EC331: Research in Applied Economics

The Channels of Monetary Transmission: Some Sectoral Estimates from Germany

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Introduction

'Monitoring aggregate money and / or credit provides unambiguously poorer and less timely signals'[1]

'The overall output response is smaller in the United Kingdom than in either France or Germany.'[2]

'In the UK, the fall in output is twice as large as in Germany in the first year of the monetary contraction, three times as large in the second.'[3]

The size and nature of the effect of monetary policy upon aggregate activity, via the monetary transmission mechanism, have been extensively discussed in academic literature in the last decade[4]. Two of the quotes illustrate that the findings are very often contradictory. This paper aims to provide new empirical evidence on the monetary transmission mechanism in Germany. This evidence is based on an estimation of the impact of a monetary shock on different sectors of the German economy. This appears to be the first study using disaggregated data. Two benefits of taking a sectoral approach have been proposed in recent papers. From an economic perspective, the channels of monetary transmission may depend upon the degree of substitution between bank and non-bank sources of finance, which may, in turn, vary across sectors. From an econometric point of view, using aggregate balance sheet data obstructs the analysis of the relative contributions of money and credit in the transmission of monetary impulses. The banks' balance sheet constraint gives money and credit a high degree of colinearity but this is removed by the use of sectoral data.

This approach gives important insight into the effect of a monetary impulse on German output and prices, and through which channels these changes occur. Separate VAR models are developed for households, firms and the aggregate economy, and by construction are directly comparable with the UK evidence from Dale and Haldane (1995). It is found that the effects of a 100 basis-point innovation in the interest rate have a weak effect on all aspects of the German economy when compared to the UK. However, this paper finds significant evidence that EMU will not cause business cycle asymmetries for the United Kingdom, one of the strongest arguments against joining the single currency. There is significant evidence of a credit channel in the propagation of monetary policy in Germany for both firm and household sectors, who react very similarly to a monetary impulse in all but timing. It is households, facing greater credit market imperfections, who react more quickly to monetary policy, not firms.

Definition of the Monetary Transmission Mechanism[5]

It can be summarised that a change in the official interest rate affects 4 key areas: market rates, asset prices, expectations and confidence, and exchange rates.

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[1] Dale & Haldane (1995) p.1623
[2] Britton & Whitley (1997) p.157
[3] Dornbusch et al (1998) p.33
[4] See bibliography for some important examples
[5] Based on that of the Bank of England (1999) and Mishkin (1995)

These areas all affect aggregate demand and thus output which feeds through to domestic inflationary pressure. The exchange rate also affects import prices, and these along with domestic prices and wages influence inflation. Market rates consist of both short and long-term interest rates. Short-term rates are altered immediately, although rates to savers may be slow to adjust. Long-term rates are also affected by expectations, meaning that if the rate change was anticipated they may not adjust a great deal, and so the central bank's reputation is a factor. Asset prices adjust because bonds have an inverse relationship with the long-term rate, and equities are discounted over time. Therefore an interest rate rise will cause bond and share prices to fall. Exchange rates change because a rise in the interest rate makes the domestic currency more attractive to foreign investors. Sudden or unanticipated rate changes will influence expectations of the future of the economy, and the confidence in these expectations, by all economic agents. Thus it may well effect spending, investment, wage bargaining and profits among other things, again highlighting the importance of a credible bank. These 4 effects then filter through to aggregate demand.

Households experience three main direct effects. Firstly, and 'most acutely and directly'[6] they face a new rate on their savings and debt. Households' marginal propensity to consume is also affected since their returns to saving will increase with a rise in the interest rate. Future consumption will become more attractive. Therefore, disposable income and spending are affected immediately. Secondly, there are wealth effects. A rise in the interest rate will affect the housing market, increasing the cost of financing house purchase and reducing demand, meaning that prices will slow/fall. A fall in the market value of a house makes individuals feel poorer, affecting spending, and make borrowing harder if they use it as collateral against a loan. Asset prices, which also contribute to household wealth, are also affected as described above. Consumer confidence, via expectations of future earnings, is also altered by a rate change, particularly if it is not, or larger than, anticipated. There will also be redistributional effects: net borrowers, who tend to have a higher marginal propensity to consume, are made worse off and net savers better off by a rate rise. Lastly, household spending is altered by the change in the exchange rate, which may result after an interest rate change. An appreciation of the domestic currency will result in an increase in the marginal propensity to import, foreign goods being cheaper, reducing domestic demand and firms' revenues.

Firms are also directly affected in 3 main ways. Firstly, firms who borrow will see this cost increase by a rise in the interest rate, which in turn affects their investment and employment decisions. Cash-rich firms however will benefit from a rise in the interest rate. Firms' capital costs may also change as a result of bond/equity price changes as mentioned earlier. Asset price changes will also affect a firm via the 'financial accelerator' effect, since loans may be secured on these assets. Here, a fall in asset prices reduces the net worth of the firm making it harder to borrow, and also makes it more difficult to raise equity finance. Secondly, as touched on previously, the exchange rate will affect domestic firms' competitiveness. With an appreciation of the domestic currency, domestic goods are comparatively more expensive both at home and abroad, thus demand for them will fall. Lastly, firms' investment is affected by future expectations since investing in fixed capital is both a major expense

[6] MPC (1999) p.6

and impossible to reverse. Furthermore, the confidence in which these expectations are held is particularly important in long-term investment.

Aims

1. To empirically examine some of the key features of the monetary transmission mechanism in Germany and to identify the sectoral channels therein

While a significant amount of literature has been produced in the last decade on the processes and significance of monetary transmission, it has, predominately, been based upon data from the US. It is plausible that Germany, due to its institutional environment, will offer a different perspective. It is usually argued that the German economy is a prime example of a bank-based system of financial intermediation. In a bank-based system, banks play a much larger role both in the channelling of wealth from savers to investors and in the governance of corporations. This contrasts with the market-based system of the US, which leaves both functions mostly to financial markets. Empirically, one large difference between the two systems lies in the financial structure of non-financial enterprises[7]. First, debt financing is more significant in bank-based systems. Second, of all debt, loans play a much larger role than commercial paper and corporate bonds in bank-based systems. Lastly, money and capital markets are less developed and less liquid than in market-based systems.[8] These differences have important implications for the ongoing money versus credit debate, and a sectoral examination of the German economy may shed some new light on the issue.

The money view argues that changes in policy are important only insofar as they affect aggregate outcomes. Since monetary policy only affects the required rate of return on new investment projects, it is only the least profitable projects that are no longer funded when rates are raised. Given that the most profitable projects continue to be funded, there is no direct efficiency losses associated with the distributional aspects of a rise in interest rates. The credit view argues that there *are* efficiency losses, by focussing on two channels of monetary transmission that are not addressed in the money view. They are the balance sheet effect and the portfolio effect, both of which tend to increase the potency of monetary policy. The balance sheet effect[9] focuses on the role of monetary policy on the net-worth of borrowers. Due to asymmetric information in evaluating an investment project, a firm's balance sheet is an important factor in determining its ability to obtain external funding. Changes in the interest rate affect the value of the firms' debt and future sales; thus a higher interest rate makes a firm less creditworthy. The portfolio effect argues that, in addition to the size of banks' balance sheets, asset allocation matters. Loans are only one of many possible assets in banks' portfolios. Asset allocation away from loans will have a negative effect on output, whenever firms exist whose only source of finance are bank loans.

However, the empirical importance of the credit view is controversial. While Cecchetti (1995) concludes that, 'monetary policy shifts *have* an important

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[7] See Steinherr & Huveneers (1994)
[8] See Edwards & Fischer (1994) for a detailed analysis of banking and finance in Germany
[9] Also known as the 'financial accelerator' effect

distributional aspect that cannot be addressed by the traditional money view,'[10] others such as Meltzer (1995) disagree. The evidence is often conflicting and ambiguous. Dale and Haldane (1995) argue that this is, 'because of the high collinearity between aggregate money and credit, which in turn stems from the commercial banks' balance sheet constraint. Almost by construction, aggregate money and credit move together. Thus identifying their potentially separate effects is hindered.'[11] The dependence of German firms on bank financing implies that the credit channel of monetary policy ought to be particularly strong in its bank-based economy. As well as being more important than in market-based systems, debt is also bank financed, and alternative forms of financing are not as readily available [i.e. loans and bonds are not perfect substitutes].

However, there are also a number of institutional features that may weaken the credit channel in Germany. Firstly there is the Hausbank relationship, the long-term association between a firm and a bank, whereby one bank provides most or all of the financial services required by the firm. This relationship is possible because in Germany universal banking allows for the provision of a large range of financial services by one bank. Secondly German banks are often represented on the supervisory board of firms. This allows them to obtain confidential information, thus lowering information asymmetries and adverse selection, and to protect the suppliers of debt finance in times of financial distress. These institutional features may mean that German banks are far more reluctant to cut off the supply of loans to firms than their US or UK equivalents, greatly reducing the existence of the credit channel. 'Since the Hausbank relationship and board supervision reduce the problems associated with asymmetric information, net worth may lose its importance as a determinant of creditworthiness.'[12]

As suggested, the use of sectoral data affords both economic econometric advantages. Econometrically, banks' aggregate balance sheet constraint need no longer hold. Significantly, the papers that have been most successful in separating money and credit effects have used disaggregated data[13]. Economically, the channels of monetary transmission are likely to depend upon the degree of substitutability between bank and non-bank sources of finance. This substitutability will vary over time between sectors.

2. To compare the evidence from Germany with that of the UK

The construction of the VAR model outlined below is deliberate in its attempt to mirror that of Dale and Haldane's sectoral study of the transmission mechanism in the UK. This would thus allow a direct comparison between the 2 economies with obvious implications for the UK adoption of the single currency. One of the strongest arguments against UK entry is that a 'one size fits all' monetary policy will not work because of the differences in the propagation of monetary policy. Extensive literature already exists on comparing the transmission mechanisms of European economies, however they are often contradictory. For example Britton and Whitley (1997) finds the response of final variables [prices and output] to be stronger in Germany than the

[10] Cechetti (1995) p.95
[11] Dale & Haldane (1995) p.1614
[12] Guender & Moersch (1997)
[13] Gertler & Gilchrist (1992), and Dale & Haldane (1995) for example

UK. Barran et al (1996) too find evidence of the strongest reactions to monetary policy in the German economy, whereas Dornbusch et al (1998) find Germany as an example of a country with weak reactions. One of the main problems of comparing these studies is that they all employ different variables and techniques in modelling monetary policy[14]. The advantage in using the same model as Dale and Haldane (1995), right or wrong, is that they are directly comparable.

