The Industrial Impact of Monetary Policy Shocks: Some Stylised Facts

by

Joe Ganley

and

Chris Salmon

of England, Threadneedle Street, London, EC2R 8AH

iews expressed are those of the authors and do not necessarily reflect those of the Bank of England. We would like to thank Clive
ne, Danny Quah, Peter Westaway, Tony Yates, an anonymous referee and the participants of the Bank's Friday workshop serie
ents. Bruce Deville, Simon Frew, and Cheryl Hunter provided invaluable research assistance.

l by the Bank of England, London, EC2R 8AH to which requests for individual copies should be addressed: envelopes should b
ion of the Publications Group. (Telephone 0171-601 4030.)

ISSN 1368-5562

Contents

Abstract

This paper investigates the disaggregated effects of monetary policy shocks on the output of 24 sectors of the UK economy. The purpose of the analysis is to identify the speed and magnitude of the reactions of firms in these sectors to an unexpected monetary tightening; and to examine whether these responses provide any evidence on the transmission mechanism of monetary policy. The results indicate that the sensitivity of output to changes in monetary conditions differs markedly across industries.

I Introduction[1]

The monetary authorities need to understand how the effects of an unanticipated change in official interest rates pass through the economy. For example, which sectors respond first to a policy innovation and are the effects more pronounced in some sectors than in others? A comparison of the impact of monetary policy across different sectors may therefore provide valuable information for the monetary authorities on how monetary policy shocks are propagated through the economy. But as King (1994) notes, "the transmission mechanism of monetary policy is one of the most important, yet least well-understood, aspects of economic behaviour." Research so far has focused on the sectoral effects of monetary policy, to see if they enhance our appreciation of the aggregate transmission mechanism relationships. For example, Dale and Haldane (1995) compare the response of the UK personal and corporate sectors to unexpected changes in monetary policy, while Gertler and Gilchrist (1994) compare the response of small and large US manufacturing firms to these shocks.

This paper takes a similar approach and compares the response of output in 24 sectors of the economy - which sum to the output measure of GDP - to an unexpected monetary tightening. Our principal aim is to provide stylised facts about the sectoral responses to monetary policy innovations, to help assess how monetary policy developments feed through the economy. As a corollary, these facts might also provide some indirect evidence about the underlying nature of the transmission mechanism.

The paper is organised as follows: section II describes the sectoral basis of our data set, showing how the different sectors are related, and the contribution of each to total output. This helps to motivate the subsequent analysis. Section III briefly discusses our estimation method, which is a fairly standard VAR approach. In section IV we discuss our main results, establishing the stylised facts and drawing out similarities and differences across sectors. Section V considers whether the patterns observed within the manufacturing sector are correlated with industry-specific factors, (average firm size, profitability and concentration ratios), which could provide clues as to the factors underlying these patterns. Section VI summarises our results.

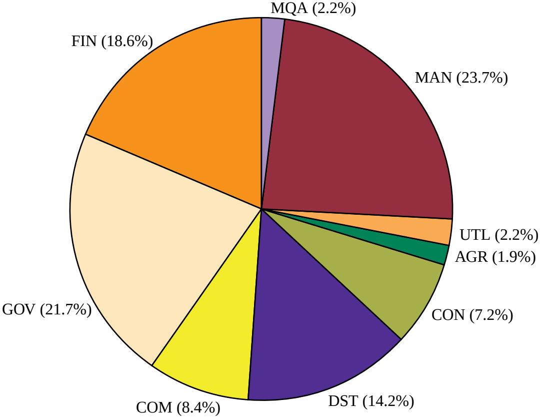
([1]) A shorter version of this paper appeared as "The industrial impact of monetary policy", *Bank of England Quarterly Bulletin*, August 1996, pages 288-98.

II Sectoral basis of the analysis

The industry breakdown used in this paper is summarised in Table A and in the Data Annex. At the broadest level, the output measure of the economy, GDP(O), can be sub-divided into four parts, namely the production industries, agriculture, construction and services. Within these four sectors, services can be split into three further components: distribution, transport and communications, and 'other services'.[(2)] Other services contribute over 40% of GDP (see Chart 1 and Table A); and the service sector as a whole over 60%. The available data do not permit any further disaggregation of services for the analysis we wish to undertake.[(3)] The production industries can also be broken into three large sub-groups: mining and quarrying, the utilities, and manufacturing. Manufacturing can be further disaggregated into what is known as the 'sub-section' level in the Standard Industrial Classification (1992), enabling us to sub-divide manufacturing into 14 component industries. The share in manufacturing output of each of these industries is shown in Chart 2.

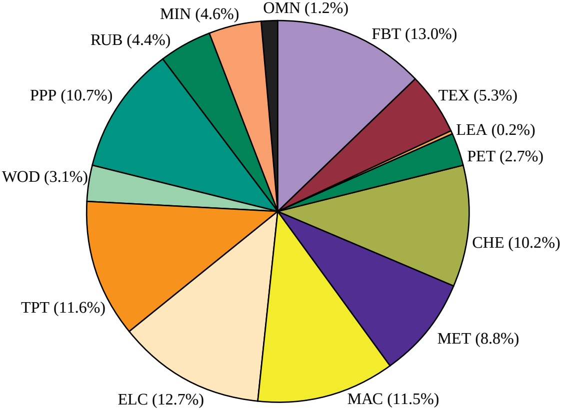
([2]) The latter aggregates financial and business services (FIN) with public sector activities (GOV).
([3]) Some greater disaggregation of services output is available in the national accounts, but not on a quarterly basis.

Chart 1
Contributions to GDP in 1990[(a)]



