The industry effects of monetary policy and their welfare implications*

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1. Introduction

Advances in economic theory and developments in European integration have stimulated research on the monetary transmission mechanism. On the theoretical front, the credit view of the transmission mechanism has emerged as a serious competitor to the prevailing money view. Meanwhile, the move towards Economic and Monetary Union (EMU) in Europe has raised concerns that a common monetary policy might have differential effects on EMU member states, caused by differences in the monetary transmission mechanism. Needless to say, such differential effects not only complicate macroeconomic management but may also erode political support for monetary union.

The traditional money view emphasizes the role of the industry mix in the transmission of monetary policy. Varying interest sensitivities in the demand for products from different industries might, so the argument goes, be responsible for differential regional effects of monetary policy. In contrast, the credit view focuses on the need for and availability of bank credit, in empirical work mostly measured by firm size and bank size. Empirical evidence in support of the credit view is provided by Bernanke and Blinder (1992) and Kashyap and Stein (1997). However, in a recent paper Carlino and DeFina (1998) fail to corroborate their findings. They show that the regional effects

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of monetary policy are positively related to the share of manufacturing in the regional economy, providing support for the competing interest rate channel.

The European evidence is even more confusing. The survey by the OECD (1999) shows that most empirical studies report differences in the monetary transmission mechanism across European countries. A consensus on the ordering of countries according to interest rate responsiveness is, however, lacking.[1] In addition to this, Kieler and Saarenheimo (1998) question the statistical significance of the reported cross-country differences.

In contrast to the expanding literature on the measurement of differential effects of a common monetary policy, little attention has been given to their welfare implications. It is often taken for granted that differential effects are an undesirable outcome of a centralized monetary policy. Most empirical work on the transmission mechanism relates the differential effects of monetary policy to differences in the short-term impact of an interest rate shock on real GDP. Essentially, this is a measure of risk. A basic economic insight is that agents who voluntarily take on more risk expect to be compensated by a higher return. Transplanted to the macro-economic context, one expects industries which suffer disproportionately from the impact of monetary policy to compensate their shareholders and employees for taking on this risk. If this were true, it would provide the European Central Bank (ECB) with an argument to discard the differential effects of its interest rate policy and focus instead on achieving price stability for the euro area as a whole.

This paper aims to make two contributions to the empirical literature. First, building on the work by Carlino and DeFina (1998), I present additional empirical evidence on the importance of the industry channel. Second, this paper is a first attempt to apply the principle of a trade-off between risk and return to the differential effects of monetary policy. The paper is organized as follows. Section 2 provides a brief overview of the channels of monetary transmission and the potential sources of differential effects of monetary policy. It also addresses the question whether differential effects arise from voluntary decisions by economic agents or from government interference.

[1] See also Brittan and Whitley (1997), Ramaswamy and Sloek (1997), Ehrmann (1998) and Favero and Giavazzi (1999).

In Section 3, I review two well-known economic theories on risk-return trade-offs by economic agents. They will be used to understand the welfare implications of the differential effects of monetary policy. Section 4 contains new empirical estimates on the interest rate responsiveness of industries in the US and an attempt to link these estimates of interest rate risk to several return measures.

2. The channels of monetary transmission

Many surveys on the monetary transmission mechanism have been written in recent years: see Bernanke and Gertler (1995), Cecchetti (1995), Christiano, Eichenbaum and Evans (1998), Gertler (1988), Gertler and Gilchrist (1993) and Mishkin (1995 and 1996). This section will briefly summarize the main channels of monetary transmission and discuss how they may lead to differential regional effects of monetary policy.

According to traditional economic theory, the transmission of monetary policy works through the interest rate channel. A tightening of monetary policy results in a higher interest rate, which in turn depresses demand for investment and (durable) consumer goods. Regional effects of monetary policy can be explained by the combination of differences in interest rate sensitivity between industries and differences in industrial structure between regions. For example, areas where many capital-intensive manufacturing industries are located may be more sensitive to monetary policy measures than areas with mainly services industries. Taylor (1995) provides a survey of the empirical work on the interest rate channel. Ganley and Salmon (1997), Hayo and Uhlenbrock (2000) and Carlino and DeFina (2000) provide European evidence on the industry channel.

A main limitation of this theory is its focus on the interest rate, which is just one of many asset prices. It therefore makes sense to consider the effect of monetary policy on other asset prices, such as exchange rates and equity prices. The effect of monetary policy on the exchange rate may lead to changes in net exports. For the exchange rate channel to have differential regional effects, we need cross-regional variation in openness (see Dornbusch, Favero and

Giavazzi 1998). The equity channel of monetary transmission is more complicated. It may either work through Tobin's *q* theory of investment demand or through a wealth effect on consumer demand (see Mishkin 1996). Regional effects of monetary policy can be caused by regional differences in Tobin's *q* or in the distribution of wealth.