Tables 1 to 4 in the appendix outline some of the institutional differences of the German and UK economies that may affect the transmission of monetary policy. In Germany, security markets are underdeveloped with respect to the UK. In 1995, stock capitalisation represented only 29% of GDP in Germany against almost 150% in the UK. The number of firms quoted in the stock market is much lower in Germany, as are new issues.[15] Table 2 demonstrates the different portfolio decisions of the private sector in the 2 economies. Bank deposits are considerably more significant in Germany, while direct securities holdings are comparable. However, a much greater proportion of households' assets in the UK are held by institutional investors and therefore, to a significant degree, tied to stock market performance. The large difference in the use of loans versus shares is shown in table 3. Loan financing is over 4 times higher in Germany than the UK, when considering loans as a proportion of firms' gross financial assets. Hence, the role played by German banks in lending to non-financial corporations is substantially bigger.[16] Equities play a much more significant role in the finances of non-financial corporations in the UK. Finally, table 4 demonstrates the greater role of the stock market in the wealth of households in the UK.

From these points it seems likely that the credit channel should be more significant in Germany than the UK, as was argued theoretically in section 1. Firstly as table 1 indicates, with low levels of stock market capitalisation it would seem that loans do play a far more significant role in the financing of German firms, which is confirmed by table 3. This may also be an indication that loans and securities are not perfect substitutes. Secondly, bank deposits are much more significant in Germany and this may mean that they react differently to those in the UK to a monetary shock. One would expect, for these reasons, that the responses of the variables in this paper to react differently to those in Dale and Haldane (1995). Since the stock market is substantially less important in Germany, the response to an interest rate shock should be less pronounced than the UK. Germany appears to have a classic bank-based system of financial intermediation, as outlined earlier, and as such may react more smoothly to a rate shock than the market-based system of the UK: deposits to rise, credit to fall following a rise in interest rates. Therefore, with different *channels* of monetary transmission, will come different effects upon final variables.

[14] See Britton & Whitley (1997) for an excellent analysis of comparing recent empirical findings.
[15] In Germany the capital market was fragmented into 8 independent regional stock exchanges until fairly recently which can, at least partially, explain the low degree of stock market capitalisation
[16] A larger proportion of these loans were long-term in Germany (>60%) than the UK (50%)

Data

The data was collected from the Bundesbank statistical database on their website;[17] quarterly data from 1970:1 to 2000:4. All the index variables were normalised to 1995 = 100 and the balance sheet variables were all in DM millions. Only some data was available in seasonally adjusted form and so seasonal dummies were added to the models. All variables except the call money rate were modelled in logarithms. The initial approach to non-stationarity in this paper was to take pure differences of the logged variables and this process performed well in making the models non-explosive. However, it was recognised that this was a second best solution when compared to cointegration, which recognises the long-run relationship between the variables.

Model

The multivariate autoregressive model in this paper was formed using the Johansen approach in PcGive. Defining a vector z of n potentially endogenous variables, it is possible to specify and model $\mathbf{z_t}$ as an unrestricted vector autoregression (VAR) involving up to k lags of $\mathbf{z_t}$:

$$\mathbf{z_t = A_1 z_{t-1} + A_2 z_{t-2} + \ldots.. + A_k z_{t-k} + u_t}\ , \quad \mathbf{u_t} \sim IN(\mathbf{0}, \Sigma) \qquad \mathbf{1.}$$

The first process in forming the models was to perform unit-root tests for stationarity. All variables were found to be I(1) including, interestingly, the interest rate.[18] 'However, it is clear that unit root tests often suffer from poor size and power properties (i.e. the tendency to over-reject the null hypothesis of non-stationarity when it is true and under-reject the null when it is false, respectively)'.[19] Thus we should treat the unit-root tests with caution and presume that, with more data, the interest rate would be I(0).

The data contained a number of external macroeconomic shocks, most notably the oil crisis of 1973-4, German re-unification in 1990 and the adoption of the Euro in 1999. While the oil crisis and the Euro could be reconciled using dummy variables, it is likely that with the influx of cheap labour from East Germany this would cause as structural break. However, a dummy variable for 1990:2 seemed sufficient in dealing with the problem. The diagnostic tests would indicate, since all but normality tests are passed, that a structural break was not the case.

The second step was to analyse the lag length required for the model. This is extremely important as it ensures that the residuals are Gaussian and do not suffer from auto-correlation, non-normality etc. A lag length of 3 quarters was found for the household and aggregate models and 2 quarters for firms, the proof of which is in the appendix. Although third and second lags for all variables were not significant, they were for the interest rate, prices and output and that is the justification for their choice.

[17] http://www.bundesbank.de, see appendix for more details on the data
[18] The results of the unit-root tests are shown in the appendix
[19] Harris (1995) p.79

Finally, the unrestricted model was tested for first-order cointegration. The numbers of cointegrating vectors were found to be 4 and 3 for aggregate and disaggregate models, respectively.[20] The model was then formed as a cointegrated VAR without imposing any identified long-run cointegrating vectors. It was felt that this process was beyond the scope of this paper and without imposing any vectors gave the model the form of an unrestricted vector error-correction mechanism, equivalent to that of Dale and Haldane (1995).[21]

Results

Figures 1 and 2 show the impulse response functions of each of the seven variables (interest rate, exchange rate, stock market, lending [credit], money [deposits], activity and prices) with respect to a 100 basis-point rise in official interest rates. These are shown for the household and corporate sectors of the German economy over a 5-year horizon. Figure 3, the aggregate model, is at the end of the paper. Since the variables are in logarithms, the impulse responses have the interpretation of cumulative growth rates relative to base. Interest rates, which are not in logarithms, are simply percentage point movements relative to base. Unfortunately, it was not possible to plot the response functions on standardised scales so care is required when making comparisons. The results are now analysed with respect to the aims outlined above.

1.a. To empirically examine some of the key features of the monetary transmission mechanism in Germany

The results of the model were both interesting and surprising in a number of aspects, in their size, timing and direction and did not completely follow prior expectations. The effect of a rise in the official interest rate is to raise [initially] the exchange rate, depress the stock market, reduce credit, raise deposits, depress activity and raise prices in the medium term. As expected, the use of quarterly data made for less volatile impulse response functions than one would anticipate from monthly data and that is shown in Dale and Haldane (1995). This is most likely because within the quarterly averages lie reactions of these variables to events and one another that are masked by the infrequency of the data.

The interest rate response function suggests that it follows a slowly mean-reverting process. This result is also found in Dale and Haldane (1995) who explain that, 'this mean-reverting tendency within official rates is consistent with the authorities' reaction function adjusting monetary policy in response to (randomly distributed) temporary shocks.'[22]

[20] See the appendix for proof
[21] See Dale & Haldane (1995) p.1615
[22] Dale & Haldane (1995) p.1618