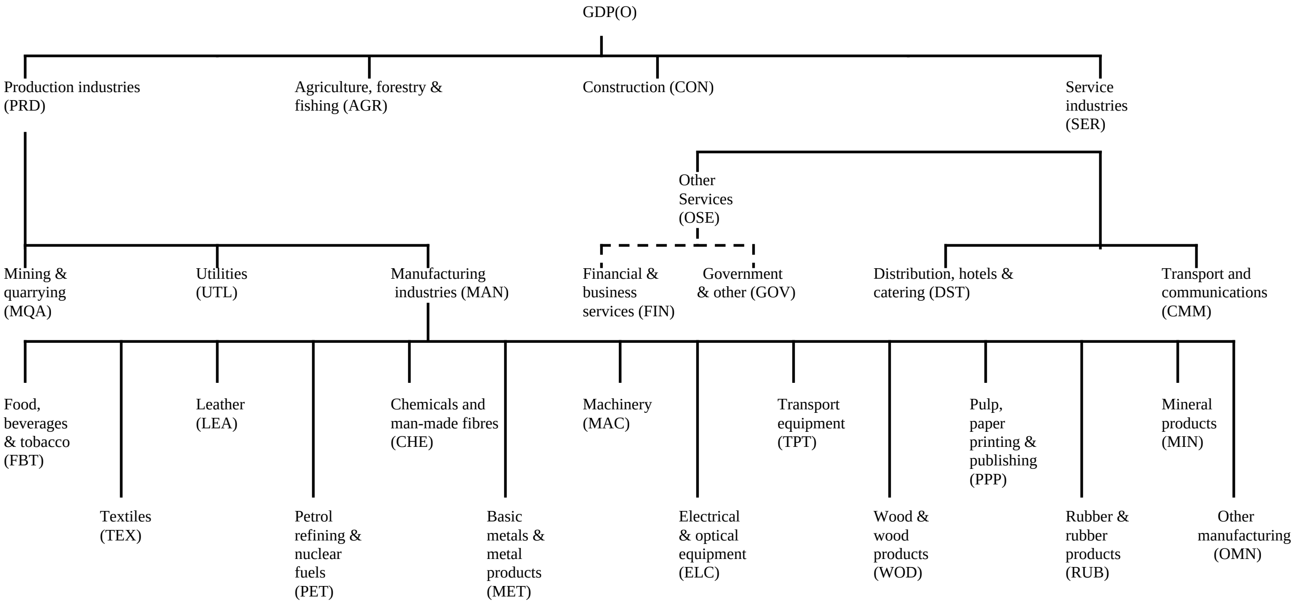
(a) The industry definitions are clarified in terms of the Standard Industrial Classification (1992) in the Data Annex.

Chart 2
Contributions to manufacturing in 1990[(a)]



(a) The industry definitions are clarified in terms of the Standard Industrial Classification (1992) in the Data Annex.

Table A
A sectoral breakdown of GDP



Note: Sector mnemonics in brackets. The Data Annex provides more detailed definitions.

In addition to these basic industry output data, we use concentration and average firm output data as proxies for the size of firms, in conjunction with proxies for internal funds to help us analyse the possible role of credit market imperfections in the transmission mechanism. Ideally, we would have liked to carry out this firm 'characteristics' analysis for all 24 of the sectors for which we have output data. But sufficiently detailed figures are identified only for the 14 manufacturing industries in our data set (see Table A).

As Chart 3 indicates, there is substantial variation in manufacturing concentration ratios.[(4)] In vehicle manufacture, for example, the five largest firms produce around three quarters of the industry's net output on average over the 1975-91 period. This figure falls to under 20% in a number of industries, including the wood, rubber and paper manufacturing industries. There is similar, but rather more marked, variation in the average output per firm across manufacturing industries (see Chart 4). Excluding petrol refining—which is heavily influenced by multinational firms—output of the average firm was greatest in chemicals (at £4.9 million in 1991), some 25 times more than in the average firm in 'other manufacturing'. The output of the average firm in manufacturing as a whole (again, excluding petrol refining) was £1.4 million in 1991.

([4]) The size data are sourced from the Annual Census of Production (various issues) and hence more timely data than 1991 are not currently available. Because collection of these statistics is time-intensive we have compiled them for 1975, 1980, 1985, 1990 and 1991. These indicate that the data do not reveal any clear trends over time and so in subsequent analysis we refer to their mean values.

Chart 3:
Manufacturing industry concentration ratios

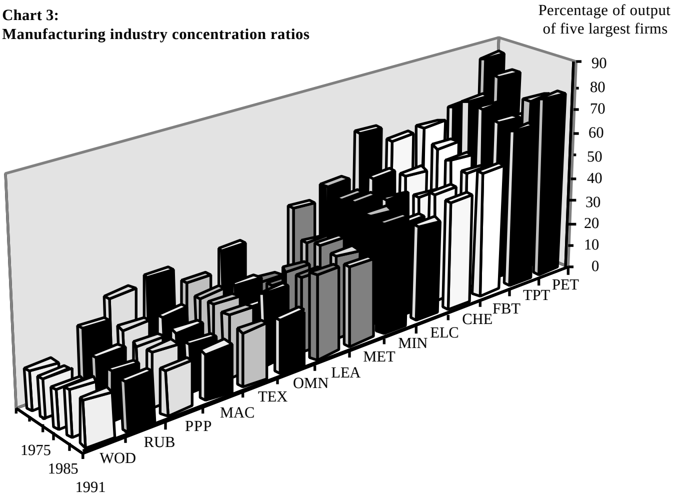
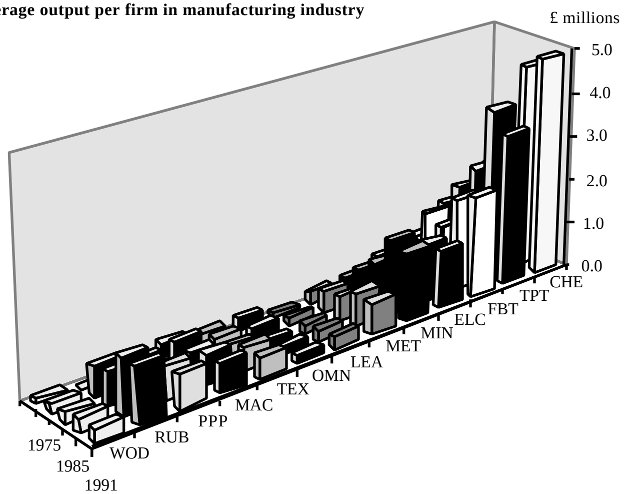


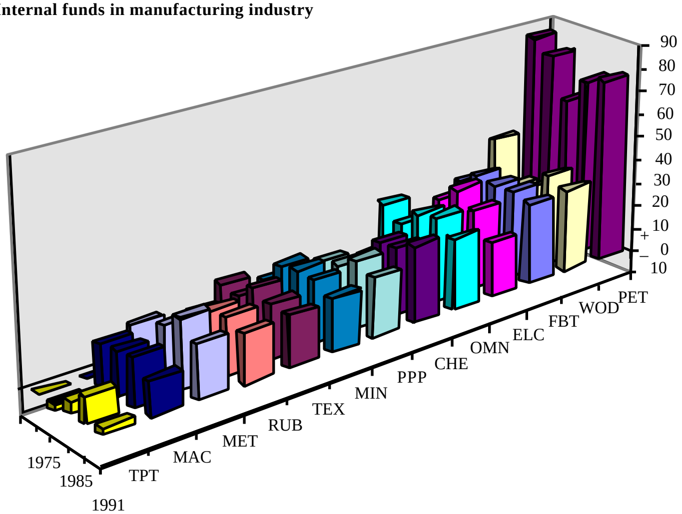
Chart 4:
Average output per firm in manufacturing industry (a)



