Discussion Paper No.16

March 2007

EXPLORING THE IMPLICATIONS OF UK MONETARY POLICY FOR SECTORS OF THE UK AND SCOTTISH ECONOMIES

Julia Darby
CPPR
University of Strathclyde

Heather Phillips
CPPR
University of Strathclyde

Abstract:

The Bank of England's monetary policy is based on UK averages, although regional differences may exist. Existing literature focusing on the US and on member countries within EMU has suggested that differential regional impacts of monetary policy could reflect differences in the mix of interest-sensitive industries, in openness and in firm size. These explanations emphasise the importance of the interest rate, exchange rate and credit channels in the transmission of monetary policy respectively. Less attention has been devoted to regional impacts of monetary policy within countries. In this paper we examine impulse responses derived from VARs for disaggregated UK and Scottish data. We characterise industry responses in terms of their size, significance and timing. We add support to earlier sectoral estimates for the UK and highlight some new results on the short-term impact of monetary tightening in industries that make use of imported intermediate goods. The Scottish estimates we present are, to our knowledge, the first available. Having checked the robustness of the results, in particular by comparing the VAR and two stage estimates we seek to compare the Scottish and UK results and find some evidence of stronger impacts of monetary tightening on the Scottish economy, reflecting both greater interest sensitivity of some sectors and a stronger contribution of interest sensitive sectors in total activity.

JEL codes: E5, R11

Keywords: monetary policy, regional impacts, UK, Scotland.

The authors would like to thank participants at the 2006 RSAIBIS Conference and seminar participants at the HM Treasury Regional Group and at CPPR for helpful comments and suggestions.

1. INTRODUCTION

The Bank of England sets a common UK monetary policy aimed at meeting the inflation target, based on a UK average. The Bank's Monetary Policy Committee take great pains both to understand, and to then explain, how changes in the official interest rate are propagated through the economy. Regional and sectoral differences in the impacts of monetary policy changes may exist. An existing literature, primarily focused on US data or country data for EMU participants, has attempted to determine whether differences in impacts reflect similar sectoral impacts and differences in sectoral composition within regions/countries, or whether the same sectors respond differently in different regions[i].

This literature attributes heterogeneous responses to monetary policy to factors such as differences in the composition of interest rate sensitive industries, to regional or sectoral differences in openness to trade and to differences in firm sizes. These explanations emphasise the interest rate, exchange rate and credit channel of the monetary policy transmission mechanism respectively.

In this paper we examine disaggregated sectoral data for the UK as a whole and repeat the analysis for similarly disaggregated data for Scotland. Specifically, we apply a Vector Auto-Regression (VAR) methodology and examine impulse response functions to quantify and compare the size, speed and significance of the impact of policy shocks on activity. To the best of our knowledge this study represents the first such analysis of sectoral monetary policy impacts in both the UK and Scotland, and indeed the first attempt to use the VAR methodology to assess differential regional impacts of UK monetary policy. The selection of Scotland as the comparator to the UK aggregate reflects data availability. In principle it would be interesting and potentially revealing to extend the study to look at the impact of monetary shocks on regional inflation and economic activity for all regions of the UK, but in practice the available regional data are limited to annual series on gross value added (GVA) over a relatively short time span. No time series data are currently published on regional price indicies. As a result there are limits to the testing that we are able to do. Annual data GVA are simply not well suited to identifying the relatively short term

movements in gross value added that might be attributable to monetary policy changes, and we can say nothing about regional inflation differentials.

In principle, if the estimated impacts of monetary policy shocks are found to be similar for the same sectors in both the whole of the UK and Scotland this could justify the use of UK wide estimates of the impact of monetary policy changes to infer a full set of regional impacts based upon the available data on the sectoral composition of regional activity and. However, to the extent that differential impacts are found for the same sectors based upon the Scottish and UK data, there would appear to be region specific factors at play, and such inference would be less feasible. The level of sectoral aggregation is also an issue here. Attribution of differential effects in the manner described above assumes that sectoral characteristics are similar across regions but there are likely to be particular cases where this assumption is questionable. An example we highlight below relates to the Financial Services sector. Given further disaggregation within Financial Services, it might be possible to infer more about the underlying causes of different estimated impacts of monetary tightening for the UK aggregate and Scottish sub-division, but again our approach is constrained by data availability.

We should stress at the outset that it is not an aim of this work to argue for anything other than UK wide monetary policy. Most would agree that credible monetary policy can do no more than set the appropriate interest rate to meet the UK inflation target. Instead this paper should be viewed as an attempt to provide greater understanding of the potentially disparate impacts of monetary policy changes. It is relevant to ask whether forecasts of the impact of policy could be improved by considering differential impacts on activity. It also seems reasonable to argue that a good understanding of the policy transmission mechanism requires this kind of disaggregated analysis.

In addition, to the extent that different sectoral and regional impacts are identified, and are quantitatively significant, this would suggest that UK monetary policy changes actually contribute to generating differential sectoral and regional cycles. The UK government has specifically emphasised the importance of the regional dimension to its central economic objectives and sets targets for regional convergence (see HM

Treasury, 2001; HM Treasury, 2004; Department of Trade and Industry, 2004) but has so far been silent on a possible mechanism for divergence working through the transmission of monetary policy. One response would be to direct attention to strengthening the operation of other adjustment mechanisms, including labour market flexibility and the regional operation of national fiscal stabilisers (much as suggested by HM Treasury in relation to dealing with one monetary policy for all within the Eurozone, see HM Treasury, 2003a, b).

In section II we provide a brief review of the existing literature on the impacts of monetary policy changes. Section III discusses the data and methodology we employ. Section IV discusses our basic results, and examines a potential factor determining the often found initial positive impact of policy tightening. Section V presents evidence on the robustness of the results while section VII draws together the comparison of UK and Scottish results. Section VII concludes.

2. BRIEF REVIEW OF THE EXISTING LITERATURE

The existing literature on the monetary policy transmission mechanism suggests several reasons as to why there may be differential impacts of changes in the official interest rate on the sectors and/or regions of an economy.

A key focus of the earlier literature been on monetary policy transmission through the interest rate channel, see for example, eg. Christiano, Eichenbaum and Evans (1994), Gertler and Gilchrist (1994), Ganley and Salmon (1997). Explanations for differential impacts have focused on the implications of different investment intensities of production, in the durability of goods produced, in links to industrial demand and to the construction sector and housing market.

Carlino and DeFina (1998) estimate State level VAR responses for the US and find that observed heterogeneous state impacts of monetary policy can be explained by differences in industry composition, by whether State banks can easily adjust their balance sheets and (weakly) by differences in proportion of small firms. This result is found by running a cross section regression of the 2-year cumulative VAR impulse on a constant, percentage of Gross State Product (GSP) attributed to manufacturing, two

measures of the percentage of State loans made by State banks, and percentage of firms with less than 250 employees. The finding of a significant industrial composition effect is consistent with the conclusions of Hayo and Uhlenbrock (2000). They use industry level data for Germany to estimate sectoral impulse response functions relative to the Manufacturing and Mining Industry. They find both positive and negative response relative to this sector, where positive responses were related to industries receiving highest levels of subsidy. They do not have regional level data but expect that regions with a more diversified industry profile (and hence offsetting positive and negative response relative to Manufacturing and Mining) would likely show a more muted response.

The analysis by Carlino and DeFina (1998) does not use industry level data and so cannot distinguish between pure composition effects (where the same industries react similarly in each State but their contribution to GSP differs) and differing State responses caused by the same industries reacting more strongly in some regions than others. This point is tackled in a cross-country study by Dedola and Lippi (2005) for three EMU countries plus the UK and US. They analyse data for individual countries disaggregated by industry and estimate 101 VARs for each country and industry pair. Having obtained 101 estimates of the impact of monetary shocks on activity they test the extent to which heterogeneity in these estimates can be explained by country and industry dummies. They find several highly significant industry dummies but cannot reject the null hypothesis that country-specific effects are individually or jointly different from zero. They conclude that the same industries react similarly across countries and that observed differences in aggregate country responses can be explained by differences in the composition of interest rate sensitive industries within each country.

The emerging consensus seems to be stacking up with Dedola and Lippi's view. Peersman and Smets (2001) and Arnold and Vrugt (2002) also concluded that regional-specific effects are much less important that sectoral-specific and sectoral-composition factors in explaining regional heterogeneity in responses.

It might be legitimate to expect regional specific effects, where the same sector reacts differently to the same shock in different regions, if there is heterogeneity in the

sector's characteristics across regions. A specific case in point, to which we shall return later, is the financial services sector. For the UK as a whole, activity in this sector has a dominant concentration in London and the London Financial Services sector might be characterised by international trading of financial instruments and, as a global financial centre, affected by global activity. Within the UK regions, while there are concentrations of activity in Financial Services, the nature of the key activities is less globally sensitive than in London. Similar arguments can be made for the comparison of Germany, and Frankfurt, another large international banking centre, as compared to other German regions and European countries.

External orientation can be important in other ways too, and several studies have discussed how differences in openness could be important in explaining sectoral and/or regional variations in response. Consider the impact of tighter monetary policy which would result in a general slowdown of domestic activity, but those sectors/regions earning a large part of their revenue overseas would experience some protection from direct interest rate effects, so the impact may be less strong. Within manufacturing too there are important differences in openness. In aggregate, Scotland is relatively more export orientated, so we should perhaps expect to see a more muted response to interest rate shocks, if this shielding effect is relevant. However, the evidence from the existing literature is inconclusive.