Figure 1: Response to a 1% Increase in Interest Rates in the Household Sector

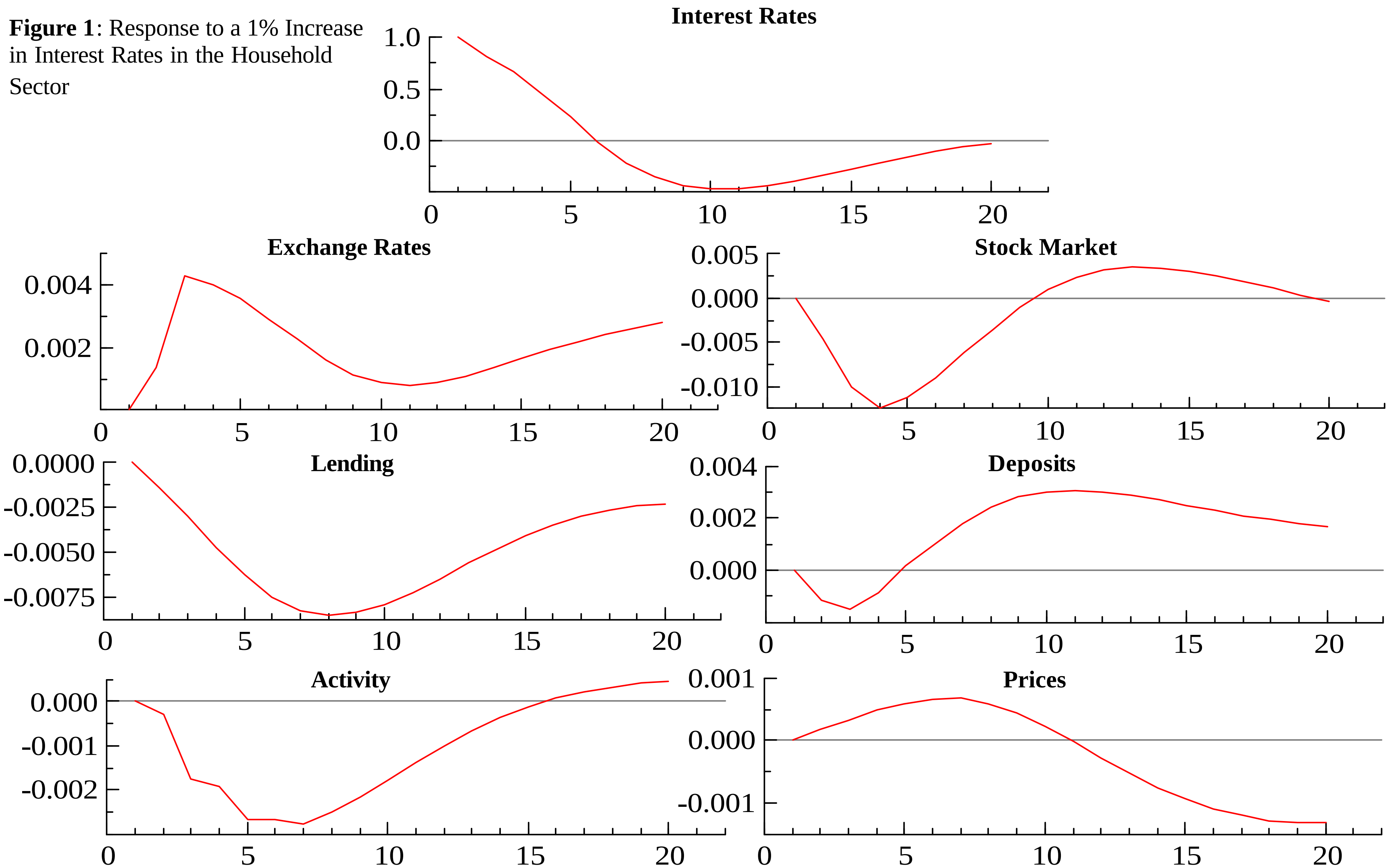
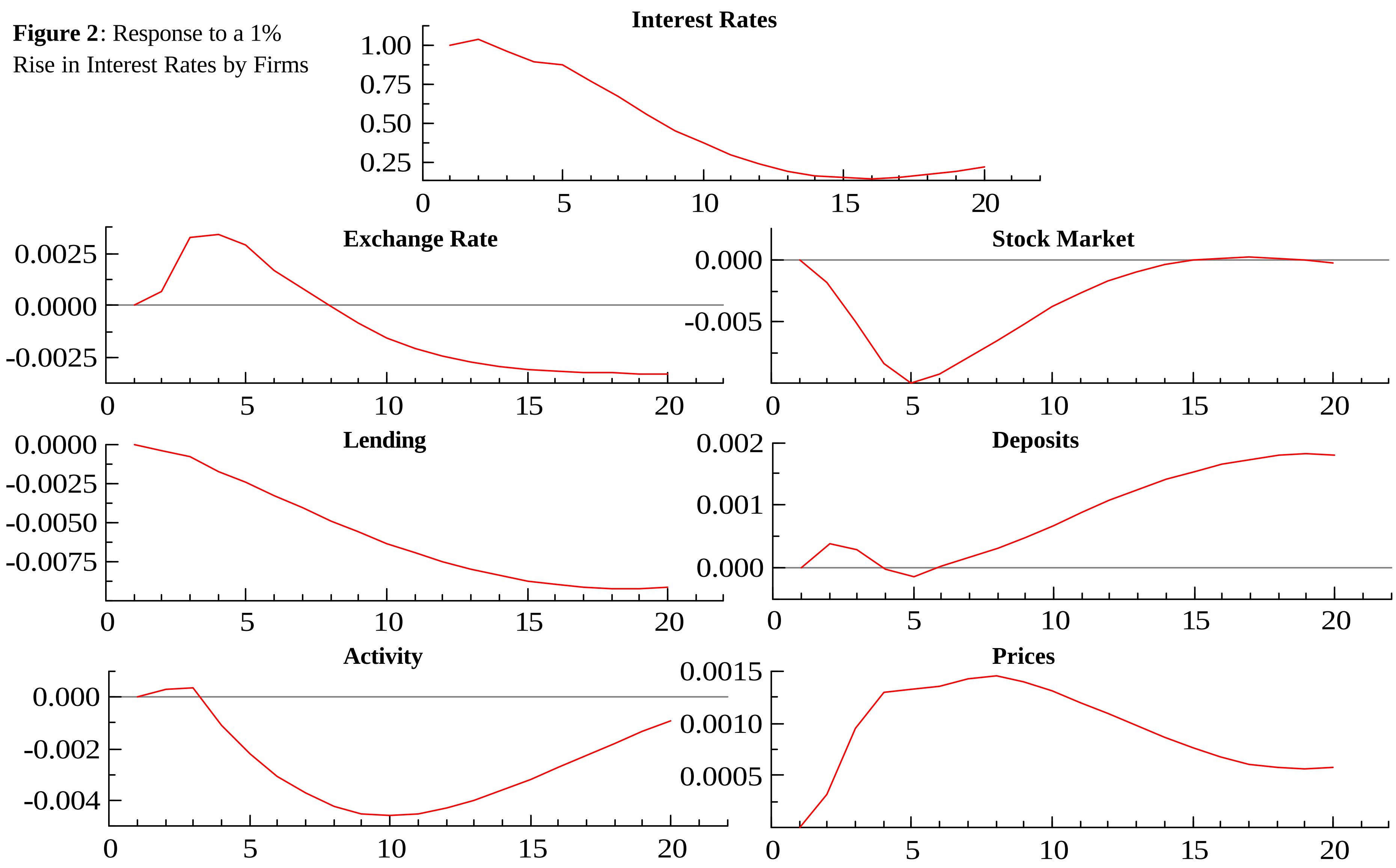


Figure 2: Response to a 1% Rise in Interest Rates by Firms



Although not immediately clear, particularly in the firms' model, price changes do follow that of activity. While the peak responses in activity occur after between 5 and 10 quarters, prices do not begin to fall until after the 8^{th} quarter, or 2 years[23]. This is consistent with the classical aggregate demand/aggregate supply model where prices fall as a result of a fall in output. The response of firms is particularly interesting and this will be discussed further below.

On real activity, it takes about 2-3 quarters before the monetary impulse systematically depresses activity. The responses gradually accumulate, peaking at around 7-10 quarters. Although not imposed, the VAR estimates for both sectors appear to generate the long-run money neutrality condition: the response of real activity to a nominal interest rate shock tends to zero by the end of the five-year horizon, for both personal and corporate sectors.

The response of prices following a monetary shock is difficult to reconcile with theory: the inflation response is perverse for the first 11 quarters for households and 24 quarters for firms. This is a classic example of the 'price puzzle' found by Sims (1992). The usual answer to the price puzzle is that there is an omitted relevant variable containing inflationary expectations, not contained in the current model. However, one would presume that the asset price variable, the DAX, would include sufficient inflationary expectations, as would the exchange rate. A better explanation might be that the price puzzle occurs for 2 reasons in this model. Firstly, as mentioned earlier, the stock market is particularly small in Germany with respect to GDP and as such does not contain the adequate inflationary expectations that a US or UK model would. Secondly, the use of quarterly data augments this situation, by masking fluctuations within each quarter. This theory is perhaps backed up by the fact that the stock market demonstrates a relatively small reaction to a rise in interest rates, and returns quickly to base.[24] A better explanation still is that prices are set in accordance with a cost mark-up strategy. An interest rate rise raises variable costs, via wages and debt payments, thereby raising prices in the short run. This continues until demand is sufficiently depressed to provide an offsetting influence. The fact that a prominent feature of the Germany economy is long-term wage contracts and a large dependence on loans for finance makes this a likely cause of the price puzzle in Germany.

1.b. The Sectoral Channels of Monetary Transmission

Comparing figures 1 and 2 reveal significant differences in the propagation of monetary policy between firms and households in the German economy. While the effects on the final variables of prices and output are larger for firms, the responses of the 4 intermediate variables are smaller than those of households. The major difference is that in all cases the household sector responds more quickly than firms. The peak effect on lending is after 8 quarters, on deposits after 10 quarters and on activity after 7 quarters. For firms these occur after 20, 20 and 10 quarters,

[23] Indeed, firms' prices initially rise, evidence of Sims' price puzzle, and this will be discussed further in the sectoral analysis. However, the point being that after activity begins to fall, inflation begins to fall.

[24] Like Dale & Haldane (1995), a long run interest rate was tested in the model as an alternative, and potentially more powerful, variable containing inflationary expectations. Again, like Dale & Haldane it had little effect on the impulse response of prices.

respectively. As mentioned earlier, prices begin to fall in the household sector earlier, after 11 quarters as opposed to 24, and the peak effect is at 18-20 quarters against 30 for firms. These findings arguably concur with that of Gertler and Gilchrist (1994) who found a more rapid response by small firms than large companies and Bernanke and Blinder (1988) who argue that small firms face greater credit market imperfections which amplifies the effects of a monetary policy change. Households, of course, face much greater credit market imperfections than firms do.

Certainly the most interesting aspect of comparing the reactions of firms and households is not the differences but the similarities, especially money and credit. For both firms and households a rise in the interest rate causes borrowing to fall and deposits to rise, in the medium to long term. Credit is also affected far more significantly than deposits: at the peak borrowing in both sectors falls by nearly 1%. It seems that Gertler and Gilchrist's buffer-stock interpretation does not apply to German firms, who appear to pass on the increased costs of a rise in the interest rate directly by raising their prices. As mentioned above, an interest rate rise is likely to affect German firms significantly, since their labour costs are fixed in the medium term and a high proportion of their debt is in loans. Therefore, they appear to meet the cash-flow shortage by raising prices. This is significant evidence that the credit channel is particularly strong in Germany, agreeing with our priors. The fact that credit does not react immediately and violently to an interest rate rise is not evidence to dismiss the credit channel. As Bernanke and Blinder (1992) have pointed out, 'loans are quasi-contractual commitments whose stock is difficult to change quickly. In the longer run, [banks] portfolios are rebalanced, with the primary effect falling on loans.'[25] Therefore, what is most significant is that loans do not rise again after output returns to base. These findings contrast with those of Guender and Moersch (1997) who find 'no evidence for a separate credit channel of monetary policy [in Germany], while confirming the standard channel working through bank liabilities.'[26] Their conclusions are cautious though because of the use of aggregate data, the disadvantages of which have already been explained. Yet this is not something that we might expect for firms in the German economy, given the hausbank relationship and bank representation on their supervisory boards. However, these findings concur with Edwards and Fischer (1994) who find no evidence that German banks are any less likely than their British counterparts to cut credit. They conclude that, 'the commonly-held view of the merits of the German system of finance for investment, in terms of the supply of external finance to firms and corporate control, receives no support from the analysis of the available evidence.'[27] There is also, however, weak evidence supporting the money view in respect to the timing of the deposit functions, particularly in the household sector. Here, deposits initially contract, until the effect on activity peaks. One could conclude, tentatively, that monitoring deposits is a good indicator of the effects of monetary policy on persons in Germany.

2. To compare the evidence from Germany with that of the UK

The impulse responses of the two sectors for the UK economy, taken from Dale and Haldane (1995), are included in the paper, as is the aggregate model. Comparing these with the results from this study gives some interesting insights into the

[25] Bernanke & Blinder (1992) p.919
[26] Guender & Moersch (1997) p.182
[27] Edwards & Fischer (1994) p.240

propagation of monetary policy in the two economies, and whether or not joining the Euro will cause business cycle asymmetries for the UK.