(a) Excluding PET, where average firm size is ten times larger than average

If firms have substantial internal funds available, then imperfections in credit markets are less likely to constrain them. So in principle we require a proxy for the stock of internal funds. But data on stocks of this sort are not directly observable. We can, however, proxy them by annual *flows*, since over time the flow will in any case determine the stock. We measure this flow as the share of industry GDP not accounted for by income from employment.(5) Chart 5 illustrates that there is quite marked variation in this proxy for internal funds across industry: on this measure, vehicle manufacture in particular appears to have low internal funds with an average 3.1% of output not appropriated by labour,(6) while petrol refining looks cash-rich (averaging 76.0%). For all other sectors the ratio is between 15% and 35%. Unlike the structural size characteristics of each industry, the flow of internal funds is clearly closely linked to cyclical changes in the economy. For example, in manufacture of wood products it was 45% in 1975, but fell to 27% in 1980. Though cyclical influences are quite marked there is little evidence of a trend (ie non-stationarity) over the sample period.(7)

Chart 5:
Internal funds in manufacturing industry



---

(5) That is, (1- (income from employment/industry GDP)) * 100. These data are sourced from Tables 2.2 and 2.3 in *United Kingdom National Accounts*, London: HMSO.

(6) This ratio is influenced by the 1970s observations where income from employment actually exceeded industry output. In 1990 the ratio was 10%.

(7) As with the indicators of size characteristics, in subsequent analysis we refer to their mean values.

III VAR methodology

The problem of identifying the effects of an unexpected monetary tightening on output has usually been approached in a Vector Autoregression (VAR) framework (eg, Christiano, Eichenbaum and Evans (1994)). Because the relationships which are defined in these are highly simplified, VAR techniques do not differentiate accurately between theoretical explanations of observed behaviour. But they are an efficient means of drawing out 'stylised facts' regarding the monetary transmission process.

We estimate separate VARs for each industrial sector and compare the effect of a monetary policy shock on each sector's output. The monetary shock is defined as an unexpected one standard deviation increase in official interest rates over our sample period, that is, an increase in official interest rates of 1.1 percentage points. To control for other macroeconomic influences on sectoral developments, we also include real GDP and the GDP deflator in our VARs, taking our lead from Gertler and Gilchrist (1994).

Before estimating the VARs we need to determine the time-series properties of the data, plotted in Charts A to F in the Data Annex. Augmented Dickey-Fuller tests suggest that GDP, its deflator, and most industries' output are unambiguously I(1) variables[(8)] (see Tables 1 and 2 in the Annex). We treat interest rates as I(0), even though the tests are marginal and can be interpreted as suggesting rates are actually I(1). We believe that this ambiguity reflects the influence of the high 1970s inflation on nominal rates; and so choose to place more weight on our theoretical priors about the properties of interest rates. Cointegration tests between the I(1) variables suggest that one or two cointegrating vectors exist between each set.[(9)]

Accordingly, we estimate a four-variable VAR in the levels of each variable, interpreting each system as an unrestricted vector error correction model. All variables apart from interest rates are in log terms. To identify the monetary policy shocks we use the Choleski decomposition - following Bernanke and Blinder (1992), Dale and Haldane (1995), and many

(8) Possible exceptions are the utilities and wood and wood products.

(9) We use the standard Johansen testing procedure - see, for example, Johansen (1995) for details.

others.[10] As is well-known, this identification procedure is somewhat *ad hoc* and relies upon a recursive relationship existing between the data. Our preferred ordering of the VAR is interest rates, real GDP, the GDP deflator, industrial output. This implies that interest rates do not respond to contemporaneous developments in the other variables in the VAR, that GDP responds to changes in interest rates only, and that industrial output responds to developments in each of the other variables. Because we are concerned only with identifying monetary policy shocks, this is sufficient for our purposes. We measure interest rates on the first business day of each quarter; it is reasonable to assume that start-of-quarter interest rates do not depend on developments in activity that take place throughout the quarter, and that are not usually published until well after the quarter-end.[11] Nevertheless, to check the sensitivity of the results to this assumption, we repeat our analysis with interest rates in second, third and fourth place in the VAR. In each case the conclusions are qualitatively similar.[12]

Because our aim is to compare results across a series of VARs, we impose a common lag length of five on each of them. As Table 1 in the Data Annex shows, the univariate autoregressive properties of the data are quite varied, with the lag length necessary to whiten the errors in the ADF test varying between nil and six, so the imposition of a common lag length is, in some ways, a compromise. But the choice of lag length five has the advantage of whitening the errors for each individual VAR,[13] and is consistent with the notion that the maximum effect of interest rates on GDP and inflation takes one to two years to manifest itself. An alternative approach would have been to calculate the optimal lag length for each VAR separately, and carry out our analysis with differing lag lengths. But in this case we would have been unsure whether differences in the profile of industrial sectors' responses to monetary policy shocks simply reflected differences in the lag lengths of each VAR.

([10]) Rudesbusch (1996) provides a critique of the approach.

([11]) Because monetary policy is forward looking, rates might respond to *forecast* developments within the quarter, but these will be functions of past outcomes, and our specification allows interest rates to respond to these past outcomes.

([12]) For brevity's sake we do not include details of this analysis here, but the results are available upon request from the authors.

([13]) If we impose a common lag length then we can make two types of error: have too few lags for some VARs, or have too many. The former error could bias the results, the latter reduce the efficiency of estimation - a less serious problem. This pointed towards using a longer, rather than a shorter, common lag length. As a further sensitivity result, we repeated our analysis with one lag VARs, and once again found the results reasonably robust. (These results are also available upon request.)

The principal output from this VAR analysis is 24 impulse response functions, which show the marginal response of each sector's output to an unexpected monetary policy tightening. Because the VARs are estimated in log levels, the difference from base each quarter indicates the cumulative output response to the policy shock.

IV The effects of monetary policy on industry output

This section gives an overview of our results on the responsiveness of industry output to an unexpected monetary tightening. Our focus is principally on the size and timing of the impact of a monetary shock on industry output. These are key characteristics of the transmission mechanism and may provide the financial markets, the monetary authorities and agents more generally with valuable information on the effects of monetary policy. The size of response in each industry indicates how the impact of unanticipated policy changes is distributed across the economy; while the timing of these responses suggests how long the 'real' effects of monetary policy innovations may persist. We try to explain the responses that we observe in terms of the business cycle. In addition, the interplay of these business-cycle factors with the firm characteristics of individual industries may provide some evidence on the relative importance of the different channels of the transmission mechanism of monetary policy.

