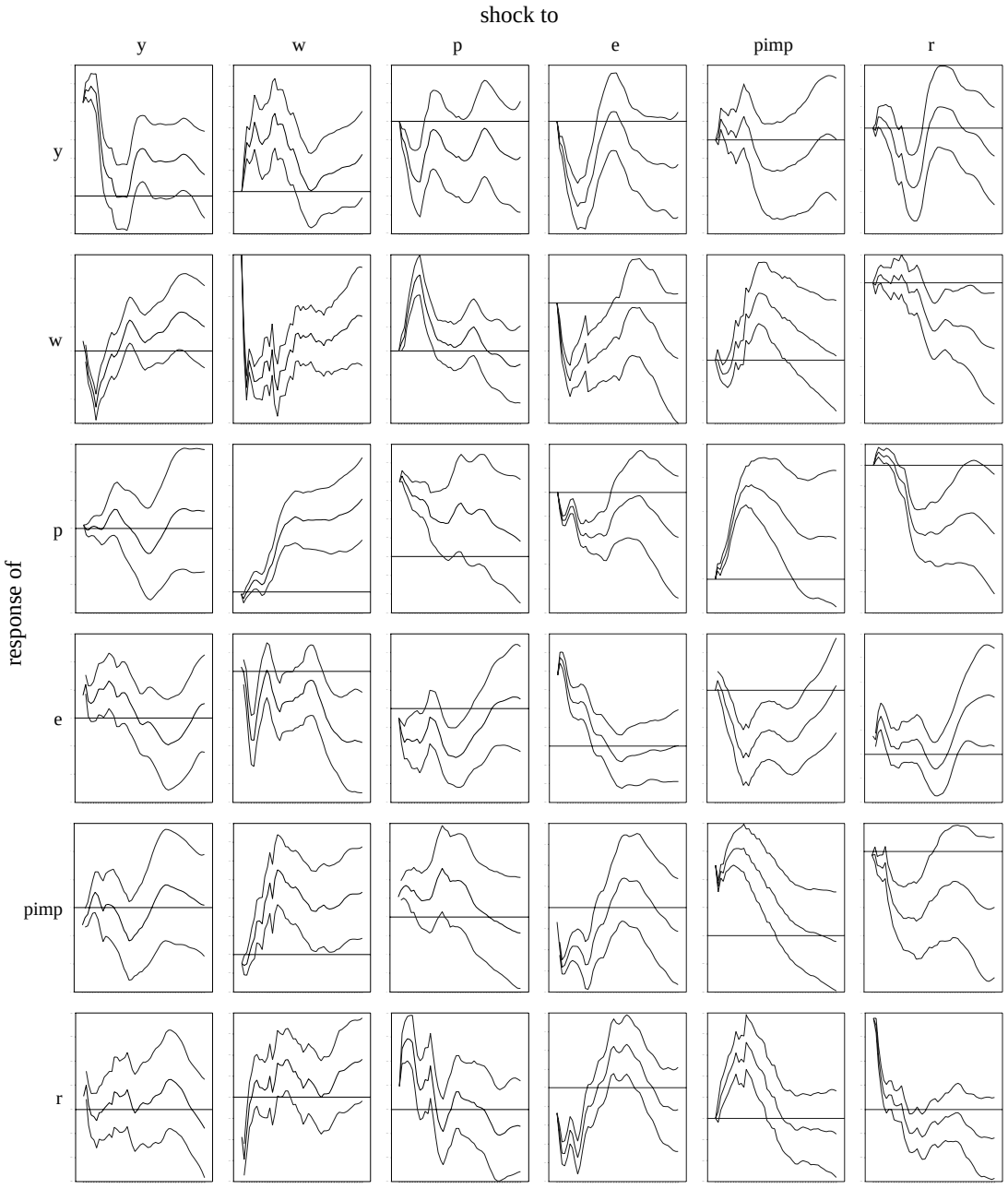
MONETARY SHOCKS (1)



(1) Structural monetary shocks (ε_r) estimated from the two VARs discussed in the text. Bottom panel: six-month moving average of the shocks, compared with the main restrictions (see text).