A new view on the monetary transmission mechanism stresses the role of information problems in credit markets. This credit view comes in two flavours: the bank lending channel and the balance sheet channel. According to the former channel, the transmission of monetary policy depends on the ability and willingness of banks to provide loans to firms (see Kashyap and Stein 1997). Because banks have a special role in solving information problems, some borrowers lack easy substitutes for bank loans. Monetary policy may then affect the economy through the supply of bank credit. Regional effects arise when regions differ in the dependence on and availability of bank credit. Areas with many small firms are predicted to react stronger to monetary policy shocks than areas with large firms, because small firms have worse access to capital markets and are therefore more dependent on bank credit. The theory also predicts areas with relatively many small banks to react more strongly to monetary policy. Small banks do not have the same access to alternative sources of funding as larger banks and are forced to cut their lending to firms at an earlier stage.

The balance-sheet channel works through the effect of monetary policy on the net worth and cash flow of firms. An expansionary policy will raise both.[2] As a result, the adverse selection and moral hazard problems in credit markets are mitigated, so that lending and investment spending may increase. The balance-sheet channel is not restricted to firms, and may also explain changes in consumer spending, as emphasized by Mishkin (1978).

The credit view may explain differential regional effects of monetary policy when there are large cross-regional differences in financial structure. Variables which have been used to measure the bank lending channel include the proportion of small banks and small firms in an economy, the health of the banking sector and the availability of non-bank funding (see Kashyap and Stein 1997). Measures

[2] The effect on net worth may be caused either by a rise in equity prices following an expansionary monetary policy or by a decline in the real value of firms' fixed nominal liabilities.

for the balance-sheet channel include collateral (see Dornbusch, Favero and Giavazzi 1998). In the European context, many authors have also pointed to large cross-country differences in the adjustability of interest rates (see Borio 1996; Barran, Coudert and Mojon 1997; Kashyap 1997; De Bondt 1998 and Mojon 1999). In countries where interest rates on debt contracts adjust more rapidly to monetary tightening by the central bank, the immediate response to monetary policy shocks will be stronger. This may work either through the negative effect of the reduced cash flow on lending (the balance sheet channel) or through a negative effect of higher interest payments on investment and consumer spending.

Though the money and credit views are usually presented as contrasting theories, this need not be the case. There may be an interdependence between interest-rate sensitivity and the availability of bank credit, when during a recession banks mainly withhold credit from firms within interest-sensitive industries. In such a case, it will be hard to disentangle the separate effects of higher interest rates and credit restrictions. Investigating this interaction effect goes beyond the scope of this paper and is left for future research.

All transmission channels described above relate to the effect of monetary policy on aggregate demand. The final effect on income is the result of the interaction of supply and demand. Differential effects of monetary policy could therefore also be the result of regional differences in the supply curve.[3]

From a policy perspective, the difference between the industry mix channel and the credit channel is not without consequence. As most Western governments have abolished industrial policies, the type and location of industries results from the free choice of private sector agents, not government planners. Differential effects of monetary policy caused by differences in industry mix are then difficult to eradicate through direct government intervention. All a government can try to do is to compensate differential effects through fiscal policy, the wisdom of which will depend on their welfare implications. In contrast, regional diversity in financial structure is only partly the result of actions of the private sector. Government regulation, ranging from the Glass-Steagall Act in the US to a multitude of national regulations in Europe, keeps banking and other financial markets re-

[3] For Europe, obvious candidates are cross-country differences in labour market structures.

gionally segmented. This may change when governments decide to take down such obstacles to integration.

Economic integration in Europe may have opposite effects on financial structure and industrial structure. Increased financial integration would allow firms and consumers all across Europe to use the same package of financial services and to access the same financial markets, reducing any regional effects of monetary policy caused by differences in financial structure. In contrast, increased industrial specialization within Europe could result in a more heterogeneous industrial structure, as economic agents flock together to reap the benefits of a greater geographic concentration of industry (see Krugman 1993). This could increase the differential effects of monetary policy due to differences in industry mix. Both financial integration and industrial specialization will take time. But the important point to note here is that these two developments have an opposite impact on the importance of differential regional effects of monetary policy.

3. Welfare implications

Regarding welfare implications, there is not too much difference between the differential regional effects of monetary policy and the frequent occurrence of asymmetric regional shocks. In both cases, a uniform monetary policy is incapable of producing similar economic growth rates across a monetary union. The important questions are: does it matter and should policy makers intervene? The desirability of policy intervention is not self-evident. First of all, policy makers have a limited choice of tools to correct regional imbalances. With monetary policy impotent and industrial policy out of fashion, policy makers are left with fiscal policy. Second, even if regional imbalances could be addressed through fiscal measures, this might not be welfare-enhancing. A crucial distinction in this regard is whether regional differences are the result of government policy or the outcomes of free choices of economic agents. In the former case, the first-best solution might be to change government policy. For example, the strong interest sensitivity of mortgage payments in the United Kingdom makes the British housing market more vulnerable to monetary policy tightening than housing markets on the European continent (see MacLennan, Muellbauer and Stephens 1998). It can be argued that this sensitivity is the result of the 'boom and bust' monetary policies of the past.[4] Changing monetary policy would in this example address the regional imbalance. When regional differences are the result of free choices of economic agents, the case for fiscal compensation is not clear-cut either. If production factors are allowed to move freely within a monetary union, one would expect their remuneration to match the riskiness of the industries in which they are employed. Below, I will briefly summarize the relevant economic theories for the production factors capital and labour.