Peersman and Smets (2002) and Dedola and Lippi (2005), were unable to find any significant evidence that degree of openness was a factor in explaining heterogeneous responses. These papers used a Markov Switching model and the VAR methodology respectively to estimate the impacts of policy changes on output and then regressed these estimates on a simple indicator of openness (the ratio of imports plus exports to GVA), while also controlling for a number of other interest rate and credit channel effects. Neither paper was able to find a significant role for openness in determining differential monetary policy effects.

It is important to note that the implications of openness described thus far focus on the relative contribution of domestic demand in the overall demand facing the sector, but have abstracted from any movement in the exchange rate caused by the monetary policy change. The theoretical impact of an unexpected tightening of monetary policy

operating through the exchange rate channel sees the higher relative interest rate inducing a capital inflow, which causes the exchange rate to appreciate (see, for example, Bank of England 1999). In the absence of pricing to market behaviour, the appreciation in the exchange rate results in a loss of competitiveness and a decline in the demand for exports. Taking this impact on competitiveness through to external demand into account suggests that export intensive sectors and/or regions would actually be *more* sensitive to monetary policy changes. This view is expressed by Hayo and Uhlenbrock (2000) in their study of German industries. They use Pearson correlation coefficients and Logit models to verify a significant link between export intensity and estimated monetary policy response. They conclude that more export dependent industries suffer greater reductions in output following an interest rare shock, and attribute this to their loss of competitiveness.

In practice the impact of monetary tightening through the exchange rate channel could offset the cushioning of the interest rate channel predicted for open sectors, and the overall effect remains ambiguous, dependent on the relative strength of the potentially offsetting effects as well as the extent of pricing to market behaviour. A number of the existing studies do not explicitly attempt to model the exchange rate effect, and this may be one reason why empirical evidence in this area has so far been inconclusive.

For production sectors we argue that another impact operating through the exchange rate is likely to be relevant. Specifically, sectors importing intermediate inputs could actually benefit from reduced costs immediately following an exchange rate appreciation. This effect is likely to be strengthened by the lesser prevalence of pricing to market behaviour in relation to basic raw materials. Reduced costs during the period of an exchange rate appreciation following an unexpected monetary tightening may explain the initial positive responses of output to monetary policy shocks that have been identified (and caused some concern) in earlier studies, see for example the results reported by Ganley and Salmon (1997), Carlino and DeFina (1998), Dedola and Lippi (2005) and Hayo and Uhlenbrock (2000).

Dedola and Lippi reported initial positive responses of activity in country VARS for the UK, Germany and Italy and for a number of sectors in these three countries as well as the US and France. Hayo and Uhlenbrock also estimate an impulse response

of monetary tightening on activity in German Manufacturing and Mining which is shown to be positive in the first year, although not significantly different from zero. (Since other sectoral responses are measure relative to Manufacturing and Mining in this paper it is not possible to see interpret the initial reponses of other sectors). Ganley and Salmon reported positive impulse responses over the the first year following the monetary policy shock in four sectors: Mechanical Engineering, Mining and Quarrying, Electricity, Gas and Water and Transport Equipment, but did not provide information on the statistical significance of these. In their study of regional responses to monetary policy changes, Carlino and DeFina found an initial positive and highly significant impact on growth in the Far West (although this finding is not discussed in the paper). As far as we are aware, no existing studies have explored whether the use of imported intermediates are a factor in explaining heterogeneity in the initial impacts of these monetary policy changes.

An interesting piece of evidence from a rather different perspective is provided by Ber, Blass and Oved (2001). They argue that export intensive sectors are cushioned from domestic credit channel effects. Their paper is concerned with the effect of monetary policy on a firm level investment. When domestic interest rates are tightened, they argue that exporting firms are able to raise credit in foreign currency markets (where they have contracts and have built a reputation with local lenders) and so do not have to reduce investment. To investigate this they run a regression of firm investment on export share (the ratio of export sales to total sales income), industry dummies and a number of variables to control for credit market imperfections. They enter the interest rate on its own and interacted with other regressors. The coefficient representing the interaction of interest rate and export share is positive and significant, so they conclude that there is a reduced effect of monetary policy tightening on export intensive firms.

The existing literature also recognises the potential role of credit channel in the monetary policy transmission mechanism in explaining differential responses. The basic idea here is that tighter monetary policy adversely affects asset prices, and hence collateral values, so impacts upon agents' ability to borrow (again HM Treasury 2003c and Bank of England 1999 provide excellent overviews). Credit constraints ultimately restrict aggregate demand and hence impact negatively on gross value

added. The importance of access to external credit differs among companies. Individual consumers and small firms who lack capital, have initially high gearing may rely more on external sources of finance are likely to be more adversely affected if interest rates rise. Larger firms are perhaps more likely to rely on ploughed back profits or recourse the stock market to seek additional finance. We are therefore led to expect that sectors and/or regions with relatively higher proportions of credit constrained individuals and firms will exhibit a stronger response to monetary policy tightening.

Empirical evidence from VAR models has been broadly supportive of the significance of the credit channel. Ganley and Salmon (1997) examine the relationship between credit market variables and sectoral output elasticity using Spearman Rank Correlation Coefficients; they find significant correlations between the average firm size within each industry, the concentration ratio (defined as the proportion of industry net output produced by the five largest firms) and the estimated output response. Carlino and DeFina's study of US States uses cross sectional regressions to explain estimated elasticities of output to monetary shocks using firm size to proxy for credit channel effects. They interpret the results as providing weak evidence for the existence of a credit channel (at the 10% level of significance). However, the use of firm size measures as credit channel proxy is criticised elsewhere in the literature, see for example Eichenbaum (1994), who argues that the results may reflect the fact that small firms have located in interest rate sensitive industries.

Dedola and Lippi (2005) use a similar approach but incorporate a number of indicators of industry characteristics that are relevant to the credit channel. Specifically they introduce three variables into their cross sectional which they interpret as reflecting the borrowing capacity of firms: firm size (measured as the average number of employees per firm in the sector, financial leverage (the ratio of total debt to shareholder capital) and the interest burden (captured by the ratio of interest rate payments to operating profit). They also use three variables to represent the financial structure of the sector and how its production decisions are affected by the user cost of capital via a supply side channel. Finally they use industry dummies and a durability dummy to control for the effect of a sector's interest rate sensitivity via the traditional interest rate channel. They find significant relationships between

the industry output response to monetary policy and the firm size, financial leverage and working capital variables indicating that there is indeed a role for a credit channel in the transmission of monetary policy.

Finally, a number of papers including Fratantoni and Schuh (2003) and Owyang and Wall (2004) have looked at the specific role of regional housing markets in explaining disparities in monetary policy response. They investigate both the demand and supply side factors which drive heterogeneous regional house price responses. They argue that the demand side is driven by differences in consumption behaviour which can be explained by disparities in regional sensitivity to changes in mortgage rates. These disparities are likely to reflect a number of factors such as owner occupation rates, the prevalence of buy-to-let mortgages, availability of equity and scope of mortgage equity withdrawal. Important factors on the supply side include regional differences in availability of land, proximity to urban centres and housing market regulation. In our work, while we recognise the potential importance of these credit channel and housing market theories of monetary policy transmission, we believe that further work would be required outside the VAR framework to access to what extent they can explain differential sectoral and/or regional impacts. For the most part, in the remainder of this paper we focus on the interest rate and exchange rate channels theories in attempting to explain our results.

3. DATA

As noted above, the analysis in this paper is restricted to sectors of the Scottish and UK economies. A full investigation of differential regional impacts of UK monetary policy should involve a comparison of responses for all UK regions; however consistent Gross Value Added (GVA) data on a quarterly basis, appropriate for the VAR analysis, is only available for Scotland and the UK. A possible strategy would be to construct interpolated quarterly data for other regions from the available annual series. However, it may be difficult to provide a convincing analysis of dynamic responses based on interpolated data. The UK sectoral data is published by the Office of National Statistics and the Scottish data by the Scottish Executive. In principle it might be useful to construct data for the "rest of the UK", excluding Scotland, but we have not taken this route as the data sources do differ and we would not want to

magnify any minor differences. The time span of our analysis is limited by the availability of the Scottish GVA data which extends back to 1995Q1. Allowing for dynamics, this gives a common estimation period is 1996Q1 to 2005Q1.