Fig. 6

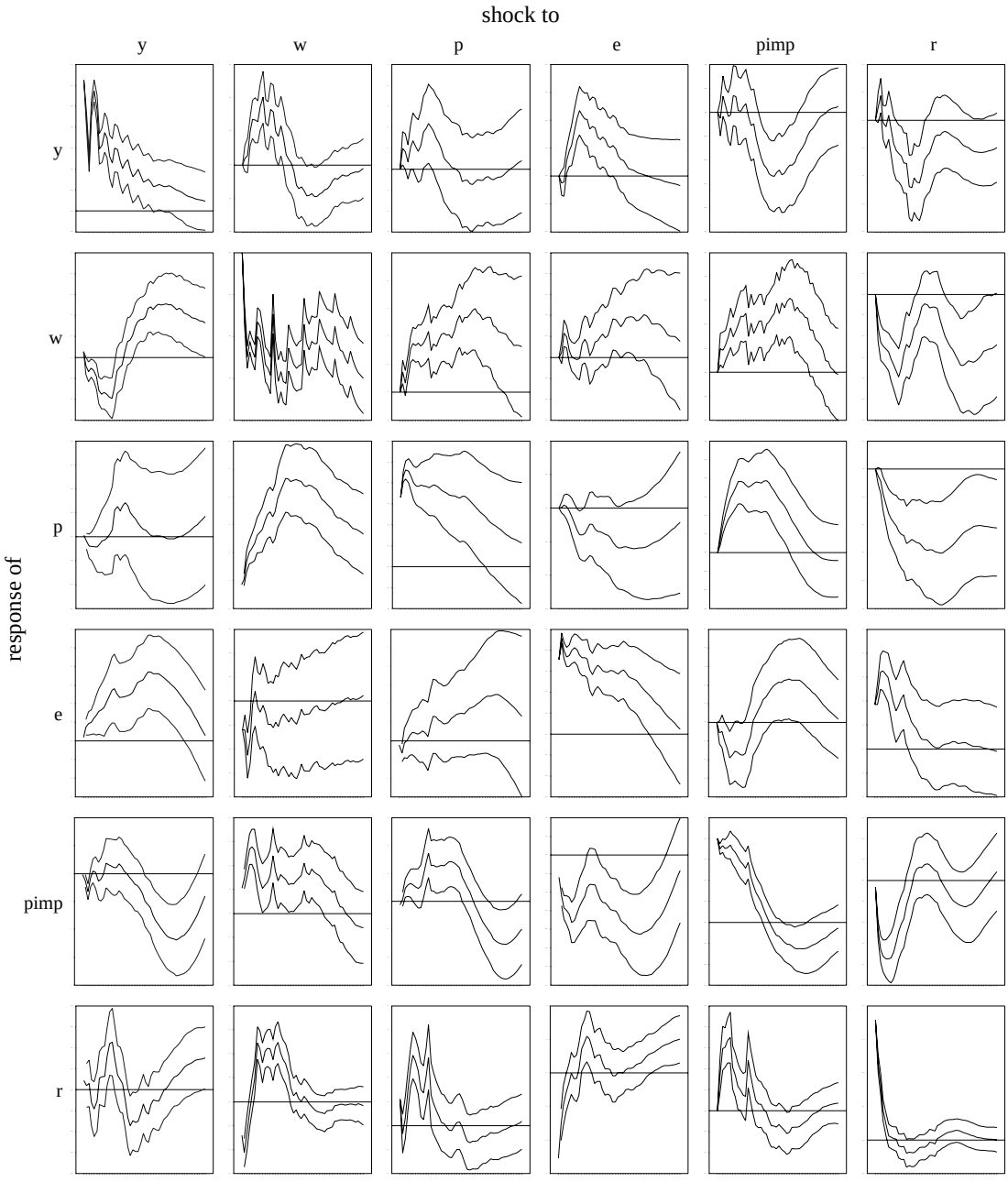
RESPONSE FUNCTIONS, 1967-1980



Y: output; w: wages; p; cost of living index; e: effective exchange rate; pimp: import prices; r: policy interest rate. One standard deviation bands are displayed.