In its most basic expression, asset pricing theory relates the expected return on capital to three inputs: a risk free rate, a risk premium and a beta. Beta measures the non-diversifiable part of the riskiness of investing in a firm. The value of the beta coefficient depends on: 1) the type of business a firm is in; 2) the operating leverage of a firm; and 3) the degree of financial leverage.[5] The first determinant relates to the cyclical nature of the business. In general, the higher the sensitivity of the demand for a firm's products to macroeconomic factors, the more cyclical the business and the higher the beta value. Higher operating leverage, measured by high fixed costs relative to total costs, increases the vulnerability to a cyclical downturn. On top of this financial leverage, measured by a high debt/equity ratio, can multiply the cyclical and operating leverage risks. Monetary policy affects firm performance through the business cycle. Firms in a cyclical industry with high operating and financial leverage will react more strongly to monetary policy shocks than noncyclical and unleveraged firms. According to finance theory, these firms should have higher beta values and higher expected returns. Providers of capital expect higher returns from investing in cyclical industries; the differential effects of monetary policy should be priced.

Empirical evidence for the effect of the business cycle on stock market returns is provided by Chen, Roll and Ross (1986), using four macro-economic variables: inflation, the term structure of interest rates, risk premia and industrial production. They find a significant relationship between these variables and systematic factors in stock market returns and, more importantly, they find the macro-variables

[4] See Smets (1997) and Arnold and De Vries (2000).

[5] See Damodaran (1997).

to be priced in the stock market. Other empirical studies have explicitly incorporated industry effects into their asset pricing model. Among the early studies, Nerlove (1968) and Arditti (1967) find that industry variables are highly significant in explaining differences in stock returns. Employing a multi-factor model including industry sector membership variables, Sharpe (1982) finds large differences in the effect of industry sector membership on returns. The Barra multifactor model, explained in Grinold and Kahn (1994), assigns a prominent role to industry factors. Finally Fabozzi and Francis (1979) show industry factors to add to the explanatory power of models seeking to explain the beta coefficient.

We must keep in mind that the risk-return relationship postulated by finance theory needs the assumption of competitive markets. In the presence of market imperfections, significant inter-industry return differentials might arise, unrelated to risk measures. The estimates in Katz and Summers (1989) suggest that in the US, capital owners receive few monopoly rents. This finding is confirmed by the empirical literature on industrial organization, which shows only weak evidence of a relationship between profit measures and variables like concentration ratios (Schmalensee 1989).

The labour market equivalent of asset pricing theory is the theory of compensating wage differentials, which has been used to explain industry wage differentials. A stylized fact in labour economics is the presence of large wage differences among industries. These differences persist after controlling for a wide variety of worker and job characteristics (see Krueger and Summers 1988 and Katz and Summers 1989). Industry wage differentials appear to be remarkably stable across time and space (Krueger and Summers 1987). Evidence from longitudinal data shows that when individual workers move between industries, their wages change by amounts similar to the estimated industry wage differentials (Krueger and Summers 1988, Gibbons and Katz 1987). Accounting for union membership and union coverage has little effect on the industry differentials. According to Katz and Summers (1989, p. 226):

> "The stability in differentials across time periods and countries strongly suggest that these wage differences result from factors fundamental to the operation of industrial economies and are not the result of particular collective bargaining systems or government interventions in the labour market".

Katz and Summers (1989) also observe that durable goods manufacturing, mining and chemicals pay much higher wages than retail trade and service industries, again after controlling for worker and job characteristics. Taking into account fringe benefits reinforces their conclusion.

The theory of compensating wage differentials holds that job attributes vary systematically with one's industry of employment; wage differentials are therefore required to compensate employees for the non-wage characteristics of the industry. Many tests of this theory have focused on measures of quality of employment, such as health hazards, commuting time, overtime and physical work conditions (Brown and Medoff 1985 and Krueger and Summers 1988). Taking these variables into account does not substantially alter the pattern of industry wage differentials, so many economists have abandoned the theory of compensating wage differentials in favour of other theories.[6]

The empirical work in this area is, however, not confined to the narrow job characteristics mentioned above, but also includes industry estimates of the risk of unemployment. Here the findings provide better support for the theory. Empirical studies by Topel (1984) and Li (1986) support the hypothesis that individuals are compensated for above-average unemployment risk. Abowd and Ashenfelter (1981) find that the labour market compensates anticipated layoffs and unemployment and show that durable manufacturing industries and construction face high unemployment risk, in contrast to government and the professional services industries. They conclude (*ibid.*, p. 162):

> "Estimated compensating differentials range from less than one percent in industries where the workers experience little anticipated unemployment to over fourteen percent in industries which experience substantial anticipated unemployment and unemployment risk".

A related paper by Diamond and Simon (1990) examines the effect of greater industrial specialization on unemployment risk. They find that individuals living in industrially more specialized cities suffer greater unemployment risk but are compensated for this by higher wages.