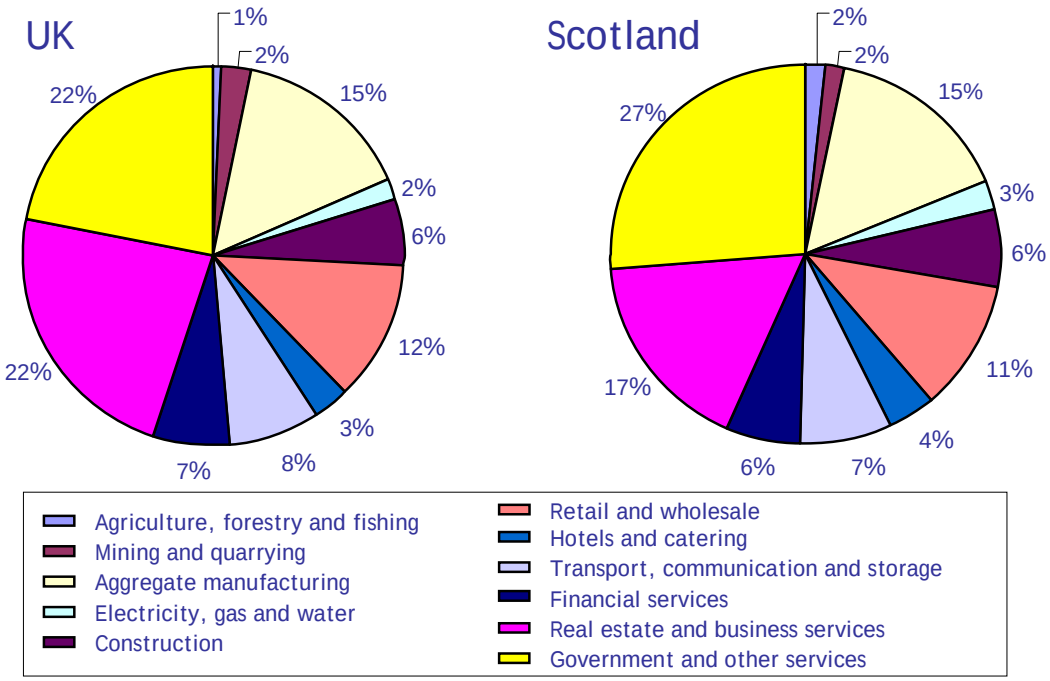
The sectoral disaggregation of gross value added available to us is set out below. The first stage of the breakdown gives 11 sectors, with further disaggregation of manufacturing.

Sectoral Dissagregation:

Agriculture, Forestry and Fishing (AB)		
Mining and Quarrying (C)		*Classification within manufacturing*:
Manufacturing (D)	→	Food, Drink and Tobacco (DA)
Electricity, Gas and Water (E)		Textiles, Clothing and Footwear (DBC)
Construction (F)		Wood Products (DD)[b]
Retail and Wholesale (G)		Paper, Publishing and Printing (DE)
Hotels and Catering (H)		Petroleum and Nuclear Fuel (DF)
Transport, Storage and Communication (I)		Chemicals and Chemical Products (DG)
Financial Services (J)		Rubber Products (DH)[b]
Real Estate and Business Services (K)[a]		Non-Metallic Minerals (DI)[b]
Government and other services (LQ)		Metals and Metal Products (DJ)
		Mechanical Engineering (DK)
		Electrical Engineering (DL)
		Transport Equipment (DM)
		Other Manufacturing (DN)[b]

Notes:
a. UK Real Estate and Business Services data is further disaggregated into Real Estate, Renting and Business Activities (Ka) and Ownership of Dwellings (Kb).
b. The Scottish data aggregates DD, DH, DI and DN to form "other manufacturing".

The sectoral compositions of UK and Scottish GVA in 2002 (the base year for the data) can be summarised in simple pie charts.



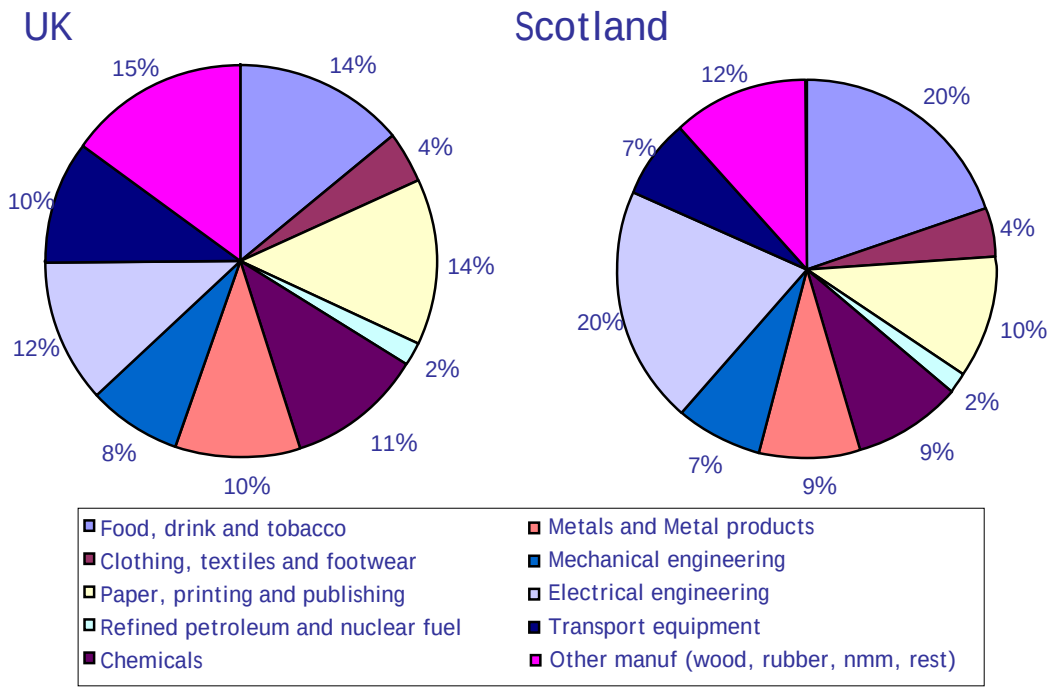
Source – Economic Trends Annual Supplement and Scottish Executive.

For the first disaggregation there is generally little more than a 1% difference in the relative size of each of the main sectors. Exceptions are Real Estate and Business Services and Government and Other Services. Government and Other Services contributes around 5% more to GVA in Scotland than in the UK.

The Manufacturing sector contributes around 15% to total GVA in both Scotland and the UK. The next chart shows how the disaggregated components within this sector contribute to total Manufacturing. For the UK data we have aggregated the Wood products, Rubber products, Non-metallic Minerals and Other manufacturing sectoral contributions into a single measure comparable with Scottish data.

The Manufacturing sector in Scotland is relatively more concentrated, with the two largest sectors, Food, Drink and Tobacco and Electrical Engineering, contributing almost 40% to Manufacturing GVA; 15% more than in the UK. The reactions of these sectors then will be of interest in judging compositional effects in the aggregate interest sensitivity of Scottish and UK activity.

Sectoral Disaggregation within UK and Scottish Manufacturing:



Source – Monthly Digest of Statistics and Scottish Executive.

4. METHODOLOGY

The VAR approach allows us to estimate the impact of monetary policy shocks on GVA within a framework which controls for feedback between the monetary policy instrument (interest rates) and other macroeconomic variables. We impose identifying restrictions on the VAR, using the Choleski decomposition, to isolate movements in GVA caused by the actual policy shocks from those that are related to events which spurred the policy action.

We estimate a separate VAR for each sector of Scotland and the UK. Our approach follows earlier work on UK sectoral data by Ganley and Salmon (1997) in that we include an interest rate variable (the London Clearing Bank's base rate) and price index (RPIX) along with UK aggregate GVA and individual sectoral real GVA. Scottish GVA data were provided by the Scottish Executive, the remainder of the data are from Economic Trends Annual Supplement. We also included the effective exchange rate in the VAR and have real oil price as a conditioning variable, using data from IMF International Financial Statistics. With the exception of the interest

rate, all variables are in logarithmic form. Full information on variable definitions and data sources are provided in the data appendix.

The Choleski decomposition employs a recursive ordering of variables which implies that each variable only responds contemporaneously to changes in variables that precede them in the order. In determining the order of variables in the VARs we replicate Ganley and Salmon who placed the interest rate first, followed by aggregate GVA, the price variable and then sectoral GVA. We also introduce the exchange rate and placed this after the price term, and before sectoral GVA. Our results are not affected in any major way if we switch the ordering of the exchange rate and price term, but are somewhat more sensitive to the positioning of sectoral GVA. From a theoretical point of view placing sectoral GVA last means the sector is able to respond contemporaneously to changes in all the other variables. Given the criticisms of the VAR approach advanced by Rudebusch (1998) and others we also conduct a number of experiments to check the robustness of our VAR results, these are reported in section V.

In general we chose a common lag order for the VARs. The choice of four lags for each variable is supported by both VAR based tests for first order serial correlation, and maximisation of Akaike's Information Criterion for the aggregate UK VAR[ii]. For a small number of sectors we found evidence of higher order serial correlation and in a couple of cases, implausibly unstable impulse response functions from the 4 lag VAR. Additional lags did not rectify the serial correlation problems, but reduction to order 3 in these sectors only, did lead to some improvement in the plausibility of the impulse responses[iii].

5. INITIAL CHARACTERISATION OF RESULTS

The key outputs from our VAR analysis are the impulse response functions, and their associated confidence interval bands. From this information, we are able to quantify how much, how quickly and how significantly each sector's GVA responds to tighter monetary policy (the model is in fact symmetric, so the signs of the effects can be reversed to see the estimated impact of a decline in the interest rate). These key elements of the responses can be illustrated using the UK mechanical engineering

sector as an example, see Chart 1. The size of the response, at its maximum, is illustrated at (A), and the time taken to reach this response is given by the distance (B), finally the significance of the response is demonstrated by the fact that the 90% confidence interval about the peak response does not encompass zero.