The most significant difference by far is the magnitude of the reactions to a shock to monetary policy. In all cases, UK variables react far more to a monetary impulse than the German equivalents. These findings agree with those of Dornbusch et al (1998) but contrast with those of Barran et al (1996) and Ehrmann (1998). There are 3 possible explanations. Firstly, the quarterly data used in this study has had a dampening effect on the impulse responses. This is confirmed by observing that the reactions of the aggregate model in Dale and Haldane (1995), also using quarterly data, also experience this. Secondly, that due to its institutional environment and for the most part a fixed exchange rate regime, a monetary policy shock in Germany has a much less significant effect on real and intermediate variables. Lastly, and perhaps most likely, is that monetary policy was particularly badly managed in the UK in the sample period used by Dale and Haldane (1995): 1974 – 1992. Interest rates were extremely volatile, as a result of various monetary targets and political influence. Therefore the paper very likely gives an extreme case of monetary policy in the UK, when compared to the relatively strict monetary regime employed by the Bundesbank in the same period. As was outlined in the definition, expectations and confidence play a vital role in the transmission of monetary policy and this is modelled to some extent by the exchange rate and the stock market variables. The fact that these variables react much more violently in the UK than in Germany is evidence of the lack of confidence in the UK regime in the sample period and the opposite for Germany. A similar study of the UK using 1992 – 2002 may well give a very different picture. Perhaps more significant is that this comparison between Germany and the UK disagrees with Britton and Whitley (1997) who deliberately construct identical models. However, their models appear too simplistic, not taking into account the stock market for example or the channels of monetary transmission. They also produce results that seem unrealistic, for example, the peak output response occurs after 3 years and does not return to base until after 10 years and peak price level response occurs after 15 years.

The second significant difference between the two countries is the behaviour of deposits, and to a lesser extent lending. In Germany, bank deposits behave as one would expect by rising after an interest rate rise, increasing the returns to capital-certain bank deposits, and augmented by the fall of the capital-uncertain stock market. In Germany, credit falls in all cases. In the UK however, deposits fall in general over the 5-year period, a seemingly bizarre result that the authors do not attempt to explain. Lending to UK firms, however, rises for the first 6 quarters after a shock, indicating a willingness of UK banks to support firms in financial difficulties. This is something that might be expected of German banks due to the Hausbank relationship, but not in the market-based system of the UK.

In general however, while the transmission of monetary policy differs between the 2 economies, the effect on the final variables is very similar. Activity falls, but returns to base over 5 years, and prices rise initially before eventually falling, although the timing is varied. Thus one might conclude that while the channels and transmission of monetary policy differ in Germany and the UK, the eventual effects on real variables are the same. Therefore, the adoption of the Euro as UK currency would not cause significant business cycle asymmetries. The differences would further disappear with the convergence of banking systems over time, and the adoption of a single European capital market and in a fixed exchange rate regime. Unfortunately, further study into the differences in magnitude, as discussed above, would need to be undertaken before this conclusion could be firmly made.

Future Research Issues

For this paper to be improved there are three points that raised themselves during the course of this study. Firstly, better data is needed to improve the accuracy of the impulse responses: the use of the retail price deflator in the household model and the GDP deflator in the aggregate model would be preferred to the CPI. Also more frequent data would be vastly more useful than was used, monthly frequency at least. Secondly, the model would be further improved by imposing long run cointegrating relations rather than leaving the model as an unrestricted vector error-correction mechanism. Lastly, for a more effective comparison with Germany, a new estimate of the transmission mechanism in the UK is needed, with expectations and confidence in the central bank at more comparable levels.

Conclusions

This paper has highlighted the conflicting nature of previous studies of the monetary transmission mechanism. Contrasting conclusions are often drawn because of the use of different techniques in modelling the effects of monetary policy. One of the most important findings has been that aggregate data masks important information by being bound by banks' balance sheet constraints, yet most papers continue to use it. One of the most successful studies has been Dale and Haldane (1995) and this paper has used their modelling technique with German data. It appears that this is the first paper to use disaggregated German data and it answers two important and topical questions: Is there a significant credit channel in the propagation of German monetary policy? Does the transmission and final effects of monetary policy differ significantly with the UK?

A small, sectoral vector autoregressive model of the German economy was estimated to simulate the effects of a 100 basis-point exogenous rise in the interest rate. The effects were traced through asset prices, bank balance sheet variables and final target variables. This model allowed us to infer a number of interesting points. First, there is significant evidence of a credit channel in the propagation of monetary policy, in both the firm and household sectors. This is because of the dependence of German firms on debt financing, predominantly in the form of loans, and an underdeveloped capital market making loans and securities imperfect substitutes. Second, the effect of monetary policy is weak on all aspects of the German economy, when compared to the UK. Interestingly, like Sims (1992), there is also a protracted period when the price response is perverse particularly for firms, although this does not violate theory. Third, unlike Dale and Haldane (1995) the transmission of monetary policy appears to be similar for firms and households in all but timing. This may be because households and firms in Germany rely on bank finance whereas UK firms have less absolute debt and less debt in the form of loans. Finally, while the channels of monetary policy differ between the UK and Germany, the final effects are relatively similar, indicating that the UK adoption of the Euro would not result in asymmetric business cycles. The evidence suggests that the UK would suffer more significant output effects, but it is argued that this is greatly exaggerated by monetary policy mismanagement in the sample period. Although results contrasting with Britton and Whitley (1997) were found, we agree that, ‘even if there have been differences in how countries have responded to a monetary policy shock in the past, we cannot be confident that these differences will persist under a different regime.’[28]

[28] Britton and Whitley (1997) p.159

Figure 3: Aggregate Response to a 1% Increase in Interest Rates

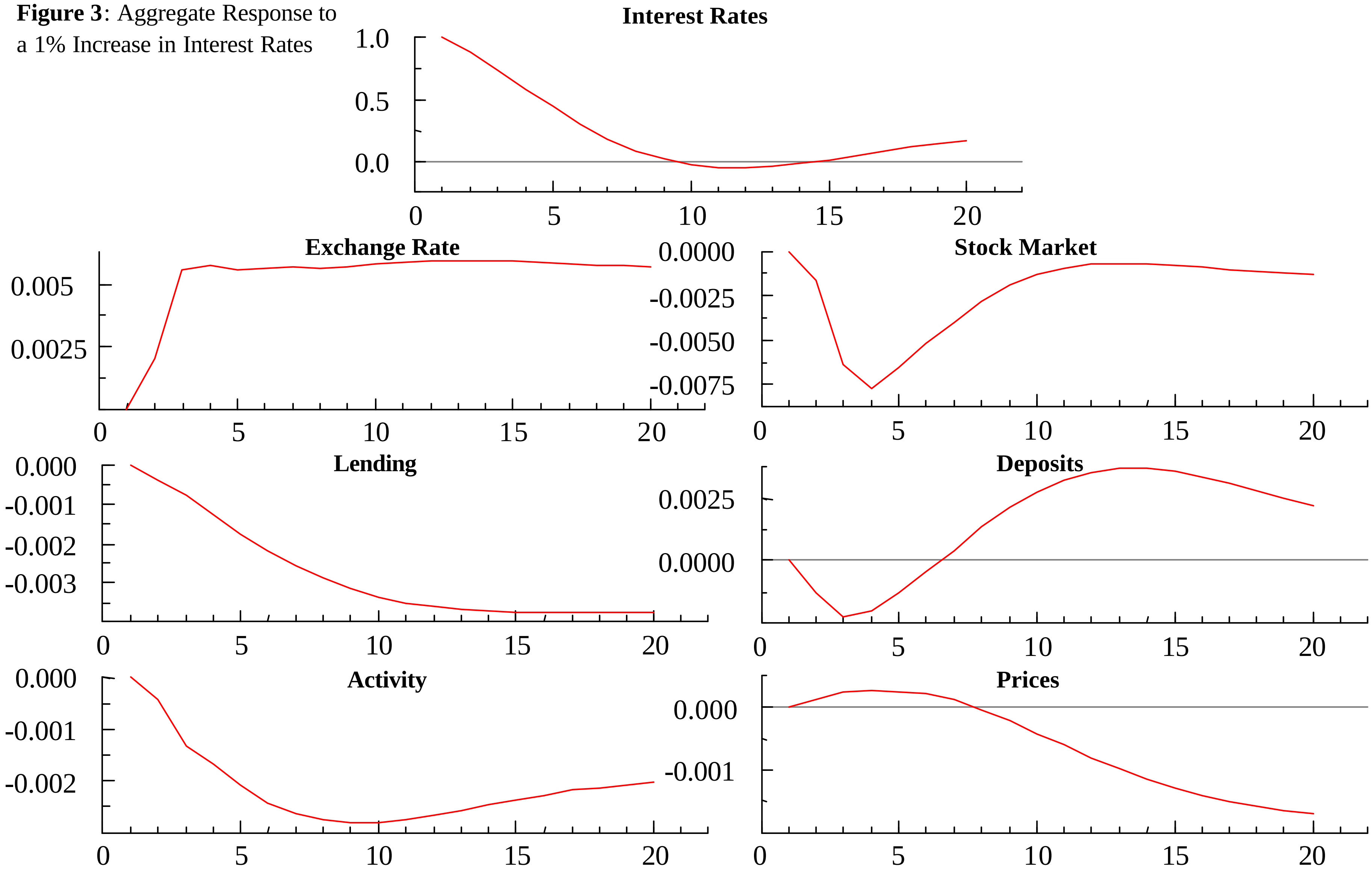


Figure 4: Household Response to a 1% Rise in Interest Rates in the UK, Dale & Haldane (1995)