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[6] The most prominent alternative theory of wage determination is the efficiency wage theory. See Stiglitz (1987) and Katz (1986) for surveys.

Both asset pricing theory and the theory of compensating wage differentials predict production factors to be compensated for business cycle risk. If both theories would be empirically validated, this would lead to an induced inter-industry correlation between wages and profits. The positive correlation between wages and profits is a well-established stylized fact in the literature on rent-sharing (see Katz and Summers 1989 and Blanchflower, Oswald and Sanfey 1996). The rent-sharing literature offers three models to explain the wage-profit correlation. The first is a non-competitive bargaining model in which workers are able to appropriate some of the firm's surplus; the second is a competitive model with demand shocks and a positively sloped labour supply curve, in which temporary frictions resulting from demand shocks lead to higher pay; the third model relies on labour contracts enabling firms and workers to share the rents in good and bad times. Interestingly, the business cycle risk explanation for the wage-profit correlation advanced above does not figure in the rent-sharing literature, though the contract model comes closest.

In addition to confirming the wage-profit relationship, Katz and Summers (1989) also show that the capital-labour ratio helps to explain industry wages. Their preferred explanation is based on the bargaining model: labour can extract rents by threatening to stop production. As interruptions are more costly for capital-intensive firms, they will be more willing to pay high wages. Again, the relationship between wages and the capital-labour ratio could also be explained by business cycle risk: capital-intensive firms have higher operating leverage and are more interest-sensitive than firms with a lower capital-labour ratio. Workers might want to be compensated for the increased unemployment risk in such industries.

It is not the aim of this paper to discriminate between alternative theories of wage determination or rent-sharing. Rather, the aim is to show that while industries may differ in their reaction to monetary policy shocks, they also remunerate their production factors differently. This last point is overlooked when policy makers worry about the differential effects of monetary policy actions on regions, but fail to take into account differential wages and returns on capital.

4. Empirical evidence

The empirical evidence presented in this section consists of two parts. The first part provides additional evidence on the importance of industry-mix variables in explaining differential effects of monetary policy. The second part is an attempt to empirically assess the welfare implications of such effects.

4.1. *The role of industry mix revisited*

Carlino and DeFina (1998) apply a two-stage procedure to measure and explain the regional effects of monetary policy in the US. First, they estimate cumulative impulse responses of state real personal income to a shock in the federal funds rate. In a second regression, they try to link these impulse responses to a variety of interest channel and credit channel variables. In what follows, I deviate from their procedure in one important respect. By estimating the effect of a monetary policy shock on sector earnings at the regional level, I can get a more complete picture of the effect of the industry mix on the transmission of monetary policy. Whereas Carlino and DeFina (1998) measure industry mix by two sectors only (manufacturing and extractive industries), my approach utilizes information on 11 US sectors in the analysis of quarterly data and 71 US sectors in the analysis of annual data.[7] The estimation of impulse responses by both region and sector allows me to assess their relative importance using an analysis of variance. In other words, I try to answer the question whether industry effects or other regional effects are the most important source of variation in impulse responses. Differences in financial structure would fall into the category of other regional effects. Note that a key assumption in this approach is that industry effects and other regional effects are independent. That is, I do not allow for interaction effects.

The empirical approach has much in common with Carlino and DeFina (1998). First, I follow their choice of monetary policy variable by modeling monetary shocks as changes in the federal funds rate. I also borrow two of their macro-economic control variables: the Bu-

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[7] All regional earnings data originate from the Bureau of Economic Analysis data files. See Appendix A for details.

reau of Labour Statistics 'core' consumer price index is used to capture trends in the aggregate price level and the ratio of the energy producer price index to the total producer price index accounts for energy price shocks. Carlino and DeFina (1998) employ a structural vector autoregression model (SVAR) which requires them to place restrictions on the transmission of shocks to the variables in the system. In contrast, this paper uses a standard non-structural vector autoregression model (VAR). However, this methodological difference has little practical relevance here. As we will see, my regional results for the effect of monetary shocks on real personal income are very close to Carlino and DeFina's (1998) outcomes.[8]

The analysis is done using a quarterly and an annual data set. For both data sets, the VAR model consists of four variables: the percentage change in real earnings in sector *i* and region *j* ($dearn_{i,j}$); the percentage change in the 'core' consumer price index (*dcpiux*); the percentage change in the producer price index for fuels and related products and power relative to the total producer price index (*drppi*) and the change in the federal funds rate (*dffr*). The difference between the quarterly and the annual estimates is in the level of detail regarding industry mix and in the sample period. The sample period runs from 1969Q1 to 1998Q3 for the quarterly data set and from 1958 to 1997 for the annual data set. The quarterly VAR-model uses four lags. The cumulative impulse responses are calculated for an eight-quarter period. For the annual model, I use two lags and a two-year period to calculate cumulative impulse responses.