Chart 1: Example: the response of GVA to a 1 s.d. increase in the interest rate

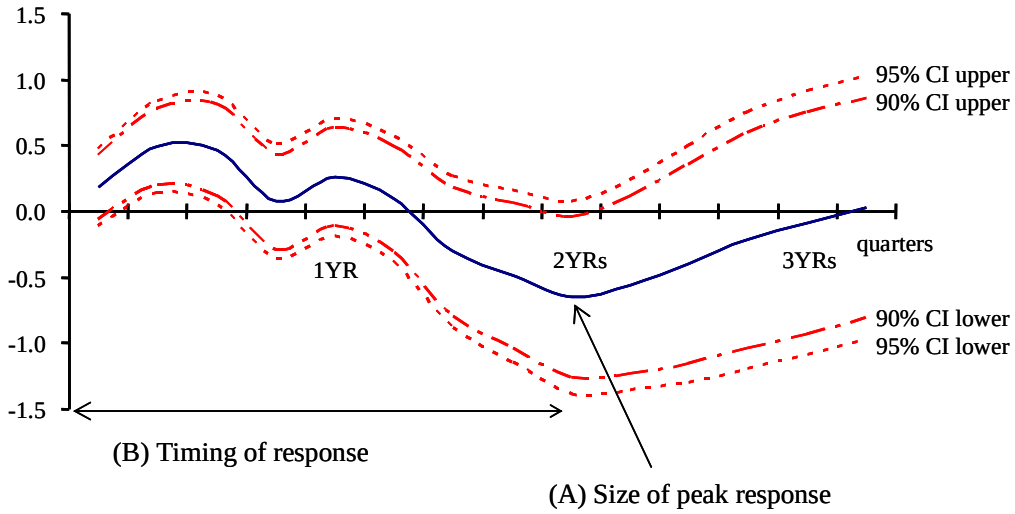


Table 1 summarises our findings for each of the sectors in which the estimated response is statistically significant. Specifically, we report the maximum percentage reduction in GVA observed in response to a 1 standard deviation increase in the official interest rate, along with the time taken in quarters to reach this response in [.]. * is used to indicate that the estimate is significantly different from zero at the at the 10% level of significance and ** at the 5% level. (Full details of the estimates for all sectors, along with a 90% confidence interval around the maximum estimated impact, are given in Table A1 at the end of the paper).

Table 1

Disaggregated responses of UK GVA	Size (%)	Timing	Significance
Electrical Engineering	-0.728	[7]	*
Mechanical Engineering	-0.650	[8]	*
Agriculture, Forestry and Fishing	-0.541	[1]	**
Mining and Quarrying	-0.490	[2]	**
Construction	-0.367	[4]	**
Non-metallic minerals	-0.250	[8]	*
Paper, Printing and Publishing	-0.210	[3]	**
Financial Services	-0.192	[8]	*
Ownership of Dwellings	-0.149	[9]	*
Food, Drink and Tobacco	-0.117	[0]	**
Government and Other Services	-0.066	[1]	*
Disaggregated responses of Scotttish GVA	Size (%)	Timing	Significance
Electrical Engineering	-1.339	[8]	**
Chemicals	-1.012	[2]	**
Electricity, Gas and Water	-0.946	[3]	**
Petroleum and Nuclear Fuel	-0.653	[1]	*
Financial Services	-0.574	[7]	*
Food, Drink and Tobacco	-0.551	[0]	**
Retail and Wholesale	-0.330	[0]	**
Misc. Manufacturing	-0.318	[0]	*
Real Estate and Business Svs	-0.253	[1]	*
Government and Other Services	-0.215	[3]	**

Among the strongest estimated responses to a tighter monetary policy within the UK are those of activity in Electrical and Mechanical Engineering; this might be expected as both sectors are relatively capital intensive. The full extent of the decline is felt after 7-8 quarters, i.e. within two years of the initial interest rate hike (after which activity recovers).

In general the longest lasting impacts are felt in sectors connected to durable goods production, and in those sectors most affected by industrial demand. Previous studies also lead us to expect strong responses from Construction and related sectors (e.g. Mining and Quarrying). This is evident in the UK case, but less so for Scotland. In general the services sectors and sectors involved in the production of non-durable goods are affected less (and often with less significance), although the Financial

Services sector within Scotland is an exception, which we will discuss in more detail below.

There are a small number of sectors for which we found no significant impact of monetary policy on activity in either the UK or Scotland. Two of these are service sectors: Hotels and Catering, and Transport, Communication and Storage. Theoretically we should not be too surprised at this result. These sectors are not particularly capital intensive and are less reliant on activity from other sectors than say the Financial Services sector. We also find no significant impact of monetary tightening on three sub-sectors within manufacturing - Textiles, Clothing and Footwear; Metals and Metal Products; and Transport Equipment. Of these, Ganley and Salmon (1997) found a very small response within Metals and Metal Products. They were able to provide further disaggregation here than is available to us and found a stronger impact on Textiles, but a much smaller impact on Leather products. The greater disaggregation used by Ganley and Salmon may have been important in capturing the relative durability of outputs, which should be expected to impact on interest sensitivity of purchases.

We are less confident in our results for Transport Equipment. This sector is relatively capital intensive, so might be expected to be interest sensitive while our results suggest there is no significant impact of monetary policy changes on activity. However, we have reason to believe that the VARs for this sector are problematic. In contrast to the other VARs, for this sector the VARs of order 4 have problems with serial correlation. The estimated impulse responses too are problematic in that they take an implausible path, cycling before reaching their maximum impacts at 24 and 30 quarters, for the UK and Scotland respectively. Additional lags did not solve the serial correlation problem. Reducing the order of the VAR to 3 improved the stability of the impulse response for Scotland and saw the maximum impact occurring18 quarters after the initial shock, but for the UK a similar reduction produced an impulse response which did not fall below zero. Further investigation of the VARs here is probably warranted in future work, given the sensitivity of these results. However, we are satisfied that the bulk of the other results are in line with expectations, and since the contribution to UK or Scottish GVA made by the problem sectors is only around

2% of total we move on, disregarding these sectors, focusing on those sectors for which significant responses were found.

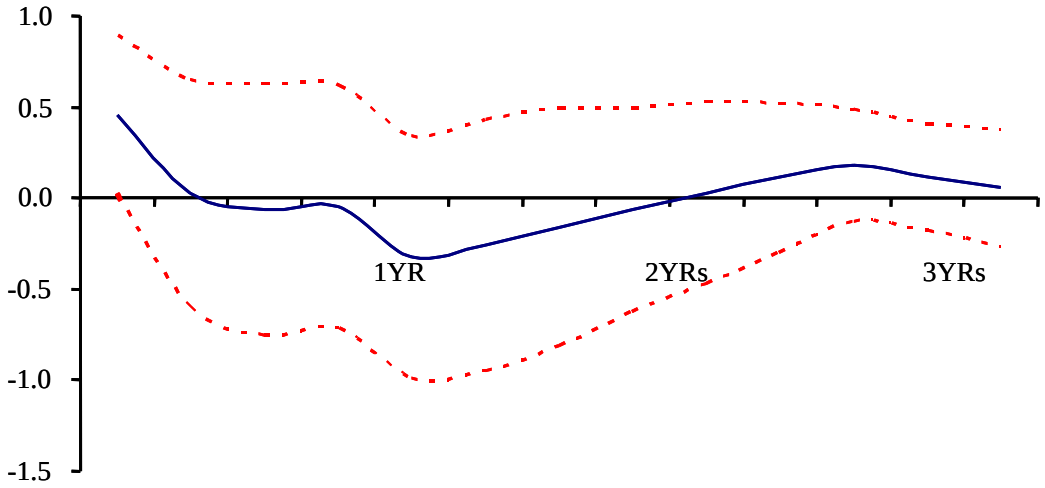
One feature of our results which can also been observed in some earlier studies is a significant increase in GVA in the first year following the shock, before we see the expected decline in activity. The results reported by Ganley and Salmon (1997) show a positive response one year following the monetary tightening in four of the sectors they examined - Mechanical Engineering, Mining and Quarrying, Electricity, Gas and Water and Transport Equipment. In our disaggregated results we find a significant initial positive response in a total of twelve UK sectors, and in seven Scottish sectors. One illustration, referring back to Chart 1, shows such a result where GVA in Mechanical Engineering increases during the first six months after the monetary tightening. As far as we are aware the existing literature has not attempted to explain this effect. Here we explore one possible explanation.

The Exchange Rate and the Use of Imported Intermediates

We suggest that there may be a link between the observed initial positive response of GVA and the operation of the exchange rate channel in the transmission of monetary policy. As discussed in Section II above, unexpectedly tighter monetary policy should quickly result in inflows in financial capital and an appreciation of the exchange rate. While this exchange rate appreciation is expected to weaken competitiveness and depress demand, it is also likely that the costs of imported inputs into production will fall. So, those sectors that import a large proportion of their intermediate inputs should initially benefit from reduced costs immediately following the exchange rate appreciation.