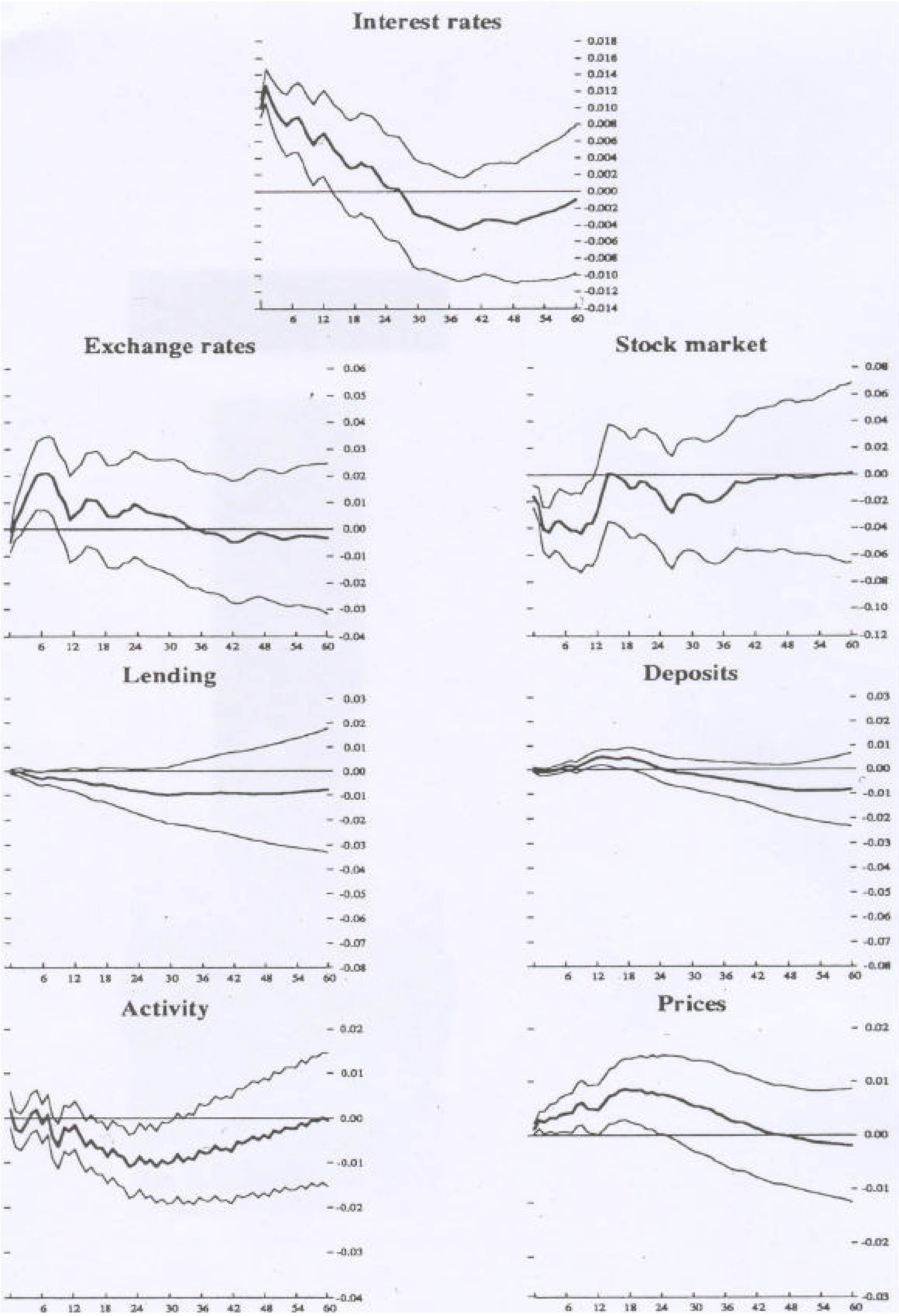


Figure 5: Firms Response to a 1% Rise in Interest Rates in the UK, Dale & Haldane (1995)

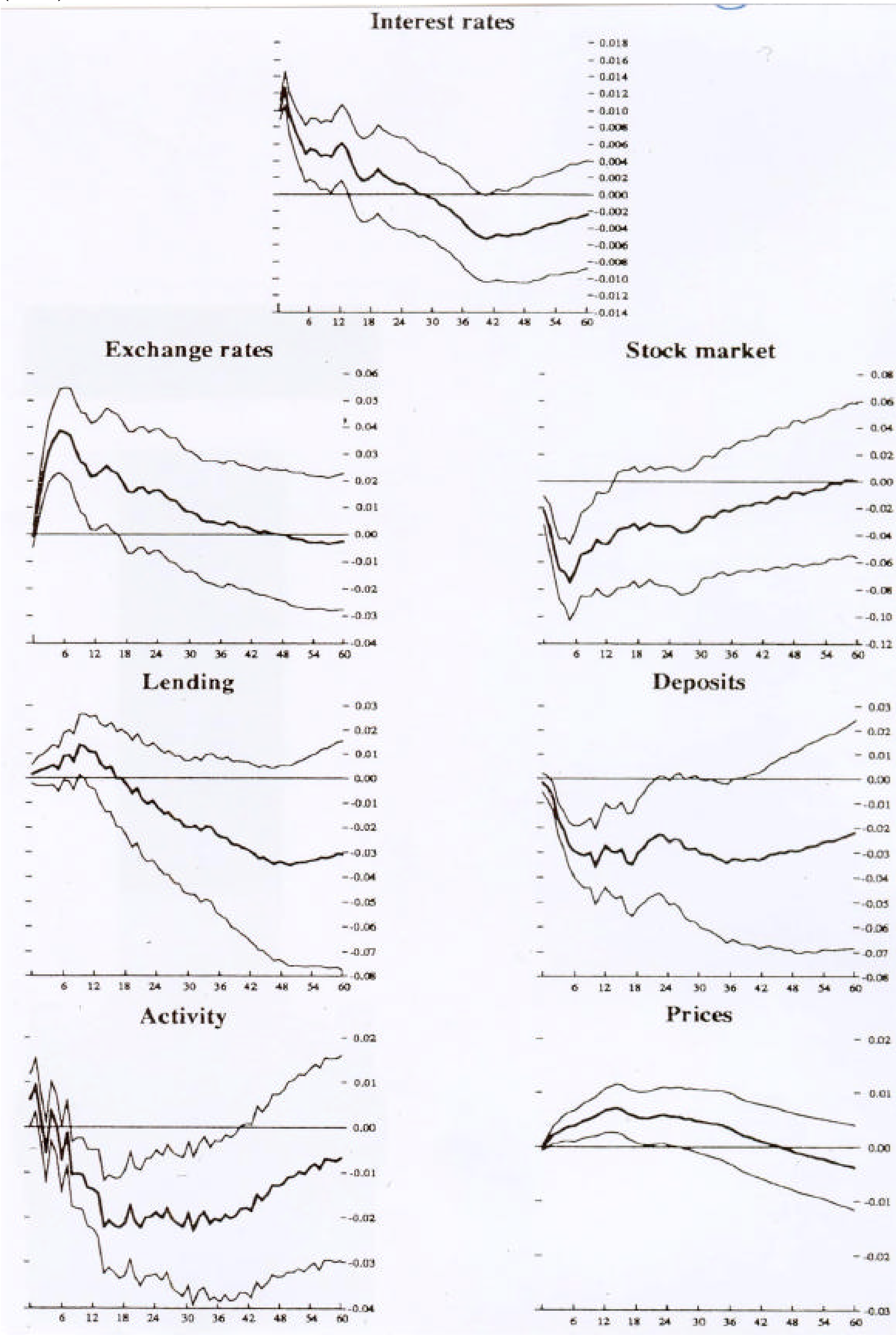
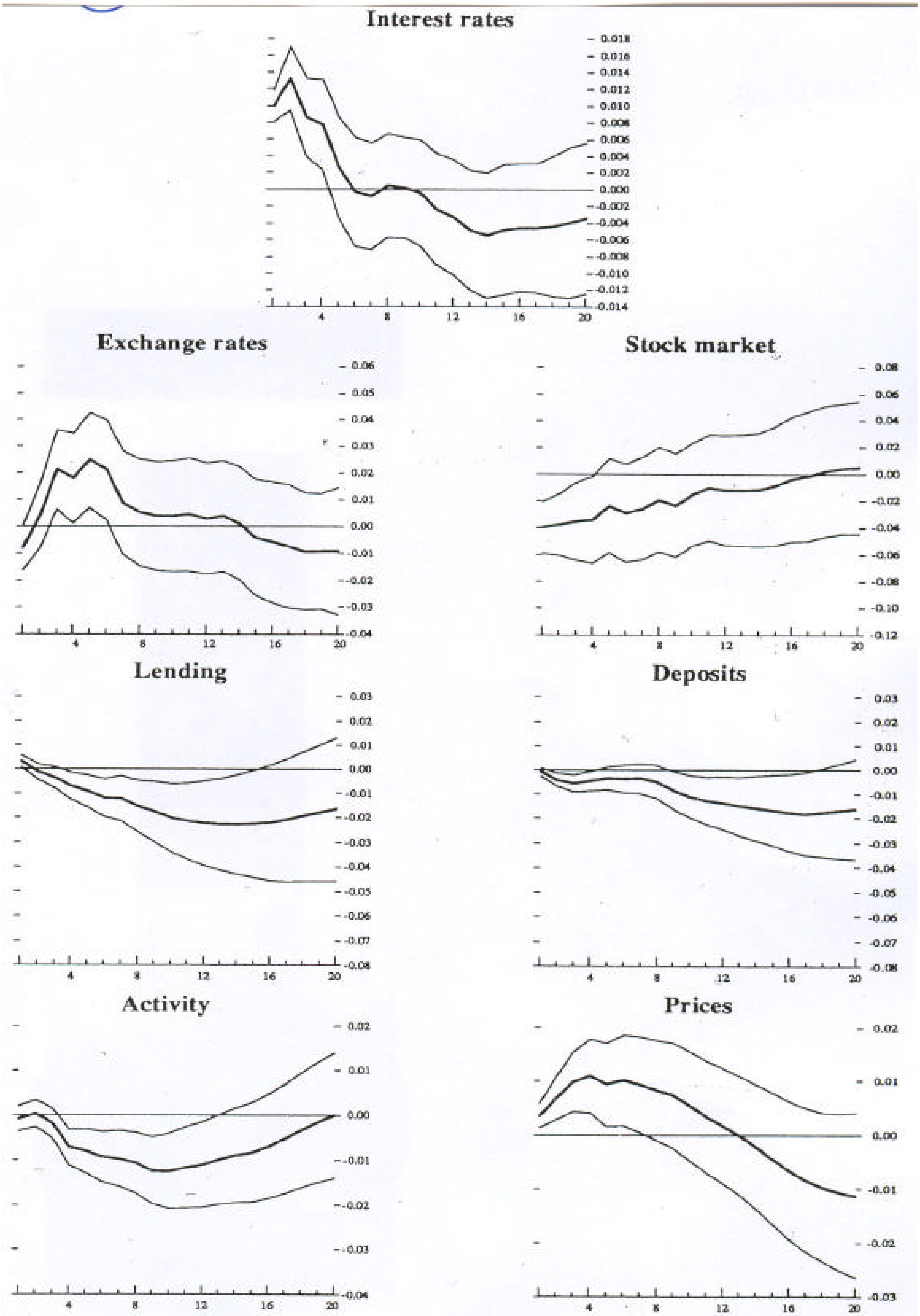