Fig. 7

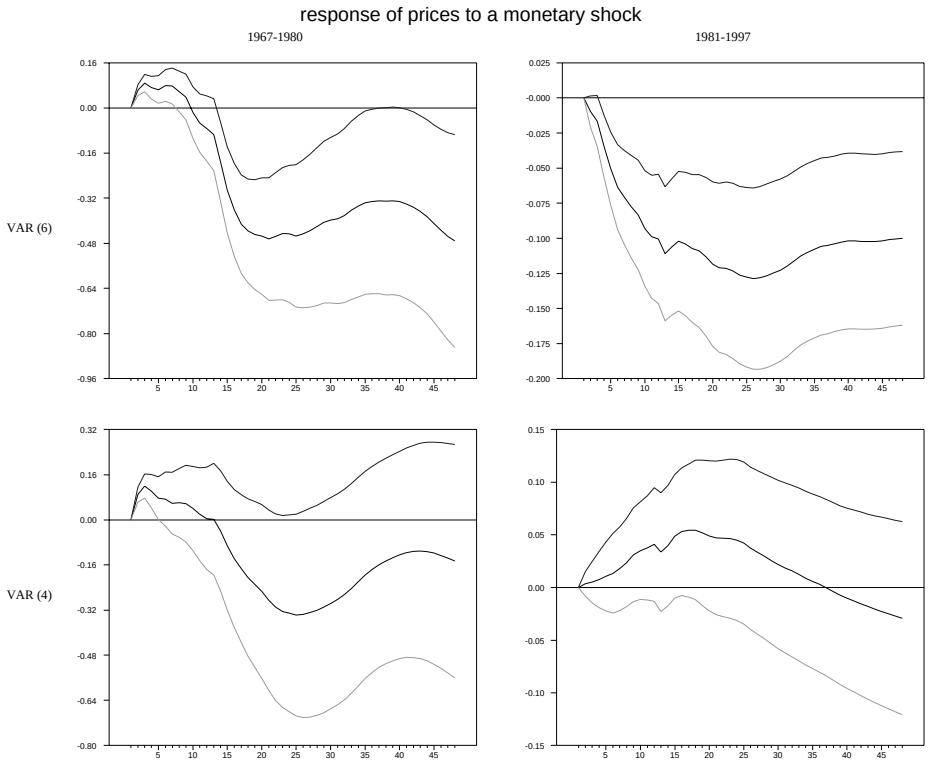
RESPONSE FUNCTIONS, 1981-1997



Y: output; w: wages; p; cost of living index; e: effective exchange rate; pimp; import prices; r: policy interest rate. One standard deviation bands are displayed.