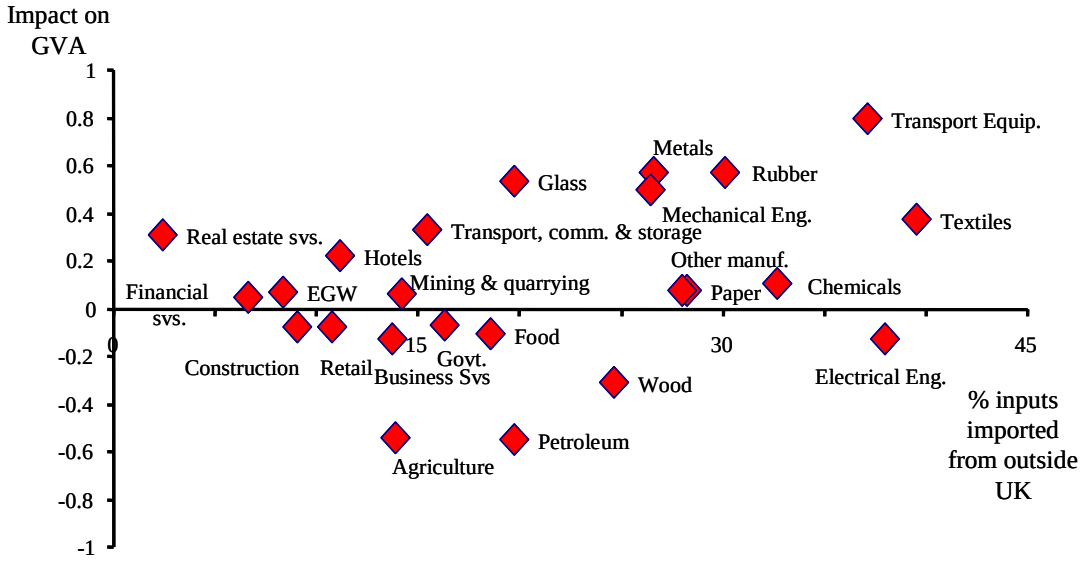
Chart 2 illustrates the impulse response function for the exchange rate variable based on the UK aggregate VAR we find that there is indeed an initial appreciation of the exchange rate immediately following the monetary policy shock, and though this is short lived, it is statistically significant.

Chart 2: response of the effective exchange rate to a 1 s.d. increase in the interest rate



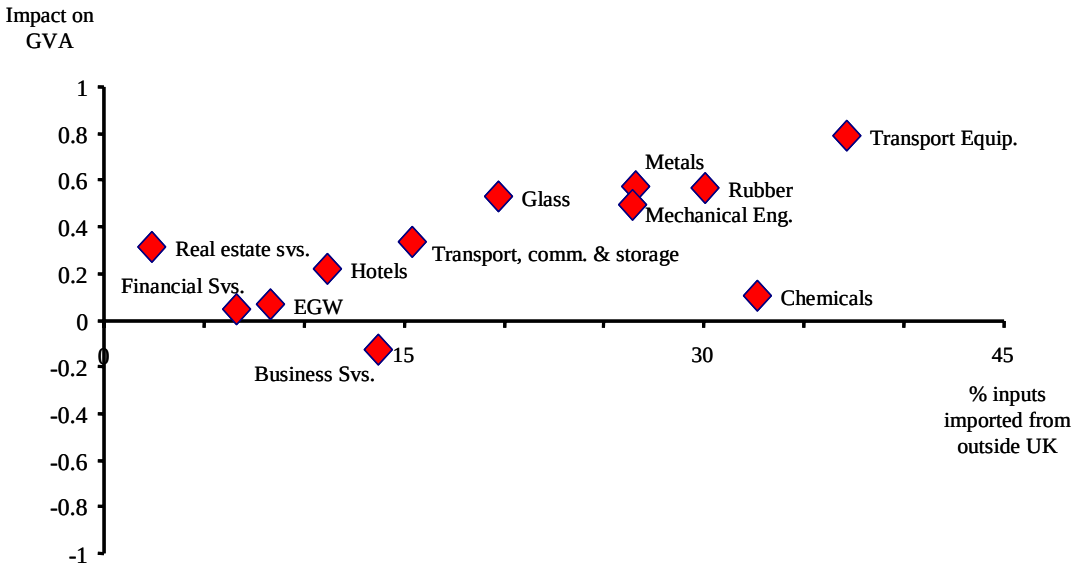
In order to explore whether there is a relationship between the proportion of imported intermediate inputs and the initial response of sectoral GVA we have collected data on the proportion of intermediate inputs used by each sector that are imported from outside the UK (based on the position in 2000 taken from the UK input-output tables) and plotted these against the estimated interest elasticities of GVA. This is illustrated for the UK in Chart 3(a).

Chart 3(a): GVA response 1 quarter following shock, against use of imported intermediates



In Chart 3(b) we restrict our attention to the sectors that exhibit significant positive responses, and a positive relationship is much more evident.

Chart 3(b): GVA response 1quarter following shock and use of imported intermediates



A more formal assessment of this relationship which takes into account the relative size and significance of the estimated impacts of monetary tightening on GVA and the extent to which each sector uses imported intermediates is obtained through regressing the impulse response at quarter 1 on a constant and the proportion of intermediate inputs that are imported, using variance weighted least squares (VWLS). We use the squared standard errors on the impulse responses to weight the observations, such that the more significant the response, the higher the weight. The null hypothesis of no relationship is rejected at the 1% level of significance[iv].

Similar analysis of the initial responses of the Scottish sectors is less conclusive. In principle the same information is available from Scottish I/O tables, and we have collected data on the proportion of intermediate inputs imported from outside of UK. However, this data fails to capture inputs that came into the UK and later to Scotland, and the estimated relationship is less strong. In principle it is possible to improve upon the measures used here, by capturing indirect inputs (that is, tracing inputs from other sectors that are import intensive) and this may improve inference. Our tentative

conclusion is that the use of imported intermediates is an important factor in determining the initial sectoral responses to monetary policy changes, and to understanding the operation of the exchange rate channel in the monetary transmission mechanism.

Robustness of the Results

Before turning to a detailed comparison of the sector by sector results for the UK and for Scotland, we examine the robustness of the results obtained with the VAR methodology. While this methodology has become dominant in the analysis of the impact of monetary policy shocks, this approach has not escaped criticism, see in particular Rudebusch (1998). To check that our key results are not limited to the VAR methodology we have also analysed the same data using an alternative two-step procedure based upon that advocated by Cover (1992). The first stage in this approach involves estimation of a monetary policy reaction function. We employ rolling regressions, and are able to exploit a longer span of data with a moving window of 60 observations used in each regression. We obtain one-step ahead prediction errors from the first stage regressions which we then use in stage two to proxy monetary policy shocks. The second stage involves output equations estimated in first differenced form. The one-step ahead prediction errors are included within the set of explanatory variables in the second stage regressions, along with lagged changes in output and a number of conditioning variables (discussed below). The impact of monetary policy shocks on output is then determined by looking at step responses from the second stage regressions.

The use of rolling regressions addresses one of Rudebusch's criticisms of the VAR approach, in that they are capable of capturing changes in the operation of monetary policy over the sample period. This approach also allows for greater flexibility in the information set employed. In the VAR framework we had to use a common choice of lag length for all variables, but within this modified Cover approach the data determined lag lengths can differ for each variable. In principle the variables included in the monetary policy reaction function should reflect the kind of information the Monetary Policy Committee are interested in when setting interest rates, although of course this modelling approach produces a simplified representation of their decision making.

The general form of the first stage equation is

$$\Delta IR_t = f\{\Delta IR_{t-i}, \Delta INF_{t-i,} \Delta \ln ER_{t-i}, \Delta \ln GVA_{t-i}\}$$

where IR is the London Clearing Bank's base rate, INF is represented by RPIX inflation, ER is the real effective exchange rate and GVA is UK Gross Value Added.

Having conducted the first stage regression using UK aggregate data, and saved the one-step ahead prediction errors we estimate equations for the first difference in the log of sectoral GVA for all UK or Scottish sectors simultaneously using seemingly unrelated regression estimation (SUR). One advantage of the SUR estimation over the VAR approach is that the cross correlations in residuals that could reflect common shocks can be exploited to improve the efficiency of the estimates. In the VAR set up it was infeasible to combine estimation across sectors given the available degrees of freedom. The general form of the second stage regressions is:

$$\Delta \ln GVAi_t = f\{\Delta \ln GVAi_{t-j}, \Delta \ln ER_{t,t-1}, \Delta \ln OILP_{t,t-1,} SHOCK_{t-j}\}$$

where OILP is oil price inflation and the one-step ahead prediction errors from the stage one regressions are incorporated as SHOCK.

As noted above, the dynamics of the GVA equations were data determined for each sector using general-to-specific searches. We found that a maximum 3 lags of GVA growth and 6 lags monetary policy shocks was sufficient to ensure that the null hypothesis of no first order serial correlation was not rejected. The conditioning variables (exchange rate and real oil price growth) entered the equations contemporaneously and/or with one lag[v].

Having obtained coefficient estimates we then used these to generate step responses showing the implied response of GVA growth to a one point increase in the monetary policy shock. As with the VAR methodology we can find the size and timing of the maximum response of GVA. Unfortunately we were not able to construct comparable confidence intervals around the response functions to compare with those we obtained

from the VAR approach, so information on the significance of the responses is purely based on the significance of the monetary policy shock terms in each sector's output equations.

The scale of the responses cannot be compared across the two methods. In the VAR case we obtained the response of GVA to a 1 standard deviation increase in the London Clearing Bank's base rate. The two step approach yields the response to a 1 unit change in the monetary policy shock series. However, we can compare the relative sizes of the estimated maximum responses. A simple way to make the comparison is via a scatter plot, as shown in Chart 4a (the lighter shaded diamonds relate to the UK maximum impacts and the darker diamonds relate to the Scottish sectoral responses)[vi].