Figure 6: Aggregate Response to a 1% Rise in Interest Rates in the UK, Dale & Haldane (1995)



Appendix

Table 1: Structure of Financial Markets, 1996

	Mkt Capitalisation (% GDP)	Trading Volume (% GDP)
Germany	29.6	33.3
UK	149.9	66.1

Source: Bundesbank, Monthly Report, January 1997, from Giovannetti & Marimon (1998)

Table 2: Financial Assets of Households, 1994
(as a proportion of gross financial assets)

	Banks	Bonds	Equities	Inst. Inv.
Germany	45%	14%	6%	28%
UK	26%	1%	12%	54%

Source: Davis, 1996

Table 3: Corporate Sector Balance Sheets, 1994
(as a proportion of gross financial assets)

	Bonds	Equities	Loans
Germany	8%	25%	50%
UK	0.1%	65%	12%

Source: Davis, 1996

Table 4: Ownership of Listed Shares by Sector, 1995

	HH	NFI	PUB	TNFI	FI	FRN
Germany	14.6	42.1	4.3	61.0	30.3	8.7
UK	29.6	4.1	0.2	33.9	52.4	13.7

Key: HH=households, NFI=non-financial institutions, PUB=public, TNFI=total non-financial institutions, FI=financial institutions, FRN=foreign

Source: Bundesbank, Monthly Report, January 1997, from Giovannetti & Marimon (1998)

Aggregate Model of the German Economy

- Unit-Root Tests

CallMr: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.776*	0.86056	0.8898	2.820	0.0057	-0.1615	
2	-3.029	0.88915	0.9170	1.382	0.1696	-0.1090	0.0057
1	-2.760	0.90185	0.9207	3.026	0.0031	-0.1087	0.0084
0	-2.140	0.92271	0.9530			-0.04747	0.0004

logGDP: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-1.433	0.97237	0.004388	1.071	0.2865	-10.79	
2	-1.304	0.97504	0.004391	1.360	0.1765	-10.79	0.2865
1	-1.170	0.97764	0.004408	-0.4992	0.6186	-10.79	0.2277
0	-1.233	0.97664	0.004393			-10.81	0.3591

logCPI: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.435	0.98282	0.001800	2.651	0.0092	-12.57	
2	-2.193	0.98416	0.001848	1.297	0.1973	-12.52	0.0092
1	-2.117	0.98469	0.001853	6.043	0.0000	-12.53	0.0145
0	-2.542	0.97911	0.002122			-12.26	0.0000

logAggD: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.176	0.95261	0.009196	1.725	0.0873	-9.306	
2	-2.104	0.95380	0.009277	0.1631	0.8707	-9.296	0.0873
1	-2.108	0.95396	0.009237	1.837	0.0689	-9.313	0.2273
0	-2.049	0.95480	0.009333			-9.300	0.0998

logAggC: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.826	0.94839	0.004284	1.212	0.2282	-10.83	
2	-2.739	0.95001	0.004293	2.065	0.0412	-10.84	0.2282
1	-2.609	0.95175	0.004355	3.881	0.0002	-10.82	0.0606
0	-2.647	0.94816	0.004616			-10.71	0.0002

logEffER: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.077	0.89614	0.007742	2.572	0.0114	-9.650	
2	-2.500	0.91578	0.007934	0.4309	0.6674	-9.609	0.0114
1	-2.477	0.91924	0.007905	2.990	0.0034	-9.624	0.0367
0	-1.898	0.93710	0.008176			-9.564	0.0017

logDax: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.631	0.92073	0.02877	1.909	0.0589	-7.025	
2	-2.274	0.93201	0.02910	-0.9442	0.3471	-7.009	0.0589
1	-2.555	0.92563	0.02909	3.641	0.0004	-7.018	0.1073
0	-1.877	0.94331	0.03061			-6.924	0.0008

DCallMr: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.768**	0.30151	0.9433	1.487	0.1399	-0.04345	
2	-4.527**	0.38816	0.9485	-1.777	0.0783	-0.04032	0.1399
1	-6.216**	0.26718	0.9577	-0.5548	0.5801	-0.02896	0.0715
0	-8.407**	0.22648	0.9547			-0.04314	0.1326

DlogGDP: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.598*	0.37510	0.004260	-2.088	0.0391	-10.84	
2	-4.878**	0.22123	0.004325	-1.516	0.1324	-10.82	0.0391
1	-6.743**	0.090078	0.004350	-1.100	0.2738	-10.82	0.0382
0	-10.78**	-0.016220	0.004354			-10.82	0.0516

DlogCPI: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.334	0.76403	0.001774	-2.856	0.0051	-12.60	
2	-3.243	0.67725	0.001831	-2.464	0.0153	-12.54	0.0051
1	-4.508**	0.57937	0.001872	-1.414	0.1602	-12.50	0.0010
0	-5.995**	0.51341	0.001881			-12.50	0.0013

DlogAggD: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.754*	0.38434	0.009396	-1.138	0.2577	-9.262	
2	-4.714**	0.30305	0.009409	-1.637	0.1044	-9.267	0.2577
1	-6.689**	0.16935	0.009480	-0.06182	0.9508	-9.260	0.1414
0	-8.878**	0.16437	0.009438			-9.277	0.2687

DlogAggC: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.574*	0.53944	0.004468	-0.5867	0.5586	-10.75	
2	-4.078**	0.51196	0.004454	-0.9657	0.3363	-10.76	0.5586
1	-4.996**	0.46171	0.004453	-1.872	0.0638	-10.77	0.5316
0	-7.306**	0.34654	0.004502			-10.76	0.1974

DlogEffER: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.839**	0.27169	0.008035	1.419	0.1588	-9.575	
2	-4.650**	0.36012	0.008072	-1.851	0.0668	-9.573	0.1588
1	-6.604**	0.22380	0.008160	0.09468	0.9247	-9.560	0.0693
0	-8.374**	0.23069	0.008124			-9.576	0.1464

DlogDax: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.973**	0.24466	0.02949	1.111	0.2692	-6.974	
2	-4.972**	0.31696	0.02953	-1.497	0.1374	-6.980	0.2692
1	-7.084**	0.19888	0.02969	1.448	0.1505	-6.976	0.1806
0	-7.719**	0.29673	0.02984			-6.975	0.1394

-Optimum Lag Length: 3

F-test on regressors except unrestricted: F(196,570) = 146.941 [0.0000] **

F-tests on retained regressors, F(7,82) =

CallMr_1	11.4869 [0.000]**	CallMr_2	0.494792 [0.836]
CallMr_3	1.99883 [0.065]	CallMr_4	2.44768 [0.025]*
logGDP_1	6.31297 [0.000]**	logGDP_2	0.530446 [0.809]
logGDP_3	2.47032 [0.024]*	logGDP_4	0.247851 [0.972]
logCPI_1	9.98457 [0.000]**	logCPI_2	1.67489 [0.127]
logCPI_3	1.36327 [0.232]	logCPI_4	1.24272 [0.289]
logAggD_1	18.5466 [0.000]**	logAggD_2	1.12662 [0.355]
logAggD_3	1.67773 [0.126]	logAggD_4	1.14337 [0.345]
logAggC_1	26.0726 [0.000]**	logAggC_2	0.353410 [0.926]
logAggC_3	1.15550 [0.337]	logAggC_4	0.683348 [0.686]
logEffER_1	13.5621 [0.000]**	logEffER_2	0.658604 [0.706]
logEffER_3	1.14008 [0.347]	logEffER_4	0.979888 [0.452]
logDax_1	15.8364 [0.000]**	logDax_2	1.29253 [0.264]
logDax_3	0.782717 [0.604]	logDax_4	1.36618 [0.231]
Constant U	6.37961 [0.000]**	CSeasonal U	5.04935 [0.000]**
CSeasonal_1U	5.47452 [0.000]**	CSeasonal_2 U	7.73440 [0.000]**

-Cointigrating Vectors: 4

I(1) cointegration analysis, 1971 (1) to 2000 (4)

rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0	308.58 [0.000]**	122.79 [0.000]**	254.57 [0.000]**	101.30 [0.000]**
1	185.79 [0.000]**	86.59 [0.000]**	153.28 [0.000]**	71.43 [0.000]**

2	99.20 [0.000]**	40.10 [0.006]**	81.84 [0.003]**	33.08 [0.059]
3	59.10 [0.003]**	31.73 [0.011]*	48.76 [0.039]*	26.17 [0.073]
4	27.38 [0.095]	13.91 [0.386]	22.59 [0.275]	11.48 [0.610]
5	13.47 [0.098]	12.37 [0.097]	11.11 [0.208]	10.20 [0.203]
6	1.10 [0.294]	1.10 [0.294]	0.91 [0.341]	0.91 [0.341]

-Test Summary

CallMr	: Portmanteau(12): 17.2293
logDax	: Portmanteau(12): 7.72587
logEffER	: Portmanteau(12): 19.4601
logAggC	: Portmanteau(12): 9.33069
logAggD	: Portmanteau(12): 27.2388
logCPI	: Portmanteau(12): 7.58177
logGDP	: Portmanteau(12): 13.5782
CallMr	: Normality test: Chi^2(2) = 41.897 [0.0000]**
logDax	: Normality test: Chi^2(2) = 6.1585 [0.0460]*
logEffER	: Normality test: Chi^2(2) = 0.61056 [0.7369]
logAggC	: Normality test: Chi^2(2) = 1.9767 [0.3722]
logAggD	: Normality test: Chi^2(2) = 13.411 [0.0012]**
logCPI	: Normality test: Chi^2(2) = 8.2996 [0.0158]*
logGDP	: Normality test: Chi^2(2) = 14.188 [0.0008]**
CallMr	: ARCH 1-4 test: F(4,80) = 0.93560 [0.4477]
logDax	: ARCH 1-4 test: F(4,80) = 0.48617 [0.7458]
logEffER	: ARCH 1-4 test: F(4,80) = 0.85442 [0.4951]
logAggC	: ARCH 1-4 test: F(4,80) = 0.49002 [0.7430]
logAggD	: ARCH 1-4 test: F(4,80) = 1.2712 [0.2883]
logCPI	: ARCH 1-4 test: F(4,80) = 0.088059 [0.9859]
logGDP	: ARCH 1-4 test: F(4,80) = 1.2611 [0.2922]
CallMr	: hetero test: F(48,32) = 0.85206 [0.6974]
logDax	: hetero test: F(48,32) = 0.42824 [0.9962]
logEffER	: hetero test: F(48,32) = 0.70395 [0.8670]
logAggC	: hetero test: F(48,32) = 0.45513 [0.9934]
logAggD	: hetero test: F(48,32) = 0.53556 [0.9755]
logCPI	: hetero test: F(48,32) = 0.43290 [0.9958]
logGDP	: hetero test: F(48,32) = 0.34117 [0.9996]