(i) Size and timing of responses in the major sectors

Our key results are summarised in Table B, which shows the maximum reduction in output in each sector and how many quarters after the shock this occurs. We interpret this as a measure of the short-run real effects of monetary policy innovations. The results show the response of industry output to an unanticipated increase in official interest rates of 1.1 percentage points. The analysis yields plausible results, in that output is depressed in the first four to eight quarters after the shock. As a benchmark, the maximum decline in whole-economy output, GDP(O), is 1.3%.(14) This

(14) This estimate comes from a three VAR system: interest rates, GDP, the GDP deflator. Because each VAR for each sector is estimated independently, the GDP impulse-response functions are not restricted to be common across VARs. However, in practice neither the GDP, nor GDP deflator, responses show significant differences across the 24 VARs.

effect is reached around three years after the original upward shock to interest rates.(15)

Table B
Size and timing of sector output responses

Industry	Maximum output reduction		Industry	Maximum output reduction	
	Per cent	Quarter		Per cent	Quarter
Memo:			Manufacturing industries:		
GDP (O)	-1.3	14	RUB	-3.6	10
			OMN	-3.2	9
			ELC	-3.0	11
Main components of GDP:			PPP	-2.5	11
CON	-2.1	10	LEA	-2.4	5
PRD	-1.5	8	WOD	-2.3	7
SER	-1.0	11	PET	-2.2	8
AGR	-0.1	30	MIN	-2.1	9
			CHE	-1.9	11
Other sectors:			MET	-1.9	7
DST	-2.1	11	TPT	-1.7	11
CMM	-2.0	11	TEX	-1.3	5
MQA	-2.0	6	MAC	-1.1	11
MAN	-1.9	9	FBT	-0.4	13
UTL	-0.9	6			
OSR	-0.6	13			

In the largest sectors of the economy—the components of GDP and of total services—the maximum decline in output generally occurs eight to twelve quarters after the shock. Most of this decline has been reversed after 30 quarters (see Chart 6(a)), which shows the timing of the response in output to the monetary tightening), so in the long run the effects of policy can be described as 'neutral' with respect to the level of output.(16)

(15) In common with other studies (for example Christiano, Eichenbaum and Evans (1994)) we find a perverse short-run inflation response where an unexpected tightening in interest rates seemingly leads to an increase in inflation. The rationale for this so called 'price puzzle' is that the innovation in interest rates is in response to news about higher future inflation.

(16) Of course, without standard errors we cannot be certain that this judgment on output neutrality is statistically robust. But after 30 quarters these errors will be very large, and so we are confident that the one standard error band would encompass zero.

rt 6 (a)

ut responses of the major

strial groups

ponents of GDP

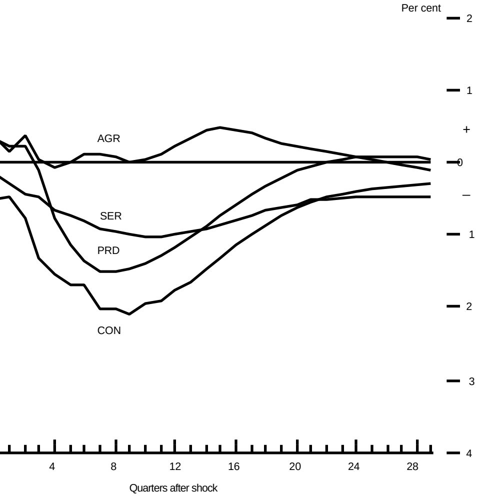
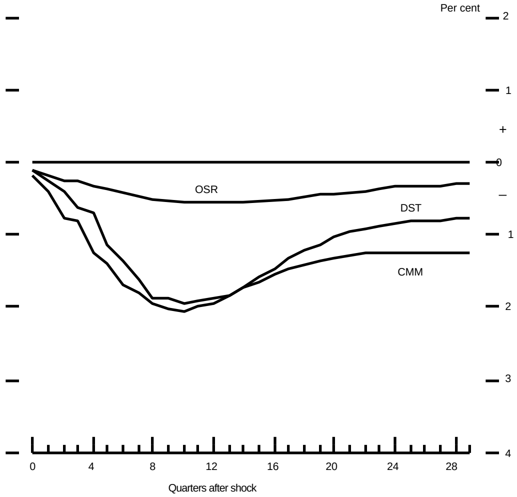


Chart 6 (b)

Output responses of the major

industrial groups

Components of total services

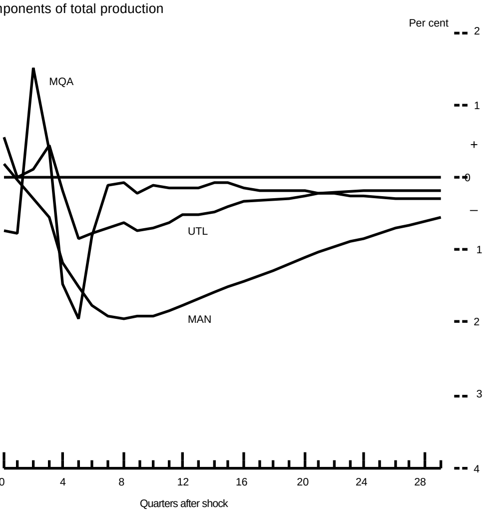


art 6 (c)

put responses of the major

ustrial groups

nponents of total production



The largest absolute responses are in the construction and distribution sectors (Charts 6(a) and 6(b)). For example, the results suggest that the decline in construction output will reach a maximum of 2.1% in the tenth quarter after the shock. This relatively large response is not unexpected, given the close links between the housing market and construction.

Among the other main sectors, the production sector shows a 1.5% reduction in output after a monetary tightening. Within the production industries, manufacturing output falls sharply in response to the monetary shock, reaching a maximum contraction of -1.9% after nine quarters; after 30 quarters it is steadily approaching zero. The utilities, especially mining and quarrying, show erratic output responses (see Chart 6(c)). These are difficult to interpret, but they may be linked to the predominance of public sector industries in these sectors over much of our sample period. In addition, the mining and quarrying data contain severe distortions owing to industrial disputes (see Chart 3 in the Annex). Within services, the smallest reaction to the shock is in other services. This may reflect the inclusion in other services of public sector activities, whose output may in part move countercyclically. Overall, the responses of these broad sectors are consistent with the cyclical variations normally associated with them. The smallest output contraction is in agriculture. This sector shows little reaction to the monetary policy shock for ten quarters; moreover it is largely positive. UK agricultural output is primarily staple products whose production would not be expected to respond procyclically.

(ii) Size and timing of the responses within manufacturing

We turn next to the output responses of the 14 industry groups within manufacturing. Rather than simply listing the results for all 14 of these industries, we group the results thematically into:

- industries that are closely linked to housing and construction;
- industries that are closely linked to changes in consumer expenditure; and
- industries that are principally selling on to other industries.