Chart 4a: Sectoral Impacts of Monetary Policy Changes Compared

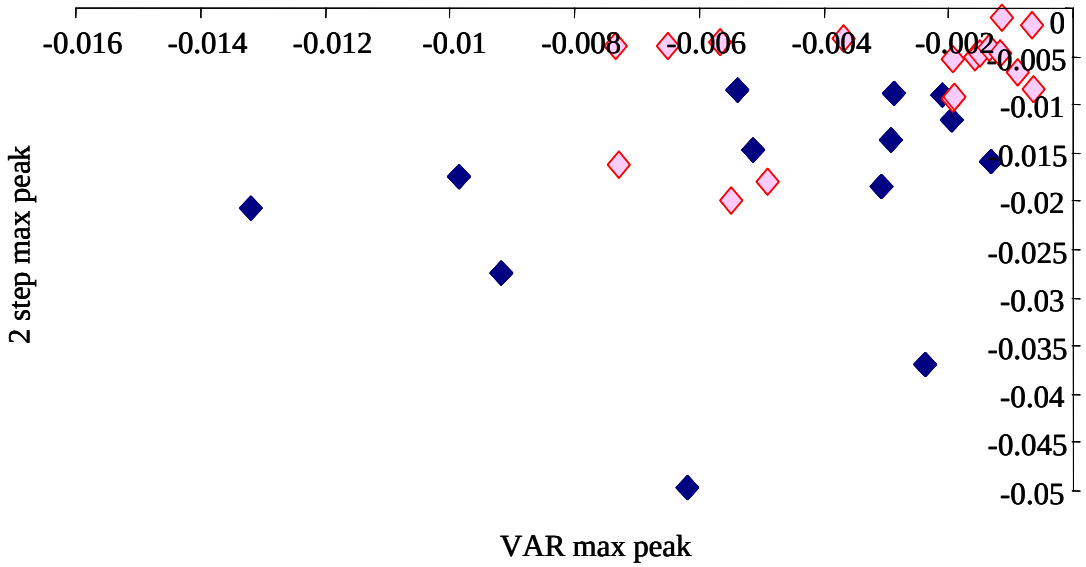
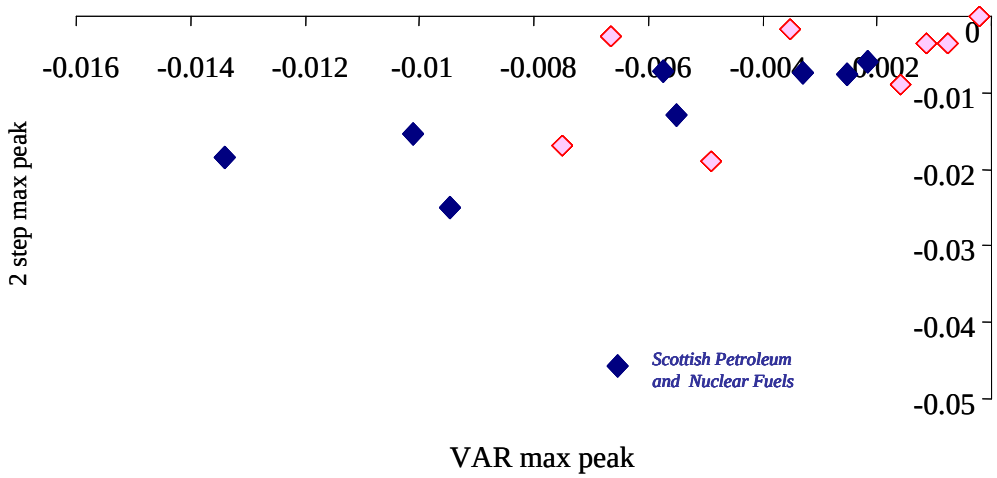


Chart 4b retains only those sectors that show significant maximum responses from the VAR approach. In both charts the points appear to lie be positively correlated suggestive of relative sectoral rankings being maintained across methods, the correlation is tighter in the case of the significant results in Chart 4b. The remaining outlier in this plot is relates to the Scottish Petroleum and Nuclear Fuel sector[vii].

Chart 4b: Sectoral Impacts of Monetary Policy Changes Compared



VAR max peak

The Spearman Rank Correlation Coefficient for the combined set of results takes the value 0.4176, meaning that the null of no relationship between the ranking of sectoral responses estimated by the alternative methodologies can be rejected at the 5% level of significance. This gives further support for a quantifiable relationship between the maximum response estimates obtained from both our VAR and 2-step methodologies.

Having determined that our key results on the sizes of the responses are robust across both methodologies we now return to our VAR results and move on to discuss the comparison of the UK and Scottish results in more detail.

6. COMPARISON OF RESULTS FOR SCOTLAND AND THE UK

We start by determining an appropriate approach to comparing results. The confidence intervals around each sector's impulse response provide a helpful initial means of comparison. First we can determine that the sectors exhibiting significant declines in GVA following an interest rate hike together account for some 52.6% of UK GVA (based on 2002 weights) and 73.4% of total GVA in Scotland respectively, suggesting that there may be a stronger effect of monetary policy in Scotland[viii]. Part of the reason for this greater interest sensitivity of GVA in Scotland relates to the composition of GVA which is more concentrated in interest sensitive sectors. However, it turns out that even within the interest sensitive sectors the response of

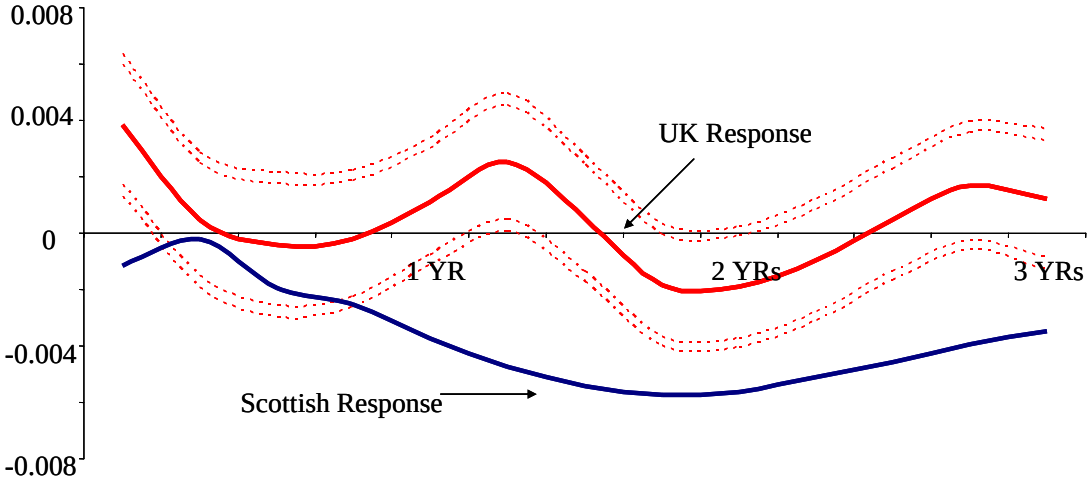
Scottish GVA is estimated to be stronger than that of the UK as a whole, so compositional factors are only part of the story.

Within the significantly affected sectors we can usefully group the results into two groups (i) sectors for which significant impacts were found for both UK and Scottish data, and (ii) sectors for which the impact of monetary policy was found to be significant only in the UK or in Scotland, but not in both. For those sectors in group (ii) we have obviously found the Scottish impact to be significantly different from the UK impacts – that is there is evidence of a differential regional impact within the same sector. For the sectors in group (i) further examination of the results is required to see if the sectoral responses are similar or significantly different from each other. As with our initial characterisation of the results we will focus on the characteristics of the responses in terms of their size and timing, as well as significance. We are also interested in assessing how the sectoral responses contribute to the overall impact on GVA so will also focus on the contribution of each sector to total GVA.

Sectors for which the Impact on GVA is Significant in both the UK and Scotland

In four sectors our estimates indicate significant maximum impacts of monetary policy changes for both UK and Scottish GVA. In terms of their contributions to total GVA, the largest sector in this group is Government and Other Services, which accounted for 24% of UK GVA in 2002 and 27% of Scottish GVA. The Financial Services sector also falls within this group and accounted for 7-8% of UK and Scottish GVA. The remaining two sectors in group (i) are Electrical Engineering and Food, Drink and Tobacco which are two of the largest sub-sectors within Manufacturing. As with Government and other Services, both these sectors account for a slightly larger proportion of GVA in Scotland than in the UK as a whole, so compositional effects suggest a stronger interest sensitivity of Scottish GVA. In addition in each of the four sectors the maximum impact estimated on Scottish data lies outside the confidence interval around the same sector's estimated UK response[ix]. We interpret this as indicating that monetary policy changes have a significantly stronger impact on the Scottish sectors, suggesting that region specific factors are relevant in addition to simple composition effects. The significantly different impact of monetary policy is particularly evident in the case of Financial Services, and the comparison is illustrated in Chart 5.

Chart 5: Response of GVA in Financial Services to a 1 s.d. increase in the interest rate



As can be seen from this illustration, the response of GVA in Financial Services falls below the UK confidence interval bands after three quarters, and while the maximum impact is reached two years after the initial policy change in both the UK and Scottish cases, the dip in Scottish GVA is significantly deeper (although the confidence intervals around the Scottish estimated impulse response are not indicated on the chart, to keep the chart legible, it is notable that the UK response at 2 years also lies outside the Scottish confidence intervals). It is worth considering possible factors behind this difference. One possible explanation could be that the UK figures are dominated by activities in London which are dependent on global rather than domestic activity, and hence relatively more sheltered from the impact of domestic interest rate changes. There is of course a strong and outward looking concentration of activity in this sector in Edinburgh, and increasingly in Glasgow too, but given the relatively greater focus on life assurance, fund management and general insurance the influence of global activity seems likely to be weaker, so too is the extent to which the sector is shielded from domestic policy change. More generally, outside of London, activity in this sector is likely to be more closely linked to activity in the relevant region.