Fig. 8

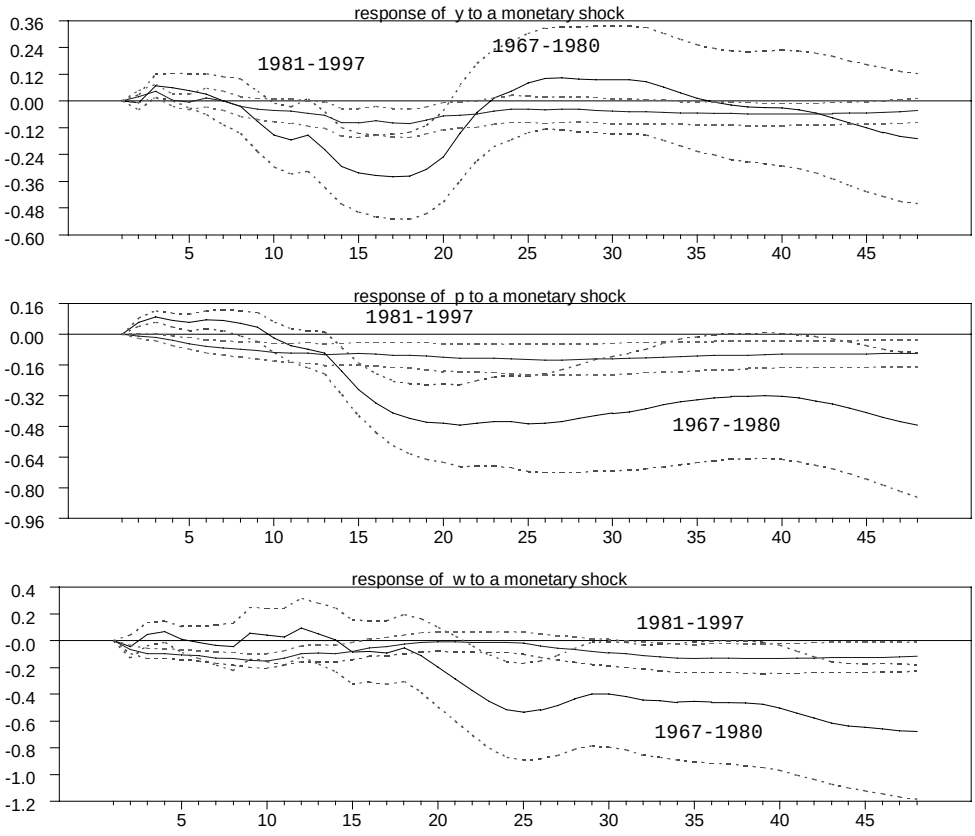
THE PRICE PUZZLE



Var (6) includes y, w, p, r , pimp, e; var(4) includes y, p, r, e. For the definitions of the variables, see note to fig. 6.

Fig. 9

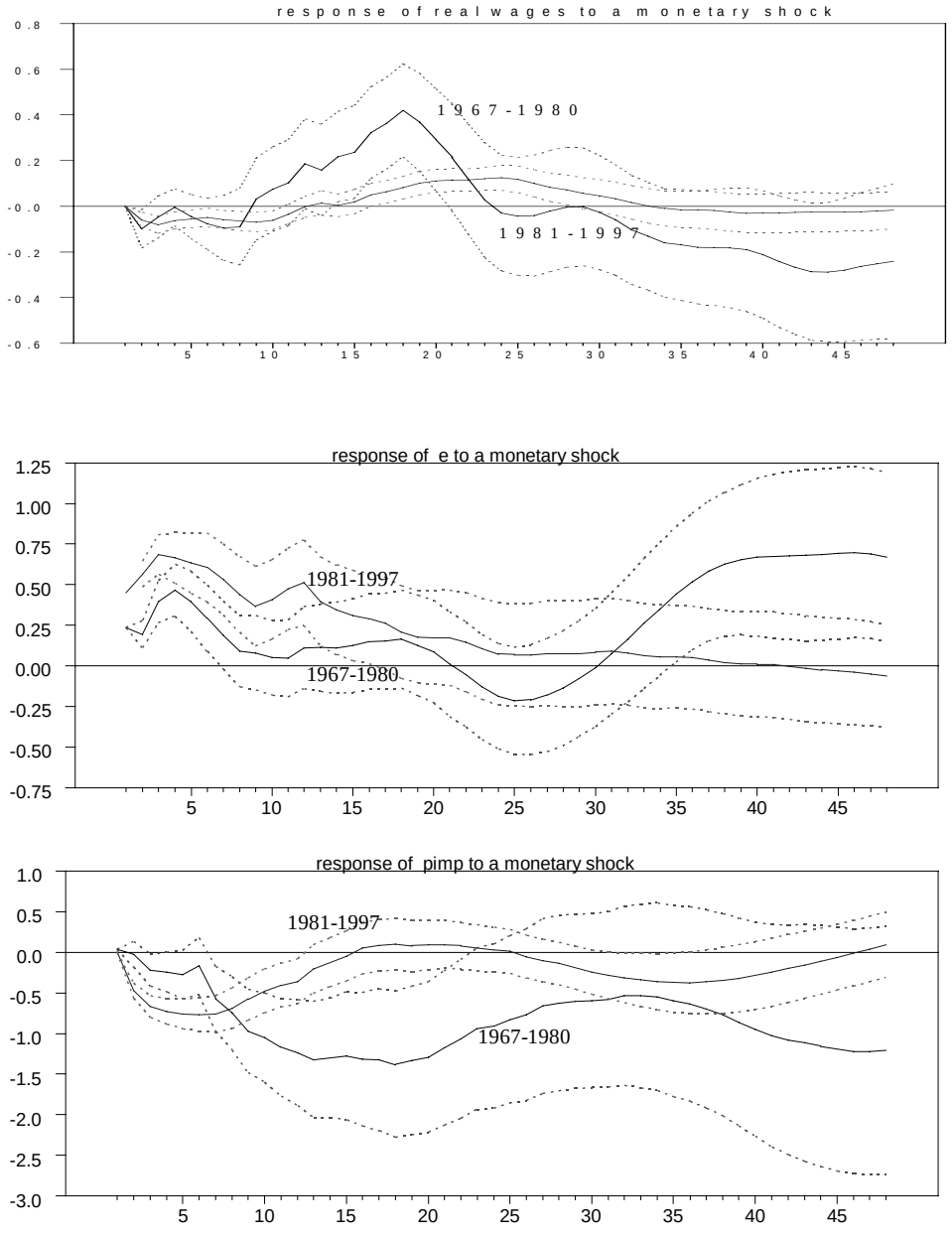
RESPONSES TO A BENCHMARK MONETARY SHOCK (1)