Vector Portmanteau(12):	536.195
Vector Normality test:	Chi^2(14)= 71.622 [0.0000]**
Vector hetero test:	F(1344,333)= 0.25415 [1.0000]

Model for Firms in the German Economy

-Unit-Root Tests

CallMr: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.776*	0.86056	0.8898	2.820	0.0057	-0.1615	
2	-3.029	0.88915	0.9170	1.382	0.1696	-0.1090	0.0057
1	-2.760	0.90185	0.9207	3.026	0.0031	-0.1087	0.0084
0	-2.140	0.92271	0.9530			-0.04747	0.0004

logIP: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.564*	0.85864	0.006775	2.022	0.0456	-9.917	
2	-3.068	0.88194	0.006867	1.727	0.0870	-9.898	0.0456
1	-2.676	0.90007	0.006927	2.928	0.0041	-9.888	0.0313
0	-1.979	0.92583	0.007154			-9.832	0.0017

logProdP: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-1.910	0.98511	0.002962	0.9515	0.3434	-11.57	
2	-1.830	0.98581	0.002960	-0.9007	0.3697	-11.58	0.3434
1	-1.935	0.98509	0.002958	8.024	0.0000	-11.59	0.4268
0	-1.927	0.98151	0.003690			-11.16	0.0000

logFD: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-0.2048	0.99196	0.02641	0.2313	0.8175	-7.196	
2	-0.1291	0.99531	0.02630	-0.2953	0.7683	-7.212	0.8175
1	-0.2462	0.99164	0.02619	-0.1030	0.9181	-7.228	0.9325
0	-0.2943	0.99055	0.02608			-7.245	0.9851

logFC: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-0.9936	0.95721	0.03174	0.2799	0.7801	-6.828	
2	-0.9604	0.96148	0.03161	0.2501	0.8030	-6.844	0.7801
1	-0.9337	0.96478	0.03148	0.2836	0.7772	-6.860	0.9323
0	-0.8932	0.96801	0.03135			-6.876	0.9743

logEffER: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.077	0.89614	0.007742	2.572	0.0114	-9.650	
2	-2.500	0.91578	0.007934	0.4309	0.6674	-9.609	0.0114
1	-2.477	0.91924	0.007905	2.990	0.0034	-9.624	0.0367
0	-1.898	0.93710	0.008176			-9.564	0.0017

logDax: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.631	0.92073	0.02877	1.909	0.0589	-7.025	
2	-2.274	0.93201	0.02910	-0.9442	0.3471	-7.009	0.0589
1	-2.555	0.92563	0.02909	3.641	0.0004	-7.018	0.1073
0	-1.877	0.94331	0.03061			-6.924	0.0008

DCallMr: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.768**	0.30151	0.9433	1.487	0.1399	-0.04345	
2	-4.527**	0.38816	0.9485	-1.777	0.0783	-0.04032	0.1399
1	-6.216**	0.26718	0.9577	-0.5548	0.5801	-0.02896	0.0715
0	-8.407**	0.22648	0.9547			-0.04314	0.1326

DlogIP: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.839**	0.27018	0.007142	1.140	0.2569	-9.810	
2	-4.799**	0.34249	0.007152	-0.8626	0.3902	-9.815	0.2569
1	-6.057**	0.28317	0.007144	-0.8698	0.3863	-9.826	0.3631
0	-8.453**	0.21895	0.007136			-9.836	0.4270

DlogProdP: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.779*	0.60369	0.002990	0.03724	0.9704	-11.55	
2	-4.112**	0.60522	0.002977	-0.6030	0.5478	-11.57	0.9704
1	-4.932**	0.57901	0.002968	1.031	0.3046	-11.58	0.8348
0	-5.032**	0.62015	0.002969			-11.59	0.7039

DlogFD: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-5.789**	-0.13407	0.02653	0.9970	0.3210	-7.185	
2	-6.128**	-0.035162	0.02653	-0.1659	0.8686	-7.193	0.3210
1	-7.772**	-0.051798	0.02642	0.3545	0.7237	-7.210	0.6015
0	-10.77**	-0.017580	0.02631			-7.226	0.7661

DlogFC: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-5.702**	-0.096383	0.03205	0.8531	0.3955	-6.807	
2	-6.122**	-0.013168	0.03201	0.07765	0.9382	-6.818	0.3955
1	-7.494**	-0.0057147	0.03187	0.06772	0.9461	-6.835	0.6937

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
0	-10.58**	0.00071121	0.03173			-6.852	0.8640

DlogEffER: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.839**	0.27169	0.008035	1.419	0.1588	-9.575	
2	-4.650**	0.36012	0.008072	-1.851	0.0668	-9.573	0.1588
1	-6.604**	0.22380	0.008160	0.09468	0.9247	-9.560	0.0693
0	-8.374**	0.23069	0.008124			-9.576	0.1464

DlogDax: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.973**	0.24466	0.02949	1.111	0.2692	-6.974	
2	-4.972**	0.31696	0.02953	-1.497	0.1374	-6.980	0.2692
1	-7.084**	0.19888	0.02969	1.448	0.1505	-6.976	0.1806
0	-7.719**	0.29673	0.02984			-6.975	0.1394

-Optimum Lag Length: 2

F-test on regressors except unrestricted: F(98,616) = 202.272 [0.0000] **
F-tests on retained regressors, F(7,96) =

CallMr_1	15.2637 [0.000]**	CallMr_2	1.45349 [0.193]
logDax_1	21.1744 [0.000]**	logDax_2	2.51511 [0.020]*
logEffER_1	20.8788 [0.000]**	logEffER_2	3.29847 [0.003]**
logFC_1	15.6550 [0.000]**	logFC_2	2.44189 [0.024]*
logFD_1	15.2019 [0.000]**	logFD_2	2.27549 [0.035]*
logProdP_1	36.7042 [0.000]**	logProdP_2	2.58455 [0.017]*
logIP_1	11.5728 [0.000]**	logIP_2	1.22118 [0.299]
Constant U	2.09877 [0.051]	Seasonal U	18.5913 [0.000]**
Seasonal_1 U	17.5634 [0.000]**	Seasonal_2 U	21.9294 [0.000]**

-Cointegrating Vectors: 3

I(1) cointegration analysis, 1970 (4) to 2000 (4)

rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0	208.46 [0.000]**	72.60 [0.000]**	172.28 [0.000]**	60.00 [0.000]**
1	135.86 [0.000]**	57.94 [0.000]**	112.28 [0.002]**	47.88 [0.003]**
2	77.92 [0.009]**	36.31 [0.021]*	64.40 [0.124]	30.01 [0.136]
3	41.61 [0.171]	17.83 [0.521]	34.39 [0.485]	14.73 [0.768]
4	23.78 [0.217]	16.13 [0.226]	19.66 [0.458]	13.33 [0.437]
5	7.65 [0.510]	5.06 [0.735]	6.32 [0.661]	4.18 [0.834]
6	2.59 [0.108]	2.59 [0.108]	2.14 [0.144]	2.14 [0.144]

-Test Summary

CallMr	: Portmanteau(12): 15.1434
logDax	: Portmanteau(12): 9.25399
logEffER	: Portmanteau(12): 11.3685
logFC	: Portmanteau(12): 5.95081
logFD	: Portmanteau(12): 22.5187
logProdP	: Portmanteau(12): 19.9482
logIP	: Portmanteau(12): 11.1807
CallMr	: Normality test: Chi^2(2) = 39.297 [0.0000]**
logDax	: Normality test: Chi^2(2) = 27.795 [0.0000]**
logEffER	: Normality test: Chi^2(2) = 1.3985 [0.4970]
logFC	: Normality test: Chi^2(2) = 1.7586 [0.4151]
logFD	: Normality test: Chi^2(2) = 23.915 [0.0000]**
logProdP	: Normality test: Chi^2(2) = 20.859 [0.0000]**
logIP	: Normality test: Chi^2(2) = 12.219 [0.0022]**
CallMr	: ARCH 1-4 test: F(4,76) = 0.89128 [0.4734]
logDax	: ARCH 1-4 test: F(4,76) = 0.71102 [0.5869]

logEffER	: ARCH 1-4 test:	F(4,76) =	0.99008 [0.4182]
logFC	: ARCH 1-4 test:	F(4,76) =	0.15590 [0.9598]
logFD	: ARCH 1-4 test:	F(4,76) =	1.0970 [0.3642]
logProdP	: ARCH 1-4 test:	F(4,76) =	1.5301 [0.2019]
logIP	: ARCH 1-4 test:	F(4,76) =	1.4221 [0.2348]
CallMr	: hetero test:	F(54,17) =	0.35145 [0.9982]
logDax	: hetero test:	F(54,17) =	0.12502 [1.0000]
logEffER	: hetero test:	F(54,17) =	0.22469 [1.0000]
logFC	: hetero test:	F(54,17) =	0.21171 [1.0000]
logFD	: hetero test:	F(54,17) =	0.27350 [0.9999]
logProdP	: hetero test:	F(54,17) =	0.91907 [0.6114]
logIP	: hetero test:	F(54,17) =	0.16373 [1.0000]

Vector Portmanteau(12): 620.638
Vector Normality test: Chi^2(14)= 129.45 [0.0000]**
Vector hetero test: Chi^2(1512)= 1437.3 [0.9144]