Heterogeneous industry characteristics could also explain the observed difference in response of the Government and Other Services sector. It's not immediately obvious why the Scottish public sector should be more adversely affected by tighter monetary

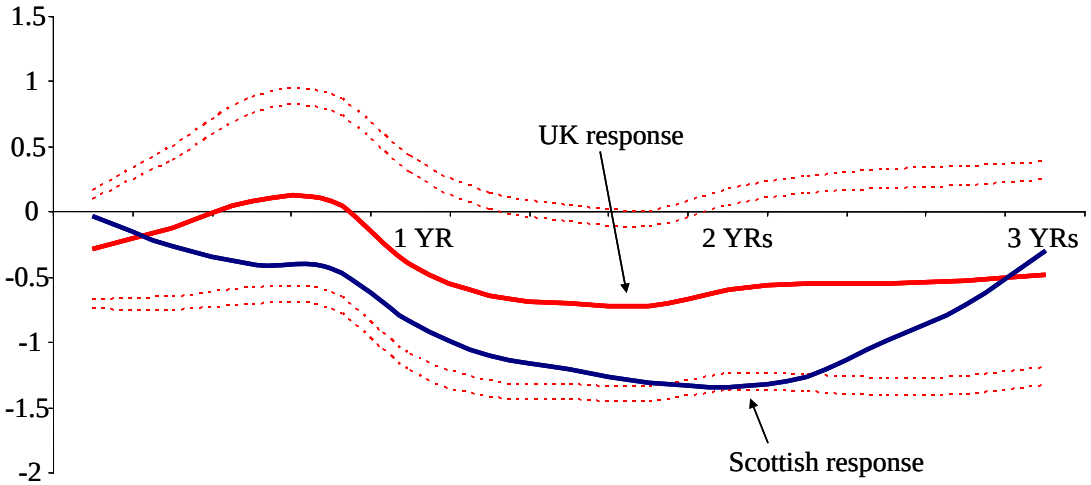
policy than the UK as a whole, although perhaps this is related to the reliance on the block grant allocated by UK government to fund devolved expenditure. Since the block grant will not respond to changes in interest rates it is possible that this inflexibility could leave the Scottish public sector more vulnerable to interest rate changes. Again compositional differences also contribute to the greater estimated interest sensitivity of Scottish GVA, since this sector contributes 4% more to aggregate Scottish GVA than the comparable sector contributes to aggregate UK GVA.

We would expect that for the components of manufacturing (Food, Drink and Tobacco and Electrical Engineering) the contribution to increased interest rate sensitivity in Scotland would be largely a compositional effect. The overall size of the Manufacturing sector is around 15% in both UK and Scotland and these two components make up around 40% of the manufacturing total for Scotland (contributing equally) but only about 25% in the UK. The effect on overall interest rate sensitivity in terms of difference in maximum response in the individual sectors is moderate. The response of the Food, Drink and Tobacco sector, although significant in both the UK and Scotland (and significantly greater in Scotland), is fast and very short-lived for both, in fact is neutralised completely within the first quarter. Results from Ganley and Salmon (1997) found a small response for this sector, they found the maximum impact occur much later (at quarter 14) however, a direct comparison is not possible since they provided no indication significance of the maximum impact. Our results and theoretical arguments on the impact of monetary policy on production of non-durable goods lead us to believe that their estimated effect are unlikely to be significant by this time.

The Electrical Engineering sector results are interesting in part because this sector has been a key mover aggregate Scottish GVA growth. The results are shown in Chart 6. The estimates reveal only moderate differences in the estimated impacts between Scotland and the UK. The Scottish point estimate at the maximum impact is certainly larger, but it lies within the 90% confidence interval around the UK result, and only just outside the 95% interval. There is a small difference in the estimated timing of the maximum impact. However, the main factor driving a greater aggregate response within Scotland will be the compositional effect, since the sector forms a greater

component of manufacturing and aggregate GVA than the same sector within the UK as a whole.

Chart 6: Response of Electrical Engineering GVA to a 1 s.d. increase in interest rate



Sectors where only the Impact in Scotland is significant

We found four sectors where the impact of monetary policy was significant only in Scotland: Petroleum and Nuclear Fuel, Chemicals, Electricity, Gas and Water and Retail and Wholesale. Since the impact on these sectors was found to be insignificant for the UK, it follows that the impact on the Scottish sector is significantly greater, so they contribute to greater overall interest rate sensitivity of the Scottish economy. All four sectors show relatively fast responses, reaching their maximum impact within the first year of the shock. The comparable estimates of UK responses are slower reaching their maximum mid-way through the third year, although given their lack of significance it would be a mistake to put too much weight on the speed of the UK sectoral responses.

The compositional effect relating to these sectors is of interest. In total the four sectors comprise 15.6% of total GVA in Scotland; the largest is Retail and Wholesale at 11.2%. This figure does not mean much on its own, but what is important is its size relative to the contribution to GVA of sectors which are significant only in the UK. As will be clear below, sectors for which the response to monetary policy is

significant only in Scotland contribute a larger proportion to Scottish GVA than do sectors for which significant responses are found in the UK as a whole.

Sectors where only the Impact in the UK is significant

The response to monetary policy from sectors significant only in the UK will mitigate the interest rate sensitivity in Scotland. We found five sectors in this category: Agriculture, Forestry and Fishing, Mining and Quarrying, Paper, Printing and Publishing, Mechanical Engineering and Construction. The largest (and most interesting) of these sectors is Construction. This sector has close links with the housing market and we would expect to find a significant response to interest rate shocks. It is somewhat surprising that we do not find this for the Scottish sector, although a cursory glance at data on differentials in house price inflation reveals substantial differences in behaviour in Scotland (where cycles in house prices have been more muted) the UK average. In addition, factors such as lower than average owner occupation rates in Scotland, a lesser prevalence of buy-to-let mortgages, historically more muted cycles in house prices and less scope for mortgage equity withdrawal are all likely to be important in explaining the lesser impact of interest rate hikes on the Scottish construction sector. In contrast, the higher prevalence of unsecured consumer credit in parts of Scotland could certainly be part of the explanation for the greater interest sensitivity of activity in the Retail and Wholesale sector.

Again the relative size of these sectors is important. In total the four sectors for which a significant response was found in the UK wide data, but not in Scottish data contribute only 12.2% to aggregate UK GVA (equivalent sectors make up 12.4% of GVA in Scotland). This is clearly less that the contribution of sectors where the response to monetary policy is significant only in Scotland. So, although there are sectors which show a significant response to monetary policy changes in the UK but not in Scotland, their contribution to aggregate GVA is not enough to mitigate the greater interest rate sensitivity in Scotland.

7. CONCLUSIONS

The recent return to tighter monetary policy refocuses attention on the likely response of economic activity. In this paper we have reviewed the existing literature on sectoral and regional impacts of monetary policy on activity. We have used a VAR methodology to examine the size, significance and timing of these impacts for disaggregated UK and Scottish data and we have discussed how our results relate to estimates elsewhere in this literature. We have also checked the robustness of our results, in particular by comparing VAR and two stage estimates, and have discussed evidence on the importance of imported intermediates in explaining the initial impact of monetary tightening.

Overall we do find some evidence of stronger impacts of monetary tightening on the Scottish economy, reflecting both greater interest sensitivity of some sectors and a stronger contribution of interest sensitive sectors in total activity. We draw particular attention to Financial Services and Electrical Engineering. Against this, the absence of a significant impact of monetary tightening on the Scottish Construction sector is surprising, but we discuss some of the factors that may explain this. We also suggest that there is scope for further research outside the VAR framework to assess the driving forces behind the observed differential impacts to monetary policy changes.

It would appear that differential impacts we have identified are sufficient to warn against simple application of UK wide estimates of sectoral sensitivity to monetary policy changes to regional data on sectoral composition with the aim of making inference on differential regional sensitivities. Futhermore, to the extent that differential effects of policy do exist we would argue that this gives greater emphasis to the need for strengthening the operation of other adjustment mechanisms, including labour market flexibility and the regional operation of national fiscal stabilisers.