This taxonomy helps to clarify, in broad terms, the likely business-cycle properties of the industries, even though not all the industries fit exclusively into just one of these categories. Implicit here is a model which links the cyclicality of the various components of output to different components of total final expenditure.[17]

House purchase is highly interest rate sensitive and so housing starts might be expected to react rapidly to a tightening in monetary policy. This in turn is likely to result in a rapid downturn in the output of industries supplying construction, for example in the manufacture of basic building materials like glass, tiles, concrete and bricks (MIN) and in wood products (WOD). The results suggest that both of these industries have a maximum output response slightly above the average response of -1.9% for the manufacturing industries as a whole. In the case of wood products this is achieved quite rapidly, after only seven quarters—the second fastest response in manufacturing.

We also examine here the size of the output responses after one and two years. These are summarised in Table C. The responses one year after the shock show the greatest range in changes in industry output. Five industries contract by more than 1%. One of these is the construction sector and three of the remaining four sectors—wood, rubber and non-metallic mineral products—supply materials to construction firms.

([17]) Pain and Westaway (1996) provide an example of an analysis of sectoral output developments that makes explicit use of this underlying model.

Table C
Which sectors react quickest to a monetary shock?

Rank	After 1 year: Industry	Output reduction per cent	After 2 years: Industry	Output reduction per cent
1	RUB	-2.1	RUB	-3.4
2	LEA	-1.9	OMN	-3.1
3	WOD	-1.6	ELC	-2.6
4	CON	-1.3	PET	-2.2
5	MIN	-1.1	WOD	-2.2
6	OMN	-1.0	PPP	-2.1
7	DST	-0.8	CON	-2.0
8	ELC	-0.7	MIN	-2.0
9	MET	-0.7	MAN	-2.0
10	CMM	-0.6	LEA	-1.8
11	TEX	-0.6	MET	-1.9
12	MAN	-0.5	DST	-1.8
13	SER	0.5	CHE	-1.8
14	PPP	-0.4	CMM	-1.6
15	CHE	-0.3	PRD	-1.5
16	OSR	-0.2	TPT	-1.5
17	PET	-0.3	TEX	-1.2
18	FBT	-0.2	SER	-0.9
19	PRD	-0.1	MAC	-0.9
20	AGR	0.0	UTL	-0.7
21	MAC	0.2	OSR	-0.5
22	MQA	0.4	FBT	-0.4
23	UTL	0.4	MQA	-0.1
24	TPT	0.5	AGR	0.1

Six industries are linked reasonably closely to consumer expenditure: food, drink and tobacco, textiles and leather goods, paper products, vehicle manufacture and other manufactured goods. But the reaction of personal consumption to monetary shocks may be quite diverse. Spending on durable items is likely to change sharply and with little delay—see for example the reaction of vehicle manufacture (TPT) in Chart 7 (a).[18] Textiles and leather goods, as producers of clothing, footwear and household furnishings, both show their maximum response after only five quarters, the fastest responses across our whole data set. However, the absolute size of the maximum responses are quite different, with that in textiles surprisingly small at only 1.3%, compared with 2.4% in leather—which is perhaps more in line with our prior expectations (see Chart 7(b)). Non-durables could be much less affected since these purchases are more likely to be made out of current

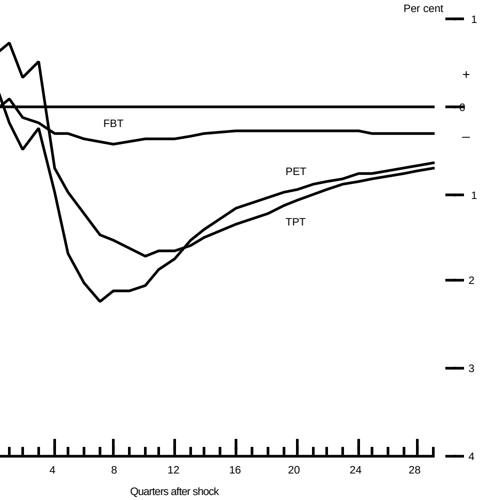
---

([18]) Although, as agents save the necessary capital, intentions to purchase durables goods might change more quickly than actual purchases. This is more likely to matter for larger-value items such as cars.

rt 7 (a)

cted output responses in

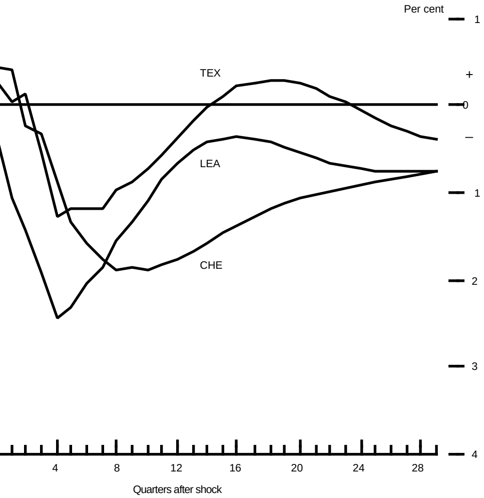
ufacturing



rt 7 (b)

cted output responses in

ufacturing



income than from borrowed funds. This is consistent with the subdued reaction of output in food, drink and tobacco (FBT) in Chart 7(a).

A further six of the industries may be linked more closely to industrial demand than to personal consumption; these are chemicals, electrical equipment, machine tools, iron and steel, refining and rubber products. The demand for intermediate goods will include purchases of materials and of capital goods. Although the empirical evidence is mixed, we would generally expect investment expenditure to be interest rate sensitive, such that purchases of capital goods are likely to fall in a downturn. However, the effects of this on industry output may be delayed by the long lead times in commitments to buy new capital goods. Thus, while investment intentions may change rapidly in response to tighter monetary policy, this may not show up in lower output for several quarters. So the reaction of these industries may be delayed. There is some evidence for this in our results, which show that four of the six industries (chemicals, electrical equipment, machine tools and rubber products) do not attain their maximum impulse response for ten or eleven quarters; the average time lag in attaining the maximum response across all 14 manufacturing industries is 8.5 quarters.

Among those industries closely linked to industrial demand, and indeed across manufacturing as a whole, the largest contraction in output, at -3.6%, is in rubber products. This is a very diverse industry, largely dependent upon industrial demand from construction, motor vehicle manufacture and services like haulage. The size of the response is consistent with the industry’s links with construction and motor vehicle manufacture. Demand for their products might be expected to show a marked response to monetary shocks, implying the derived demand for their inputs is also likely to be sensitive to monetary policy innovations. The timing of the maximum response in rubber products is also slower than average, which may be the result of a more gradual slowdown in purchases from service-related industries.