(1) Responses to a one-standard-deviation monetary shock. Percent deviations from baseline on the vertical axis.

Fig. 10

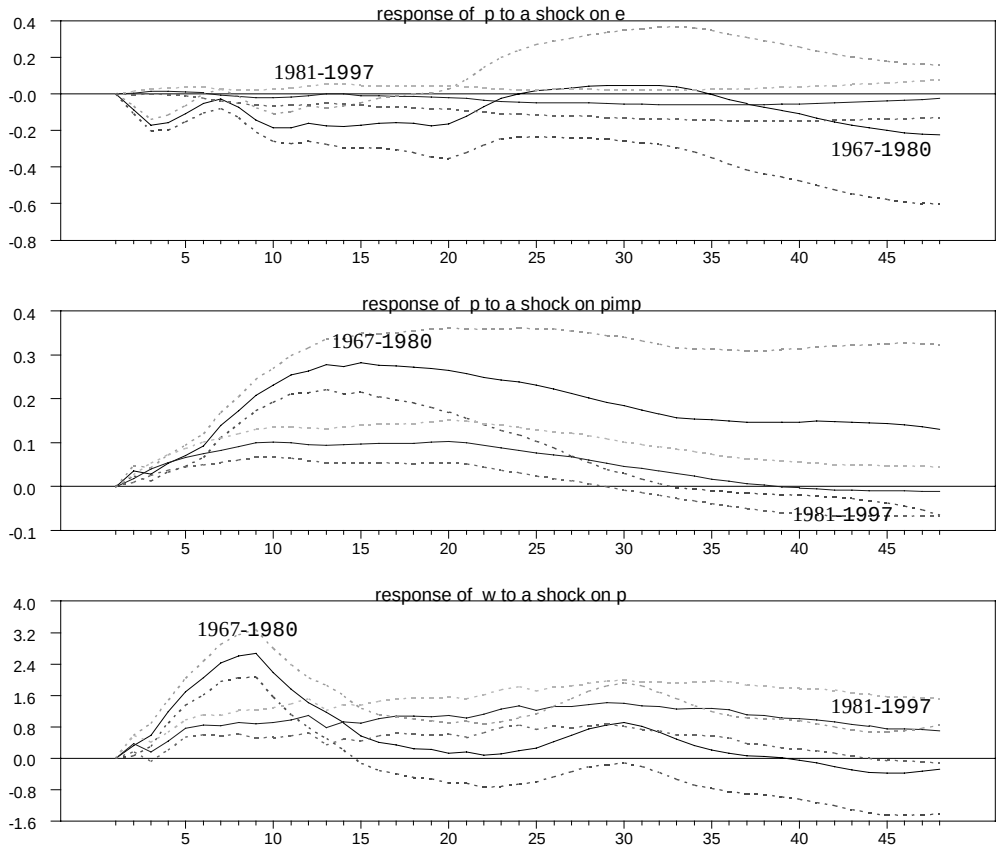
RESPONSES TO A BENCHMARK MONETARY SHOCK (1)