Estimation results for the quarterly data are in Table 1 below. Table B1 in Appendix B contains the more detailed annual results. The first row in Table 1 shows the effect of a one standard deviation innovation in *dffr* on the percentage change in real personal income for eight US regions and for the US as a whole. The correlation coefficient between these regional impulse responses and the estimates by Carlino and DeFina (1998) is 0.87, which is highly significant.[9] Two other findings by Carlino and DeFina (1998) are corroborated. First,

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[8] Moreover, I have experimented with the ordering of the variables in the VAR, to address the standard criticism that VAR results may be sensitive to a change in ordering. This appeared not to be the case. I conclude that the results are quite robust to the choice of econometric methodology.

[9] See Carlino and DeFina (1998, Table 4). As Carlino and DeFina report positive responses, whereas I report negative ones, the correlation coefficient is between the absolute values.

their mitigating effect of the share of extractive industries in a state's income on the impulse response is mirrored by the positive impulse response for the mining sector in Table 1. A theoretical reason for this is that higher interest rates will increase the opportunity costs of not extracting oil and minerals. Therefore, an increase in interest rate will stimulate mining activity. Another reason why the mining sector moves against the grain is that the oil crises in the 1970s had a positive impact on the mining sector, but negative consequences for the rest of the economy. Second, the impulse responses for the manufacturing industry (in particular durable goods) are in general more negative than the aggregate impulse responses. Carlino and DeFina's (1998) finding of a high responsiveness of the Great Lakes economy to monetary policy shocks is confirmed, see the value of –1.21 for personal income and the value of –2.66 for durable goods manufacturing. The latter value reflects the responsiveness of the car industry in the Great Lakes area to changes in interest rates.

In addition to confirming earlier results, Tables 1 and B1 paint a much richer picture of the effect of industry mix on the transmission of monetary shocks. For example, Table 1 shows the strong effect of monetary policy on construction activity across regions and the much weaker effect of interest rate changes on the services industry and the government sector. The financial services industry also shows a relatively high responsiveness to monetary shocks, which can be attributed mainly to the volatility in the real estate sector, as the more detailed estimates in Table B1 illustrate. A further inspection of the individual impulse responses in Tables 1 and B1 is left to the reader.

I will now turn to the analyses of variance which are reported in the standard two-way Anova-format at the bottom of Tables 1 and B1. Both Anova-tables show that the main source of variation in impulse responses is the industry, not the region. In Table 1, the null hypothesis that the 11 industries have the same mean impulse response is rejected at almost any significance level with a F-value of 91.5. Though the null hypothesis that the 8 regions have equal impulse responses is also rejected at a 5% level, the F-value is just 6.5, much smaller than the F-value for the industry effect. Turning to the annual data, the Anova-results in Table B1 show the industry effect again to be highly significant; the regional effects are insignificant at a 5% level. Concluding, industry variation in impulse responses dwarfs all other regional sources of variation, including the possible effect of credit channel variables.

TABLE 1

CUMULATIVE IMPULSE REPONSES, US REGIONS, 1969Q1-1998Q3[a]

Code	Industry	US	FWST	GLAK	MEST	NENG	PLNS	RKMT	SEST	SWST
10	Personal income[b]	−0.78	−0.57	−1.21	−0.70	−0.88	−0.51	−0.62	−0.92	−0.29
Earnings in:										
100	Agricultural services and other	−1.85	−1.75	−1.71	−1.41	−2.90	−1.98	−1.78	−2.20	−1.26
200	Mining	2.91	2.84	2.07	1.98	3.47	2.74	3.26	2.45	4.17
300	Construction	−2.61	−2.47	−3.08	−2.62	−4.09	−2.92	−2.49	−2.37	−1.53
410	Durable goods manufacturing	−1.63	−0.89	−2.66	−0.71	−0.24	−1.67	−0.95	−2.24	0.22
450	Nondurable goods manufacturing	−1.12	−0.90	−1.40	−1.15	−1.18	−0.70	−0.89	−1.14	−0.18
500	Transportation and public utilities	−0.83	−0.42	−1.57	−0.83	−0.72	−1.07	−0.29	−0.94	−0.09
610	Wholesale trade	−0.51	−0.64	−0.70	−0.59	−1.00	−0.50	−0.22	−0.61	0.17
620	Retail trade	−1.60	−1.46	−1.74	−1.77	−2.02	−1.40	−1.83	−1.89	−1.39
700	Finance, insurance and real estate	−2.08	−2.20	−2.23	−2.26	−1.76	−1.89	−2.34	−1.90	−1.79
800	Services	−0.87	−0.81	−0.98	−0.80	−1.04	−0.96	−0.74	−0.98	−0.60
900	Government	−0.70	−0.52	−0.87	−0.72	−1.29	−0.94	−0.85	−0.73	−0.64

Analysis of variance

Source	*SS*	*DF*	*MS*	*F*	*p-value*
Industries	164.47	10	16.447	91.516	3.95E-36
Regions	8.21	7	1.174	6.530	6.17E-06
Error	12.58	70	0.180		
Total	185.27	87			

[a] Effect of a one standard deviation innovation in the change of the federal funds rate (*dffr*) on the percentage change in real earnings in sector *i* and in region *j* ($dearn_{i,j}$).

[b] Personal income is *not* equal to the aggregate of all sector earnings. See the documentation in the BEA data files.