Overall, the results indicate that the impact of monetary policy is concentrated in some industries which, except in the case of rubber products, may also react first—thereby providing the authorities with early information on the impact of policy innovations.

V Firm characteristics and the effects of monetary policy

Our results have shown that, at least in the short run, monetary policy can have varying effects on the output of different sectors in the economy. Considerable uncertainty remains in the wider literature as to precisely how these effects are obtained. A recent symposium in the *Journal of Economic Perspectives* (Fall, 1995) examines the many possible routes through which a monetary shock may be propagated. Gaps in some of the more conventional explanations have led a number of economists to explore whether asymmetric information between borrowers and lenders, and 'frictions' in credit markets, might help to explain the differing potency of monetary policy across sectors.

These frictions are based around the difficulties involved in extracting full information on the creditworthiness of certain types of borrower. Insofar as banks are experts in credit risk appraisal, borrowers whose risk is harder to measure—notably small firms and personal borrowers—may become almost exclusively reliant on banks as a source of external finance. As Gertler (1988) notes 'financial constraints are likely to have more impact on the real decisions of individual borrowers and small firms than large firms'. It has been argued, however, that these credit market frictions are not a distinct, free-standing alternative to traditional views of the monetary transmission mechanism. Rather, they are best interpreted as a set of factors that may amplify and propagate conventional interest rate effects.(19)

Larger firms are likely to be less dependent on bank credit because they will have access to external funds generated in the capital markets. This is because more information is available on large firms and this can often be pooled relatively cheaply—for example by ratings agencies—which allows dispersed investors in financial markets to assess their credit risk. With a greater range of external funds at their disposal, larger firms may be better able to 'smooth' their spending and output decisions.

Some evidence for the existence of credit market imperfections has been found in Dale and Haldane (1995). Using a VAR methodology similar to our own, they compare the response of the personal and corporate sectors to a monetary tightening. They find that, in the short run, companies raise their borrowing and reduce their deposits; the personal sector, by contrast,

(19) See Bernanke and Gertler (1995).

increases its deposits while its bank borrowing declines. The difference between personal and corporate sector responses—in particular the decline in personal sector borrowing—is attributable to the more acute credit market frictions faced by household borrowers. Similar results were found by Gertler and Gilchrist (1994) in a comparison of small and large manufacturing firms in the United States. Their results suggested that, after a monetary tightening, small manufacturing firms bore a disproportionate share of the downturn in aggregate output.

Disaggregated data on small and large manufacturing firms are not available in the United Kingdom. So we cannot test directly for the effects of credit market frictions in the manner of Gertler and Gilchrist. But data on the concentration, net output and number of firms in manufacturing can be used to give an approximate guide to the size of firms in particular industries. This allows us to examine indirectly the effects of credit market frictions insofar as these data reveal that particular industries are made up of small or large firms.

In Table D we compare the maximum responses in industry output with proxies of firm size, namely the concentration ratio and average firm size in each industry within manufacturing.(20) The concentration ratio indicates the proportion of net output accounted for by the five largest firms in each industry and gives a measure of how skewed that industry is towards large firms. We use this information in conjunction with the data on average firm size, which measures the average value added or net output of firms within each industry. These two industry characteristics appear to show some link with the effects of monetary policy shocks. For example, industries like other manufacturing and rubber products—with below-average concentration and low average firm output—generally show a larger maximum response to the shock. Of course, there are exceptions to these linkages. Firms producing office machinery and electrical parts, for example, can be characterised as 'reasonably large', yet this industry shows the third strongest output reaction, while 'small' firms, such as those producing machine tools, show the second smallest response.

(20) The data on the concentration ratio, average output, and internal funds are averages over the period 1975 to 1991.

Table D
Manufacturing industries: output responses and firm characteristics

Industry	Maximum output reduction, per cent	Concentration ratio, per cent of output, five largest firms	Average output, £ millions	Internal funds, per cent	Ranking of: Maximum output redution	Concentration ratio	Average output	Internal funds
RUB	-3.6	22.8	1.0	20.69	14	13	7	10
OMN	-3.2	27.3	0.2	31.52	13	9	13	5
ELC	-3.0	49.1	1.0	31.76	12	5	6	4
PPP	-2.5	23.7	0.5	24.35	11	12	10	7
LEA	-2.4	27.4	0.2	21.43(a)	10	8	14	9(a)
WOD	-2.3	16.5	0.2	35.30	9	14	12	2
PET	-2.2	76.0	15.9	76.02	8	1	1	1
MIN	-2.1	48.2	1.0	23.04	7	6	5	8
MET	-1.9	36.6	0.6	18.38	6	7	8	11
CHE	-1.9	49.3	3.1	26.51	5	4	2	6
TPT	-1.7	69.8	2.5	3.91	4	2	3	13
TEX	-1.3	26.3	0.4	21.43(a)	3	10	11	9(a)
MAC	-1.1	24.1	0.5	17.07	2	11	9	12
FBT	-0.4	55.7	1.5	35.15	1	3	4	3
Average	**-2.2**	**39.5**	**2.1**	**27.6**	**n.a**	**n.a**	**n.a**	**n.a**

Spearman rank correlation coefficient, probability value: 0.91 0.89 0.31
(a) Internal funds not separately identified for TEX and LEA.
n.a not available.

To determine whether these linkages have any statistical significance, Spearman rank correlation coefficients are calculated between the output responses from the VAR model and the two industry characteristics. Both the concentration ratio and the average firm size measures are significantly correlated with the output responses at around the 90% level.(21) So there appears to be some link between industry-size measures and the output

(21) We have not directly combined our mean (average output) and spread (concentration) measures of industry size into a composite indicator for these tests.

responses.[22] One possible interpretation of this is that credit market imperfections may play a role in the transmission mechanism. For example, the textiles and leather industries sell into markets which we would expect to behave similarly over the cycle. But their output responses to the monetary shock are very different. Textiles has the third smallest response, at -1.3%. Leather, where firms are on average little more than half the size of those in textiles, shows a much larger output contraction of -2.4%. Similar contrasts can be observed in other industries like wood products and non-metallic minerals: both serve similar markets, but the firms in wood products are typically much smaller and generate a larger response to the shock than those in non-metallic minerals.

Another potential influence on the response to monetary shocks could be profitability. Highly profitable industries potentially have access to proportionately more internal funds. If so, monetary policy shocks, in increasing the *cost* of external funds and the *return* on internal funds, may have a more limited impact on their activity, *ceteris paribus*. We proxy internal funds by the share of industry GDP not accounted for by income from employment.