(1) Responses to a one-standard-deviation monetary shock. Percent deviations from baseline on the vertical axis. For the definitions of the variables, see note to fig. 6.

Fig. 11

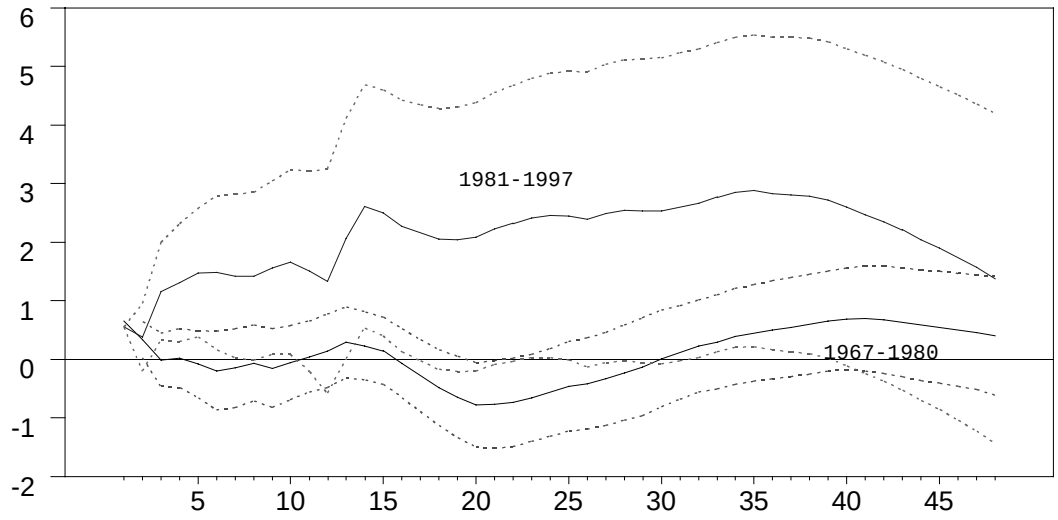
RESPONSES OF PRICES AND WAGES (1)



(1) Responses to a one-percentage point shock. Percent deviations from baseline on the vertical axis. For the definitions of the variables, see note to fig. 6.

Fig. 12

RESPONSE OF THE REAL EXCHANGE RATE TO A PRICE SHOCK(1)

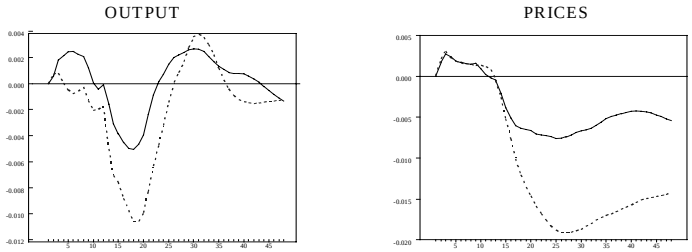


(1) Responses to a one percent shock. Percent deviations from baseline on vertical axis.