See Appendix A for further details.

4.2. *Evidence on compensating wages and returns*

Having established the importance of the industry mix for the transmission of monetary policy, I now proceed addressing the welfare implications of differential regional effects of monetary policy. As the regional variation in impulse responses is dominated by the variation in industrial composition, this section contains data by industry only, not by industry and region.[10]

Table 2 gives the results of a first, crude attempt to link the impulse response estimates of Table 1 to various measures for compensating wages and returns. The data in Table 2 suffer from two drawbacks. First, the industry classification used is on a one-digit level, which limits the number of available observations. Second, the data come from different sources with varying sample periods, which may limit their comparability. These limitations will be rectified later on, when I will use the NBER manufacturing database. However, in contrast to the NBER database, Table 2 includes data for the non-manufacturing sectors, enabling a more complete overview of the US economy.

The first data column in Table 2 repeats the cumulative impulse response (*cir*) estimates for the US from Table 1. Next, four measures for inter-industry wage differentials (*wagediff*) are taken from the Krueger and Summers (1988) paper. These wage differentials have been corrected for job and worker characteristics. The fourth wage differential (84TC) is a 'total compensation' measure, including fringe benefits. As a crude update, the hourly dollar earnings (*hrear*) for 1997 are listed in the sixth data column. The correlation between this update and the Krueger and Summers (1988) measures is always higher than 0.8, which confirms the consensus view that inter-industry wage differentials cannot be explained by job and worker characteristics. The final two columns list capital market measures. *Beta* is a so-called full-information industry beta estimate, which incorporates industry-specific information contained in the betas of industrial conglomerates into the estimation process (see Kaplan and Peterson 1998). The industry beta is a risk measure akin to the impulse response measure. The final column gives a return on capital estimate by sector (*return*),

[10] Data availability is a second reason for this. Many data on wages and profits by industry are not available at the regional level.

using capital and profit estimates from the US Survey of Current Business.

Correlation coefficients between the labour and capital market measures and my impulse response estimates are at the bottom of Table 2. However, the very small number of observations does not allow us to draw any firm conclusions from these. A further problem in interpreting Table 2 is posed by the mining sector. This is the only sector with a positive *cir*, which implies that an increase in the interest rate leads to an *increase* in mining sector earnings. The absolute size of the mining *cir* is quite high. The question then is whether, in considering the riskiness of a sector, we should look at both the sign and the size of the cumulative impulse response or the size only. The answer to this question is not straightforward and depends on the diversifiability of risk.

For the labour market measures, one can argue that the size of the coefficient is all that matters. If investments in human capital are mainly sector-specific, employees will consider the unemployment risk *within* that sector. This risk is measured by the size of the response of their sector earnings to a monetary policy action, not by the sign. This would plea for using the absolute value of *cir* in calculating the correlation coefficients. However, if investments in human capital are not sector-specific, one can make a counter-argument based on diversification. Because of the counter-cyclical nature of the mining industry, workers laid off in the mining sector might easily find another job when the rest of the economy is booming. If this argument were valid, the sign of *cir* is also important in calculating the correlation coefficients.

In my view, the diversification argument is much more forceful for the capital market than for the labour market, as financial capital can be much more easily moved around industries than human capital. Because of this interpretation problem, Table 2 lists correlation coefficients for the original *cir* measures and their absolute values. Additionally, correlation coefficients are calculated excluding the mining sector. Assuming that labour mobility across sectors is much lower than capital mobility, I would prefer using the absolute values of *cir* for the labour market measures *wagediff* and *hrear* and the original values for the capital market measures *beta* and *return* (this preference is indicated in bold in Table 2).

Due to the small number of observations, most of the t-values of the correlation coefficients are low. I therefore focus on the sign of the correlation coefficients. In comparing rows a) and b) in Table 2, note the sign reversal of the correlation coefficients between *cir* and *wagediff* and *hrear* after excluding the mining sector. Comparing rows a) and c), the significance of the correlation coefficients is increased somewhat by taking absolute values, but it remains low. In contrast, for *beta* and *return*, excluding mining or taking absolute values drastically reduces the significance of the correlation coefficients.

Wage data for the government sector were not available. Obviously, the beta value and the return on capital cannot be calculated for this sector. Probably, data for government wage differentials would strengthen my results, assuming that private sector jobs are better paid than public sector jobs and taking into account the low *cir*-value for the government sector. But this remains speculative.