But as Table D shows, the rankings of the impulse-responses and the internal funds measure do not match up significantly. The probability value associated with Spearman's rank correlation coefficient (0.31) is very low. Although the association between internal funds and the impulse response is close for MIN, CHE and LEA, it is weak for the majority of manufacturing industries. The apparent low explanatory power of the internal funds data could suggest that access to internal funds is less important than firm size. But we suspect this result may merely reflect the use of a poor proxy. Further investigation of the link would be necessary to resolve this issue.

VI Summary

The effects of an unanticipated monetary policy tightening seem to be unevenly distributed across sectors of the economy. The size and timing of contractions in output confirm that some industries are especially sensitive to a tightening of monetary conditions. As might be expected, sectors such

(22) As another simple test, we estimated a cross-sectional OLS relationship between industries' maximum output and their size characteristics. The characteristics do not enter this equation significantly, suggesting the relationship is not of a simple linear form.

as construction show a sizable and rapid decline in output whereas others, like services, show a much more muted reaction. Manufacturing as a whole also responds quite sharply to a monetary tightening but some large industrial sectors, notably the utilities, show a subdued response. Within manufacturing there is a quite wide variation in responses. The smallest is in the manufacture of food, drink and tobacco, which shows only a very modest decline in output, while others—including rubber products and electrical equipment—show much larger changes. Some of the industries showing the largest responses are made up of relatively small firms, perhaps indicating that credit market imperfections may play a role in the monetary policy transmission process.

Data Annex

Industry Data: SIC (1992) industry definitions

AGR:	Section A, B	Agriculture, hunting and forestry; fishing
PRD:	Section C, D, E	Mining and quarrying (MQA); manufacturing (MAN); electricity, gas and water supply (UTL)
CON:	Section F	Construction
SER:	Sections G to Q	All service industries
DST:	Section G, H	Wholesale and retail trade, repairs; hotels and catering
CMM:	Section I	Transport, storage and communications
OSR:	Section J, K, L, M, N, O, P, Q	Financial and business services; public administration, education, health and other services
FBT:	Subsection DA	Manufacture of food products, beverages and tobacco
TEX:	Subsection DB	Manufacture of basic textile fibres and clothes
LEA:	Subsection DC	Manufacture of leather products and footwear
WOD:	Subsection DD	Manufacture of wood products and building materials
PPP:	Subsection DE	Manufacture of paper, publishing and printing
PET:	Subsection DF	Manufacture of refined petroleum products, coke and nuclear fuel
CHE:	Subsection DG	Manufacture of basic chemical products, paint, soap, pharmaceuticals

RUB:	Subsection DH	Manufacture of tyres, rubber products and building materials
MIN:	Subsection DI	Manufacture of non-metallic mineral products, glass, tiles, building materials
MET:	Subsection DJ	Manufacture of iron and steel, castings
MAC:	Subsection DK	Manufacture of machine tools, basic components
ELC:	Subsection DL	Manufacture of office machinery, electric motors and parts
TPT:	Subsection DM	Manufacture of motor vehicles, aircraft, shipbuilding
OMN:	Subsection DN	Other manufacturing of furniture, miscellaneous household goods

Source: Standard Industrial Classification of economic activities 1992 (London: HMSO) from which fuller details can be obtained.

Macro Data: Definitions

GDP(O)	Output measure of GDP.
GDPD	GDP deflator.
IR	Interest Rates; official band 1 stop rates at start of quarter; available from authors upon request.

Chart A

The components of GDP and GDP

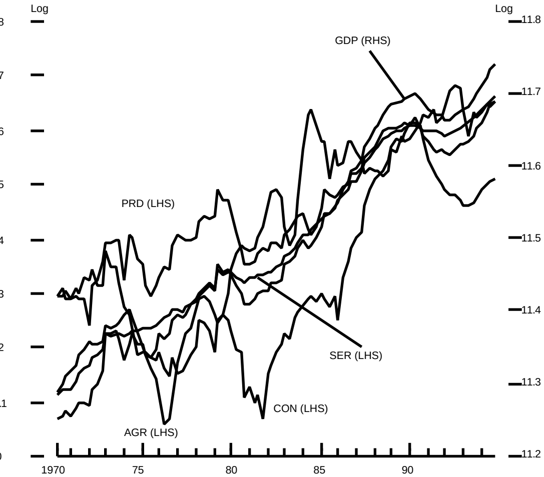


Chart B

The production industries and the GDP

deflator

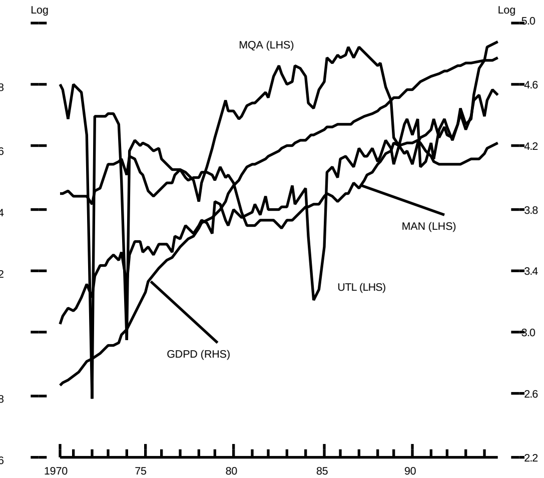


Chart C

Service industries and the interest rate

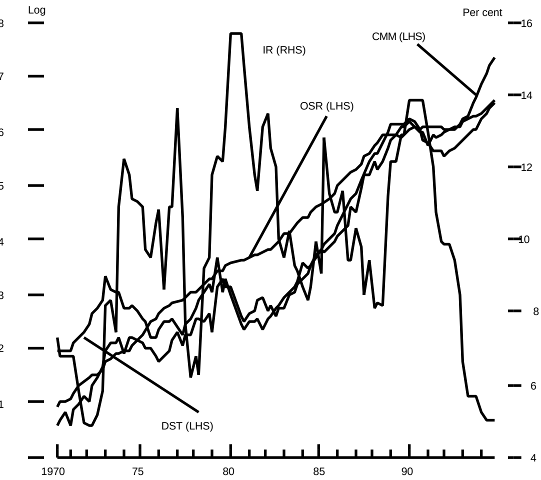
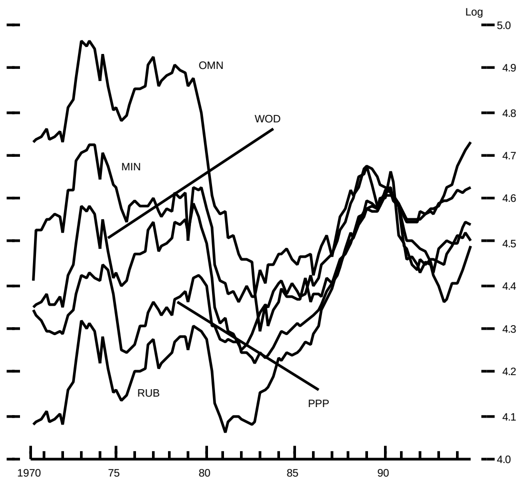