Model for Households in the German Economy

-Unit-Root Tests

CallMr: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.776*	0.86056	0.8898	2.820	0.0057	-0.1615	
2	-3.029	0.88915	0.9170	1.382	0.1696	-0.1090	0.0057
1	-2.760	0.90185	0.9207	3.026	0.0031	-0.1087	0.0084
0	-2.140	0.92271	0.9530			-0.04747	0.0004

logRetVol: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-1.509	0.94641	0.007740	1.390	0.1672	-9.651	
2	-1.341	0.95255	0.007772	0.5467	0.5857	-9.650	0.1672
1	-1.283	0.95513	0.007748	-2.946	0.0039	-9.664	0.3308
0	-1.836	0.93496	0.008004			-9.607	0.0150

logCPI: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.435	0.98282	0.001800	2.651	0.0092	-12.57	
2	-2.193	0.98416	0.001848	1.297	0.1973	-12.52	0.0092
1	-2.117	0.98469	0.001853	6.043	0.0000	-12.53	0.0145
0	-2.542	0.97911	0.002122			-12.26	0.0000

logHHD: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	0.2264	1.0071	0.02355	0.05658	0.9550	-7.426	
2	0.2625	1.0077	0.02344	-0.3101	0.7571	-7.442	0.9550
1	0.1720	1.0048	0.02335	-0.2278	0.8202	-7.458	0.9520
0	0.1093	1.0029	0.02325			-7.474	0.9852

logHHC: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-0.2005	0.99567	0.03378	0.1715	0.8642	-6.704	
2	-0.1671	0.99650	0.03364	-0.1886	0.8507	-6.720	0.8642
1	-0.2131	0.99566	0.03349	0.1306	0.8964	-6.736	0.9682
0	-0.1916	0.99619	0.03335			-6.753	0.9939

logEffER: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-3.077	0.89614	0.007742	2.572	0.0114	-9.650	
2	-2.500	0.91578	0.007934	0.4309	0.6674	-9.609	0.0114
1	-2.477	0.91924	0.007905	2.990	0.0034	-9.624	0.0367
0	-1.898	0.93710	0.008176			-9.564	0.0017

logDax: ADF tests (T=120, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.631	0.92073	0.02877	1.909	0.0589	-7.025	
2	-2.274	0.93201	0.02910	-0.9442	0.3471	-7.009	0.0589
1	-2.555	0.92563	0.02909	3.641	0.0004	-7.018	0.1073
0	-1.877	0.94331	0.03061			-6.924	0.0008

DCallMr: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.768**	0.30151	0.9433	1.487	0.1399	-0.04345	
2	-4.527**	0.38816	0.9485	-1.777	0.0783	-0.04032	0.1399
1	-6.216**	0.26718	0.9577	-0.5548	0.5801	-0.02896	0.0715
0	-8.407**	0.22648	0.9547			-0.04314	0.1326

DlogRetVol: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.516**	0.038048	0.007779	-0.8038	0.4233	-9.639	
2	-5.506**	-0.040466	0.007767	-1.496	0.1374	-9.650	0.4233
1	-7.998**	-0.21130	0.007810	-0.4253	0.6714	-9.647	0.2416
0	-13.89**	-0.26272	0.007781			-9.663	0.3867

DlogCPI: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-2.334	0.76403	0.001774	-2.856	0.0051	-12.60	
2	-3.243	0.67725	0.001831	-2.464	0.0153	-12.54	0.0051
1	-4.508**	0.57937	0.001872	-1.414	0.1602	-12.50	0.0010
0	-5.995**	0.51341	0.001881			-12.50	0.0013

DlogHHD: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-5.530**	-0.076169	0.02369	0.5637	0.5741	-7.412	
2	-6.085**	-0.021117	0.02362	-0.1534	0.8784	-7.426	0.5741
1	-7.672**	-0.036270	0.02351	0.2352	0.8145	-7.443	0.8434
0	-10.73**	-0.013654	0.02342			-7.459	0.9409

DlogHHC: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-5.581**	-0.066846	0.03402	0.6916	0.4907	-6.688	
2	-6.056**	-0.000863	0.03394	-0.1296	0.8971	-6.701	0.4907
1	-7.580**	-0.013348	0.03379	0.2245	0.8228	-6.718	0.7812
0	-10.50**	0.007790	0.03365			-6.734	0.9087

DlogEffER: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.839**	0.27169	0.008035	1.419	0.1588	-9.575	
2	-4.650**	0.36012	0.008072	-1.851	0.0668	-9.573	0.1588
1	-6.604**	0.22380	0.008160	0.09468	0.9247	-9.560	0.0693
0	-8.374**	0.23069	0.008124			-9.576	0.1464

DlogDax: ADF tests (T=118, Constant+Trend+Seasonals; 5%=-3.45 1%=-4.04)

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
3	-4.973**	0.24466	0.02949	1.111	0.2692	-6.974	
2	-4.972**	0.31696	0.02953	-1.497	0.1374	-6.980	0.2692
1	-7.084**	0.19888	0.02969	1.448	0.1505	-6.976	0.1806
0	-7.719**	0.29673	0.02984			-6.975	0.1394

-Optimum Lag Length: 3

F-test on regressors except unrestricted: F(147,604) = 125.223 [0.0000] **

F-tests on retained regressors, F(7,89) =

CallMr_1	14.1998 [0.000]**	CallMr_2	0.430258 [0.881]
CallMr_3	2.22899 [0.039]*	logDax_1	21.5054 [0.000]**
logDax_2	1.29528 [0.262]	logDax_3	1.12298 [0.356]
logEffER_1	16.3250 [0.000]**	logEffER_2	0.311922 [0.947]
logEffER_3	1.28026 [0.269]	logHHC_1	15.0826 [0.000]**
logHHC_2	1.05076 [0.402]	logHHC_3	0.540645 [0.801]
logHHD_1	14.1144 [0.000]**	logHHD_2	0.775899 [0.609]

logHHD_3	0.408446 [0.895]	logCPI_1	13.2225 [0.000]**
logCPI_2	1.48224 [0.184]	logCPI_3	2.14250 [0.047]*
logRetVol_1	4.64095 [0.000]**	logRetVol_2	3.14616 [0.005]**
logRetVol_3	2.40554 [0.027]*	Constant U	1.79281 [0.098]
Seasonal U	13.8661 [0.000]**	Seasonal_1 U	3.50958 [0.002]**
Seasonal_2 U	1.55328 [0.160]		

-Cointegrating Vectors: 3

I(1) cointegration analysis, 1970 (4) to 2000 (4)

rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0	230.57 [0.000]**	90.81 [0.000]**	190.55 [0.000]**	75.05 [0.000]**
1	139.76 [0.000]**	65.40 [0.000]**	115.50 [0.001]**	54.05 [0.000]**
2	74.36 [0.019]*	27.21 [0.261]	61.45 [0.194]	22.48 [0.581]
3	47.15 [0.057]	25.35 [0.093]	38.97 [0.264]	20.95 [0.289]
4	21.80 [0.320]	15.66 [0.256]	18.02 [0.575]	12.94 [0.472]
5	6.14 [0.683]	4.97 [0.746]	5.08 [0.799]	4.11 [0.842]
6	1.17 [0.279]	1.17 [0.279]	0.97 [0.325]	0.97 [0.325]

-Test Summary

CallMr	: Portmanteau(12): 16.5972	
logDax	: Portmanteau(12): 12.4272	
logEffER	: Portmanteau(12): 20.4383	
logHHC	: Portmanteau(12): 38.4296	
logHHD	: Portmanteau(12): 7.51874	
logCPI	: Portmanteau(12): 11.9981	
logRetVol	: Portmanteau(12): 8.6226	
CallMr	: Normality test: Chi^2(2) =	20.371 [0.0000]**
logDax	: Normality test: Chi^2(2) =	28.921 [0.0000]**
logEffER	: Normality test: Chi^2(2) =	3.4945 [0.1743]
logHHC	: Normality test: Chi^2(2) =	9.7441 [0.0077]**
logHHD	: Normality test: Chi^2(2) =	27.204 [0.0000]**
logCPI	: Normality test: Chi^2(2) =	4.3398 [0.1142]
logRetVol	: Normality test: Chi^2(2) =	3.0522 [0.2174]
CallMr	: ARCH 1-4 test: F(4,73) =	1.3713 [0.2523]
logDax	: ARCH 1-4 test: F(4,73) =	0.88925 [0.4748]
logEffER	: ARCH 1-4 test: F(4,73) =	0.70512 [0.5910]
logHHC	: ARCH 1-4 test: F(4,73) =	0.51894 [0.7220]
logHHD	: ARCH 1-4 test: F(4,73) =	0.10493 [0.9804]
logCPI	: ARCH 1-4 test: F(4,73) =	0.24154 [0.9139]
logRetVol	: ARCH 1-4 test: F(4,73) =	0.52845 [0.7152]
CallMr	: hetero test: F(57,9) =	0.28776 [0.9982]
logDax	: hetero test: F(57,9) =	0.074756 [1.0000]
logEffER	: hetero test: F(57,9) =	0.12878 [1.0000]
logHHC	: hetero test: F(57,9) =	0.11822 [1.0000]
logHHD	: hetero test: F(57,9) =	0.12381 [1.0000]
logCPI	: hetero test: F(57,9) =	0.075063 [1.0000]
logRetVol	: hetero test: F(57,9) =	0.091573 [1.0000]

Vector Portmanteau(12):	611.484	
Vector Normality test:	Chi^2(14)=	83.630 [0.0000]**
Vector hetero test:	Chi^2(1596)=	1475.2 [0.9855]

Data

Balance Sheet Variables: Fortunately, unlike in the UK, data on lending to and deposits from the private sector is readily available in Germany. Aggregate deposits were modelled by ‘total deposits by private sector’[29] and aggregate credit by ‘total credit to private sector’. For households these variables were found as ‘total deposits by private individuals (excluding entrepreneurs)’ and ‘total credit to private individuals (excluding entrepreneurs)’. There was similar data for firms that did not include banks or other financial institutions.

Asset Prices: Official interest rates were modelled by the ‘call money rate’, the most short-term rate available. The exchange rate variable is given by the DM effective exchange rate index, and the stock market by the DAX. They are all quarterly averages.

Real Activity and Prices: The aggregate real output and prices were proxied by GDP at 1995 prices and the CPI. Real household demand was measured by the retail sales volume index, and prices by the CPI again[30]. Firm’s output was measured by industrial production, and prices by the index of producer prices.

All the index variables were normalised to 1995 = 100 and the balance sheet variables were all in DM millions. Only some data was available in seasonally adjusted form and so seasonal dummies were added to the models. All variables except the call money rate were modelled in logarithms.

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[29] My thanks go to Irma Sgarz for her invaluable help in collecting and translating the data

[30] Unfortunately, after extensive searching, data on either the GDP deflator or the retail price deflator could not be found. The author recognises the limitations of using the CPI, but it was decided that this would not greatly affect the model or its results.

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