TABLE 2

COMPENSATING WAGES AND RETURNS, ONE-DIGIT LEVEL

Code	Industry	*cir*[a]	*wagediff*				*hrear*	*beta*	*return*
		1969-98	1974	1979	1984	1984TC	1997		1985-93
200	Mining	2.91	0.20	0.26	0.24	0.25	16.17	0.47	−0.12%
300	Construction	−2.61	0.23	0.14	0.13	0.11	16.03	1.24	12.99%
400	Manufacturing	−1.38							8.60%
410	Durable goods	−1.63	0.06	0.07	0.12	0.17	13.73	1.32	
450	Nondurable goods	−1.12	0.03	0.02	0.07	0.10	12.33	0.94	
500	Transportation, public utilities	−0.83	0.12	0.10	0.17	0.23	14.93	0.84	2.61%
610	Wholesale trade	−0.51	0.04	−0.02	0.05	0.03	13.44	1.02	8.60%
620	Retail trade	−1.60	−0.18	−0.10	−0.17	−0.20	8.34	1.13	7.76%
700	Finance, insurance, real estate	−2.08	0.07	−0.03	0.07	0.08	13.33	1.27	4.11%
800	Services	−0.87	−0.08	−0.08	−0.09	−0.13	12.28	1.44	3.94%
900	Government	−0.70							
Correlation coefficients									
a)	r with *cir*		0.25	0.55	0.42	0.37	0.32	**−0.81**	**−0.71**
	t-statistics		*0.67*	*1.76*	*1.22*	*1.04*	*0.91*	***3.61***	***2.66***
b)	r with *cir* (excl. Mining)		−0.38	−0.34	−0.14	−0.09	−0.20	−0.42	−0.50
	t-statistics		*1.01*	*0.87*	*0.36*	*0.23*	*0.49*	*1.13*	*1.28*
c)	r with absolute value of *cir*		**0.53**	**0.62**	**0.41**	**0.33**	**0.40**	−0.25	−0.05
	t-statistics		***1.66***	***2.09***	***1.19***	***0.93***	***1.17***	*0.67*	*0.12*

[a] Taken from Table 1.
See Appendix A for further details.

Summing up, Table 2 provides at best mixed evidence on the existence of compensating wages and returns for the risk of monetary policy shocks. In order to address the two data problems mentioned above, we now turn to evidence for the US manufacturing sector from the NBER manufacturing database. A major advantage of using this database is that the wage and profit data derive from the same source and cover the same sample period. The use of a two-digit industry classification also increases the number of observations to 20. A drawback is that this database is confined to the manufacturing sector. Subsequent results therefore relate to the relationship between business cycle risk and compensation between subdivisions within the manufacturing sector, not between the major sectors identified in Table 2.

The following five wage and return measures were constructed from the NBER data: real payroll per employee (*rpay/emp*); real production workers wages per hour (*rprodw/prodh*); real production workers wages per production worker (*rprodw/prode*); real profitability per real capital (*prof/cap*) and the real percentage growth rate in profitability (*dprof*).[11] The first four variables enter the statistical model in percentage growth rates. Using the same VAR-model and the same macroeconomic control variables as in Section 4.1, impulse responses have been estimated of the effect of a one standard deviation innovation in the change in the federal funds rate on the wage or return measure for each of the 20 manufacturing sectors. Next, means and standard deviations of the levels of *rpay/emp*, *rprodw/prodh*, *rprodw/prode*, *prof/cap* and of *dprof* have been calculated per sector. For all five measures, Table 3 contains correlation coefficients between the means on the one hand and the standard deviations and impulse responses on the other hand. All correlation coefficients have been calculated using the observations for the 20 manufacturing sectors. As in Table 2, Table 3 presents the results for the original estimates of the impulse responses and for their absolute values, though the distinction does not make much of a difference here. The results show that for all measures the correlation coefficient between the means and the standard deviations is high and significantly different from zero at a 5% level. The results for the impulse response risk measure are much weaker: in the one case in which the correlation coefficient is significant (*prof/cap*), it has the wrong sign. The signs for the other four correlation coefficients between the means and the impulse responses are correct (a more negative value for the impulse response leads to a higher wage or a higher return).

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[11] See Appendix A for details on the calculation method.

In summary, the data from the NBER manufacturing productivity database provide only weak evidence for the existence of a risk-return relationship in labour and capital markets, in which a greater responsiveness of manufacturing industries to changes in interest rates is compensated by higher wages and profits.

TABLE 3

COMPENSATING WAGES AND RETURNS, TWO-DIGIT LEVEL, 1958-94

	Correlation coefficients with mean (t-values)					
Measure	Impulse response		Impulse response (abs)		Standard deviation	
rpay/emp	−0.265	(1.166)	0.280	(1.238)	0.478	(2.311)
rprodw/prodh	−0.268	(1.181)	0.366	(1.670)	0.512	(2.532)
rprodw/prode	−0.323	(1.449)	0.353	(1.602)	0.520	(2.585)
prof/cap	0.467	(2.241)	−0.491	(2.392)	0.879	(7.803)
dprof	−0.227	(0.999)	0.293	(1.299)	0.611	(3.273)

See Appendix A for details.

5. Conclusions

This paper has shown that in a well-integrated economy like the United States, most regional variation in the impact of monetary policy shocks can be attributed to differences in industrial composition, corroborating earlier findings by Carlino and DeFina (1998). In most modern economies, automatic stabilizers do their work in alleviating regional setbacks. It is not at all obvious that more should be done by government. In so far as regional vulnerability to monetary policy shocks results from the free choice of shareholders and employees regarding their industry, both asset pricing theory and labour market theory would predict that they receive compensation for voluntarily taking on this risk.