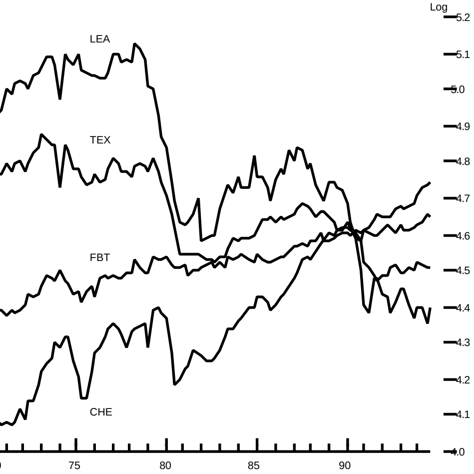
Chart D

Manufacturing industries



rt E

ufacturing industries



rt F

ufacturing industries

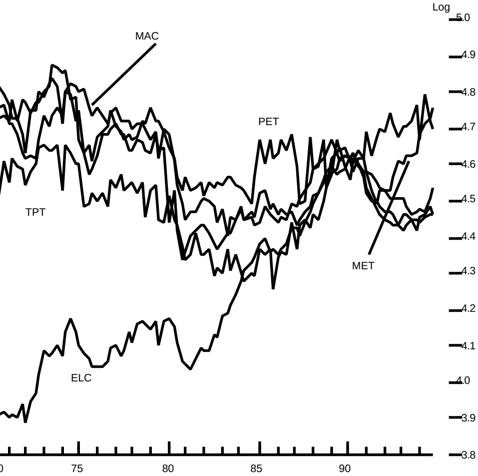


Table 1
Augmented Dickey-Fuller integration tests: levels of variables

Variable	ADF test statistics	
	With trend	Without trend
GDP (4)	-1.72	-0.33
GDPD (6)	-0.82	-2.76
IR (0)	-1.87*	-1.97*
PRD (0)	-2.50	-0.68
AGR (5)	-2.10	-0.77
CON (2)	-1.88	-0.92
SER (3)	-2.65	-0.69
OSR (4)	-1.98	-1.32
DST (2)	-1.81	-0.33
CMM (4)	-1.45	-0.35
MAN (2)	-1.86	-1.51
UTL (0)	-4.27*	-1.61
MQA (4)	-2.82	-1.98
FBT (1)	-3.47	-1.06
TEX (0)	-2.11	-0.94
LEA (0)	-2.11	-0.27
PET (4)	-1.66	-1.89
CHE (4)	-1.90	-0.58
MET (0)	-2.24	-2.09
MAC (0)	-1.92	-1.33
ELC (0)	-1.68	0.19
TPT (1)	-1.43	-1.51
WOD (3)	-3.13	-3.08**
PPP (4)	-1.50	-0.61
RUB (4)	-1.56	-0.38
MIN (0)	-2.59	-2.30
OMN (2)	-1.83	-1.27

Note: the number of lags necessary to whiten the errors is shown in brackets after each variable. The tests indicate that we cannot reject the hypothesis of non-stationarity unless indicated as follows:

* Reject at 10% confidence level
** Reject at 5% confidence level

Table 2
Augmented Dickey-Fuller integration tests: first differences

Variable	ADF test statistics	
	With trend	Without trend
ΔGDP (4)	-8.59	-8.64
ΔGDPD (6)	-3.55*	-2.14*
ΔIR (0)	-9.25	-9.18
ΔPRD (0)	-9.56	-9.60
ΔAGR (5)	-4.12	-4.10
ΔCON (2)	-4.02	-4.00
ΔSER (3)	-3.14	-3.17*
ΔOSR (4)	-3.57*	-3.41*
ΔDST (2)	-3.46	-3.45
ΔCMM (4)	-4.03	-4.08
ΔMAN (2)	-4.01*	-4.01
ΔUTL (0)	-9.34	-9.39
ΔMQA (4)	-6.12	-6.06
ΔFBT (1)	-8.63	-8.59
ΔTEX (0)	-10.38	-10.42
ΔLEA (0)	-9.33	-9.38
ΔPET (4)	-5.16	-5.11
ΔCHE (4)	-4.96	-4.99
ΔMET (0)	-11.26	-11.27
ΔMAC (0)	-10.2	-10.2
ΔELC (0)	-9.41	-9.41
ΔTPT (1)	-8.39	-8.39
ΔWOD (3)	-4.38	-4.39
ΔPPP (4)	-3.79*	-3.73
ΔRUB (4)	-3.93	-3.90
ΔMIN (0)	-11.6	-11.7
ΔOMN (2)	-3.94*	-3.97

Note: the number of lags necessary to whiten the errors is shown in brackets after each variable. We can reject the hypothesis of non-stationarity at a 99% confidence interval unless indicated as follows:

* Cannot reject non-stationarity at 99% confidence level.

References

Bernanke, B and Blinder, S (1992), 'The Federal Funds Rate and the Channels of Monetary Transmission', *American Economic Review,* 82, pages 901–21.

Bernanke, B and Gertler, M (1995), 'Inside the Black Box: The Credit Channel of Monetary Policy Transmission', *Journal of Economic Perspectives*, 9, pages 27–48.

Christiano, L, Eichenbaum, M and Evans, C (1994), 'Identification and the Effects of Monetary Policy Shocks', *Federal Reserve Bank of Chicago Working Paper,* WP–94–7.

Dale, S and Haldane, A G (1995), 'Interest Rates and the Channels of Monetary Transmission: Some Sectoral Estimates', *European Economic Review*, 39, pages 1,611–26.

Gertler, M (1988), 'Financial Structure and Aggregate Economic Activity: An Overview', *Journal of Money, Credit and Banking,* 20, pages 559–88.

Gertler, M and Gilchrist, S (1994), 'Monetary Policy, Business Cycles and the Behaviour of Small Manufacturing Firms', *Quarterly Journal of Economics,* 109, pages 309–40.

Johansen, S (1995), 'Likelihood-Based Inference in Cointegrated Vector Auto-Regressive Models', *Oxford University Press,* Oxford.

King, M (1994), 'The Transmission Mechanism of Monetary Policy', *Bank of England Quarterly Bulletin,* August, pages 261-67.

Pain, N and Westaway, P (1996), 'The Demand for Domestic Output and Imports in the UK: A Dynamic Systems Approach', *The Manchester School*, 64, no1, pages 1-21.

Rudebusch, G (1996), 'Do Measures of Monetary Policy in a VAR Make Sense?', *mimeo*, Federal Reserve Bank of San Francisco.