APPENDIX

Table A1: Maximum impact on GVA for all sectors of the UK and Scotland

		UK Max Impact		Qtr	90% Lower	90% Upper	Scotland Max Impact		Qtr	90% Lower	90% Upper
AB	Agriculture, Forestry and Fishing	-0.541	**	1	-0.902	-0.181	-0.186		2	-0.419	0.047
C	Mining and Quarrying	-0.490	**	2	-0.839	-0.141	-0.350		3	-0.717	0.018
D	Manufacturing	-0.106		7	-0.232	0.021	-0.254		9	-0.606	0.097
DA	Food, Drink and Tobacco	-0.117	**	0	-0.204	-0.029	-0.551	**	0	-0.826	-0.276
DBC	Textiles, Footwear and Leather	-0.190		6	-0.898	0.517	-		-	-	-
DD	Wood products	-0.996		10	-3.150	1.158					
DE	Paper, Printing and Publishing	-0.210	**	3	-0.379	-0.042	-0.225		0	-0.767	0.318
DF	Petroleum and Nuclear Fuel	-0.548		1	-1.212	0.117	-0.653	*	1	-1.206	-0.099
DG	Chemicals	-0.192		11	-0.408	0.023	-1.012	**	2	-1.727	-0.296
DH	Rubber products	-0.110		5	-0.480	0.261					
DI	Non-metallic minerals	-0.250	*	8	-0.493	-0.007					
DJ	Metals and Metal Products	-0.115		14	-0.378	0.148	-0.177		3	-0.987	0.633
DK	Mechanical Engineering	-0.650	*	8	-1.262	-0.037	-0.280		10	-0.821	0.262
DL	Electrical Engineering	-0.728	*	7	-1.345	-0.110	-1.339	**	8	-2.452	-0.227
DM	Transport Equipment	-0.566		24	-2.045	0.914	-0.208		18	-1.070	0.654
DN	DN: Other manufacturing	-0.156		0	-0.420	0.108					
	DOTH: DD,DH,DI,DN (misc manuf.)						-0.318	*	0	-0.623	-0.013
E	Electricity, Gas and Water	-0.088		10	-0.245	0.070	-0.946	**	3	-1.447	-0.444
F	Construction	-0.367	**	4	-0.569	-0.165	-0.335		7	-0.902	0.233
G	Retail and Wholesale	-0.734		1	-0.242	0.095	-0.330	**	0	-0.538	-0.121
H	Hotels and Catering	-0.157		15	-0.337	0.023	-0.239		1	-0.577	0.100
I	Transport, Storage and Comm	-0.063		7	-0.409	0.283	-0.345		2	-0.742	0.052
J	Financial Services	-0.192	*	8	-0.371	-0.012	-0.574	*	7	-1.146	-0.001
Ka	Real Estate, Renting and Business Svs	-0.135		3	-0.360	0.090					
Kb	Ownership of Dwellings	-0.149	*	9	-0.288	-0.009					
K	Real Estate and Business Services						-0.253	*	1	-0.505	-0.002
LQ	Government and Other Services	-0.066	*	1	-0.127	-0.005	-0.215	**	3	-0.336	-0.094

Data

Variables use in VAR analysis

Variable Name	Description
IR	Base interest rate of London clearing banks
LGVA	Log of aggregate UK Gross Value Added Basic prices: chained volume measure 2002 weights
RPIX	All items retail price index excluding mortgage interest 1987 weights
LEX	Log of Sterling effective exchange rate
L*sector*UK	Log of sectoral Gross Value Added for the UK Basic prices: chained volume measure 2002 weights Source: UK National Statistics, Economics Trends Annual Supplement 2005.
LS*sector*	Logarithm of individual sectoral Gross Value Added for Scotland Basic prices: chained volume measure 2002 weights Source: Scottish Executive, Quarterly Scottish GDP index, October 2005
OIL P	Average world price of crude oil (US dollars) converted into sterling using the sterling dollar exchange IMF Source: IMF International Financial Statistics 2005 (Crude oil prices) Economic Trends Annual Supplement 2005 (Exchange Rate)

Additional data sources:

Sectoral composition of GVA in (2002) - Economic Trends Annual Supplement (Main sectors) No. 31, 2005
Components of Manufacturing , Monthly Digest of Statistics, May 2006

Information on imported intermediates as % of total intermediate inputs was provided by Grant Allan, Strathclyde University, based on work reported in Allan et al. (2006)

REFERENCES

Allan, G.J., Hanley, N.D., McGregor, P.G., Swales, J.K. and Turner, K.R. (2006), "The Macroeconomic rebound effect and the UK economy", University of Strathclyde and Centre for Public Policy for Regions, report for The Department of Environment Food and Rural Affairs, London.

Arnold I J M and Vrugt E B (2002) 'Regional Effects of Monetary Policy in the Netherlands' *International Journal of Business and Economics*, Vol 1 (2), pp 123-134

Bank of England (1999) 'The transmission mechanism of monetary policy' report prepared under the guidance of the Monetary Policy Committee. Bank of England, London.

Ber H, Blass A and Oved Y (2002) 'Monetary Policy in an Open Economy: The Differential Impact on Exporting and Non-Exporting Firms', Discussion Paper No. 3191, Centre For Economic Policy Research

Carlino G and DeFina R (1998) 'The Differential Regional Effects of Monetary Policy', *The Review of Economics and Statistics*, Vol 80 (4), pp 572-587

Carlino G and DeFina R (1999) 'The differential regional effects of monetary policy: Evidence from the U.S. states' *Journal of Regional Science*, Vol 39, pp 339–358

Christiano L, Eichenbaum M and Evans C (1994) 'The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds', Working Paper Series, Macroeconomic Issues No. 94-2, Federal Reserve Bank of Chicago.

Cover, J P (1992) 'Asymmetric Effects of Positive and Negative Money-Supply Shocks', *The Quarterly Journal of Economics*, Vol 107 (4), pp 1261-1281

Dedola L and Lippi F (2000) 'The Monetary Transmission Mechanism: Evidence from the Industries of Five OECD Countries', Discussion paper no. 2508, July, Centre for Economic Research

Dedola L and Lippi F (2005) 'The Monetary Transmission Mechanism: Evidence from the Industries of Five OECD Countries', *European Economic Review*, Vol 49, pp 1543-1569

Department of Trade and Industry (2004) 'Regional Competitiveness and the State of the Regions' Department of Trade and Industry, London

Eichenbaum M. (1994) Comment in monetary policy. In: Mankiw, N.G. (Ed.), *Studies in Business Cycles*, Vol. 29. University of Chicago Press, Chicago. pp. 256–261.

Fratantoni M and Schuh S (2003) 'Monetary Policy, Housing and Heterogeneous Regional Markets', *Journal of Money, Credit and Banking*, Vol 35 (4), pp 557-589

Ganley, J and Salmon C (1997) 'The Industrial Impact of Monetary Policy Shocks: some stylised facts', Working Paper, No 68, The Bank of England

Georgopoulos, G J (2001) 'Measuring the Regional Effects of Monetary Policy', paper presented at The Midwest Finance Association meetings, Cleveland Ohio, March.

Gertler M and Gilchrist S (1994) 'Monetary Policy, Business Cycles and the Behaviour of Small Manufacturing Firms', *Quarterly Journal of Economics*, Vol 59, pp 309–340.

Hayo B. and Uhlenbrock B (1999) 'The Industry Effects of Monetary Policy in Germany', Working Paper B14, ZEI Centre for European Integration Studies

H M Treasury (2001) ‘Productivity in the UK: 3 – The Regional Dimension’, H M Treasury, London

HM Treasury (2003a) ‘Fiscal stabilisation and EMU’ HM Treasury, London.

HM Treasury (2003b) ‘EMU and labour market flexibility’ H M Treasury, London

HM Treasury (2003c) "EMU and the monetary transmission mechanism", H M Treasury, London

HM Treasury (2004) ‘Public Spending Review 2004: Public Service Agreements 2005-2008’, HM Treasury, London.

Owyang H J and Wall M T (2004) ‘Structural Breaks and Regional Disparities in the Transmission of Monetary Policy’, Working Papers No 2003-008B, Federal Reserve Bank of St. Louis

Peersman G and Smets F (2001) ‘The Monetary Transmission Mechanism in the Euro Area: More Evidence from VAR Analysis, Working Paper No. 91, European Central Bank

Peersman G and Smets F (2002) ‘The Industry Effects of Monetary Policy in the Euro Area’, Working Paper No. 165, European Central Bank

Peersman G and Smets F (2005) ‘The Industry Effects of Monetary Policy in the Euro Area’, *The Economic Journal*, Vol 115, April, pp 319-342

Rudebusch G D (1998) ‘Do Measures of Monetary Policy in a VAR Make Sense’, *International Economic Review*, Vol 39 (4), pp 907-931

Schunk D L (2005) ‘The differential impacts of monetary policy: Are the differences diminishing?’ Papers in *Regional Science* 84 (1), pp127–136.

NOTES:

[i] See, for example, Carlino and DeFina (1998, 1999), Dedola and Lippi (2000, 2005), Georgopoulos (2001), Hayo and Uhlenbrock (1999), Peersman and Smets (2001, 2005), Schunk (2005).

[ii] The null hypothesis of no first order serial correlation is not rejected in all but one sectoral VAR in each of the UK (Government and other services) and Scotland (Metals); while there was some evidence of higher order serial correlation does in some sectors this was not eliminated by extending the lag length. Lag choice by maximisation of AIC was possible only in the aggregate UK VAR due to degree of freedom restrictions.

[iii] UK (Rubber products, Metals, Retail and wholesale), Scotland (Metals, Mechanical engineering, transport equipment, financial services)

[iv] The estimated equation took the form

estimated impact on GVA = 0.184 + 0.013(pecentage of intermediate inputs that are imported)

the estimated slope coefficient was significant at the 1% level.

[v] In order to operationalise the general to specific search we first settled upon the lag structure for the exchange rate and oil price variables, while keeping longer lags the GVA and monetary policy SHOCK terms. Joint and single significance tests were employed at the 5% significance level for the conditioning variables and for GVA growth. We retained monetary policy shocks that were significant at least at the 15% level.

[vi] A simple OLS regression yields a positive relationship that is significant at the 5% level. There are two outliers (Scottish Mechanical Engineering, and Petroleum and Nuclear Fuels), excluding these improves the significance of the relationship.

[vii] The National Accounts conventions have North Sea Oil extraction into a separate UK account. So Scottish data for this sector covers oil refining but not extraction.

[viii] As mentioned above, Ganley and Salmon (1998) simply reported maximum impacts and did not compute their significance.

[ixix] Below the 90% CI for Electrical Engineering but below the 95% CI for all others