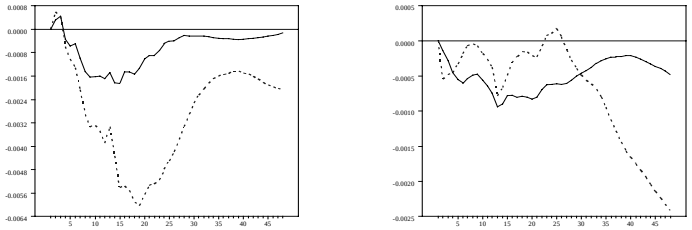
Fig. 13

MEASURES OF MONETARY POLICY

1967 - 1980

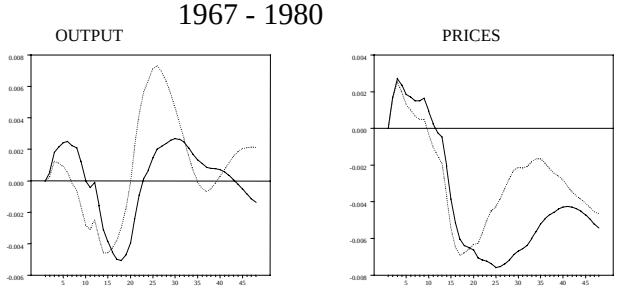


1981 - 1997

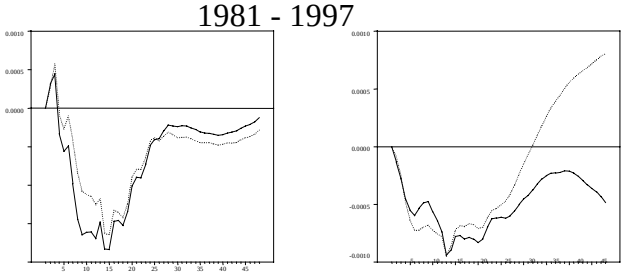


Straight line: responses to a monetary shock in the benchmark VAR. Dotted line: responses to a monetary shock when the discount rate is the monetary policy measure (see text)

1967 - 1980



1981 - 1997



Straight line: responses to a monetary shock in the benchmark VAR. Dotted line: responses to a monetary shock controlling for the quantity of bank loans (see text).

Appendix

Data sources:

Output: Gross Domestic Product (Istat, base 1990), monthly interpolated based on the index of industrial production, base 1990 (Chow-Lin method). Cost-of-living index: Istat. Contractual wages: International Monetary Fund, International Financial Statistics, line 65ey. Effective exchange rate: International Monetary Fund, *International Financial Statistics*, line neu. Import prices: International Monetary Fund, *International Financial Statistics*, line 75. Official discount rate (monthly average): Bank of Italy, CD ROM *Base Informativa Pubblica*, *s*eries S744716D. Effective rate on fixed term advances: from 1968 to 1970: Bank of Italy, *Bollettino*, various issues, table "Tassi del mercato monetario e finanziario"; from 1971:1 to 1991:3, Bank of Italy, CD ROM *Base Informativa Pubblica*, series S870253M; since 1991:4: Bank of Italy, CD ROM *Base Informativa Pubblica*, monthly average of the daily series S612077D. Marginal rate on repo operations: Bank of Italy, CD ROM *Base Informativa Pubblica*, monthly averages of daily observations of series S846195D and S194828D (marginal rates on repos and on reverse repos).

The FTA series has 25 missing observations (in the months when no operation was conducted); these were replaced by the sum of the discount rate and a linear interpolation of the FTA-discount rate differential (as discussed in the text, this rate used to be set as the discount rate plus a variable spread, increasing with the frequency of recourse to the facility). The official rate (section 5) is the discount rate (monthly average) until 1993, 3; the rate on fixed term advances (FTA) since 1993, 4 (since 1993, 4, the FTA rate is equal to the discount rate plus a fixed spread, set by the Bank of Italy, initially at zero).

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