This paper has cited evidence indicating that business cycle risk is priced in both capital and labour markets. In addition, new evidence shows a weak relationship between the impact of monetary policy shocks and compensating wage and return differentials across industries. Though the evidence is far from conclusive, some industries are definitively more risky but also more profitable to both shareholders and employees than other industries. In that case, government intervention aimed at addressing the riskiness of those industries through for example subsidies would not necessarily be welfare-enhancing. Such intervention could reduce risk and increase return, distorting the risk-return trade-off which economic agents face in the private sector. Instead, governments could better address those regional differential effects of monetary policy which result from existing government policies.

At present, the possibility that a common monetary policy may have differential regional effects is an important issue in the operation of the EMU. In Europe, differential regional effects could be potentially more divisive than in the United States, given that political integration in Europe still lags behind economic integration. It is hard to draw firm policy conclusions for Europe on the basis of findings for the United States. The European economy suffers from institutional, cultural and linguistic barriers which are largely absent in the United States. Looking forward, however, the trend towards harmonizing institutional differences across EMU members will probably continue and may reduce the present institutional segmentation in the euro area. For example, increased financial integration may in time reduce any regional effects of monetary policy caused by differences in financial structure. In contrast, increased specialization within Europe could result in a more heterogeneous industrial structure, more akin to that of the United States.

Differences in industrial structure are thus likely to gain importance at the expense of institutional or policy-induced differences, which presently may still hamper a uniform transmission of European monetary policy. For European governments, there is still a large task in removing the remaining institutional obstacles to a uniform transmission of monetary policy. In the meantime, the ECB would do best to discard the differential effects of its interest rate policy and focus on achieving price stability for the euro area as a whole.

APPENDIX A

1. Data from the Bureau of Economic Analysis

Quarterly data on sector earnings from 1969Q1 to 1998Q3 (used in Table 1)

Annual data on sector earnings from 1958 to 1997 (used in Table B1)

$dearn_{i,j}$: percentage change in real earnings in sector i and in region j; earnings deflated with the national Consumer Price Index (*cpiu*).

Regions: FWST: Far West; GLAK: Great Lakes; MEST: Mid East; NENG: New England; PLNS: Plains; RKMT: Rocky Mountains; SEST: South East; SWST: South West.

2. Data from the NBER Manufacturing Productivity database[1]

Annual data from 1958 to 1994

sic: original 4-digit SIC codes refer to 1972 industry classification and range from 2011 to 3999

emp: number of employees (in 1000s); available at 4-digit level, aggregated to 2-digit level

pay: total payroll (millions of dollars); available at 4-digit level, aggregated to 2-digit level

prode: number of production workers (in 1000s); available at 4-digit level, aggregated to 2-digit level

prodh: number of production worker hours (in millions); available at 4-digit level, aggregated to 2-digit level

prodw: production workers wages (millions of dollars); available at 4-digit level, aggregated to 2-digit level

vadd: value added by manufacture (millions of dollars); available at 4-digit level, aggregated to 2-digit level

cap: real capital stock (millions of 1987 dollars); available at 4-digit level, aggregated to 2-digit level

invest: new capital spending (millions of dollars); available at 4-digit level

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[1] See Bartelsman and Gray (1996).

piinv: price deflator for investment (1 in 1987); available at 4-digit level

rinvest: real new capital spending (millions of 1987 dollars): = *invest/piinv*; calculated at 4-digit level

dep: depreciation: = *cap* – *cap(t + 1)* + *rinv*

prof: profitability (millions of 1987 dollars): = *(vadd – pay)/cpiu* – *dep*; calculated at 4-digit level, aggregated to 2-digit level

dprof: percentage growth rate of *prof*; calculated at 2-digit level

rpay: total payroll (millions of 1987 dollars): = *pay/cpiu*; calculated at 2-digit level

rprodw: production workers wages (millions of 1987 dollars): = *prodw/cpiu*; calculated at 2-digit level.

3. Other data

ffr: federal funds rate

dffr: change in federal funds rate

cpiu: consumer price index (CPI-U, 1 in 1987)

dcpiu: percentage change in *cpiu*

cpiux: BLS 'core' consumer price index (excluding the effects of food and energy prices)

dcpiux: percentage change in *cpiux*

rppi: producer price index for fuels and related products and power relative tot the total producer price index

drppi: percentage change in *rppi*

wagediff: comparable wage differentials for 2-digit industries taken from Table II in Krueger and Summers (1988) for 1974, 1979, 1984 and 1984TC (total compensation); aggregated to 1-digit level by taken weighted averages (with BEA 2-digit sector earnings as weights)

beta: full-information industry betas at 2-digit level taken from Table 2 in Kaplan and Peterson (1998); aggregated to 1-digit level by taken weighted averages (with BEA 2-digit sector earnings as weights) *hrear:* average hourly earnings, $, U.S. Census Bureau, *Statistical Abstract of the United States*, September 1998

return: corporate profits divided by current-cost net stock of fixed private non-residential capital, averaged over 1985-93, U.S. Department of Commerce, *Survey of Current Business*, May 1997 and Data Service and Information GmbH, *International Statistical Yearbook*.

APPENDIX B

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