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Working Paper

Regional Effects of Monetary Policy in Sweden

Working Paper, No. 2012:9

Provided in Cooperation with:

Department of Economics, School of Economics and Management, Lund University

Suggested Citation: Svensson, Emma (2013) : Regional Effects of Monetary Policy in Sweden, Working Paper, No. 2012:9, Lund University, School of Economics and Management, Department of Economics, Lund

This Version is available at:

<https://hdl.handle.net/10419/260036>

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Department of Economics
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Regional Effects of Monetary Policy in Sweden

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April 2012
Revised March 2013



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Regional Effects of Monetary Policy in Sweden

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This version: March, 2013

Abstract

This paper investigates the effects on employment in 21 Swedish regions of a monetary policy shock using a VAR model with exogenous foreign variables for the 1993:1-2007:4 period. The regional impulse responses clearly indicate asymmetric effects in which employment falls significantly in some regions, while not changing significantly in others. These differences seem to stem from the interest and exchange rate channel, whereby regions with larger shares of employment in the goods sector and higher export intensity are adversely affected. In addition, there is one group of regions that, surprisingly, see increased employment in response to the same policy shock.

Keywords: Monetary transmission; Vector Autoregression (VAR); regional differences

JEL classification codes: C32; E52; F41

1 Introduction

What constitutes an optimal currency union geographically has been debated for decades. Shocks hitting a currency union can have drastic effects in some regions and small or no effects in others due to differences in economic and social infrastructure. Fundamentally, every nation is itself a currency union, in many cases comprising an eclectic mix of geographical entities forged into a nation state. This diverse regional mix has implications for economic policy. While fiscal policy can be tailored to suit the prevailing regional economic conditions, monetary policy is national by nature and its effects will depend on regional characteristics (see Domazlicky, 1980). This paper investigates the effect of

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a monetary policy shock on regional employment in Sweden and the causes of potential asymmetric effects.

Many studies examine the effects of a monetary policy shock in one nation or across nations but few studies assess the implications for regions within one country. Much can be learned by examining the effects of the transmission mechanism within one country since the research does not struggle with the same institutional differences as do cross-country studies such as those of the Euro Area/European Union.¹ A nation provides a more coherent legal, financial, and normative environment.

The vector autoregressive model, pioneered by Sims (1980), is a popular tool for assessing the monetary policy transmission mechanism. Using this approach at the regional level a number of studies find asymmetric responses to a contractionary monetary policy shock. Carlino and Defina (1999) find asymmetric effects on American state per capita income (see also Owyang and Wall, 2009) and Georgopoulos (2009) on Canadian provincial employment. In Europe, Arnold and Vrugt (2002, 2004) find differences in regional output in the Netherlands and Germany. There is also evidence from developing countries where Ridhwan et al. (2011) find asymmetric responses in regional output in Indonesia and Nachane et al. (2002) on Indian state domestic product.

This paper investigates the effect of a contractionary monetary policy shock on employment in the Swedish regions, *län*, 1993:1 to 2007:4. These regions are all subject to the same overarching regulatory and financial environment, and to the same central bank, *Riksbanken*, which imposes the same policy shock across all regions. It uses a VAR model with exogenous foreign variables and estimate impulse responses to assess the effect of a monetary policy shock on regional employment. The chosen time period is characterized by a coherent policy environment in which explicit inflation targeting has been the goal. Inflation targeting together with a switch from a fixed to a floating exchange rate in 1992, has given monetary policy a prominent role in Swedish economic policy-making, from 1993 onwards.

This paper complements the abovementioned studies of regional asymmetric effects in a number of ways. First, there are qualitative differences in the way the transmission mechanism works in a large and fairly closed economy, such as the US, and a small open economy, such as Sweden. In the latter case, foreign impulses and exchange rate effects play an important role (e.g. Kim and Roubini, 2000). Second, the studies on the Netherlands, Germany and India struggle with data issues. The use of annual data may cause timing issues in identifying the effect of monetary policy transmission, and it limits the number of observations.² Third, the number of official regions in Sweden is larger than the

¹For an overview of the problems facing the Euro Area countries see Peersman, 2004, for the legal environment see Cechetti, 1999.

²The data period in the Netherlands is 1973 to 1993, and in Germany 1970 to 2000 for the Western regions and 1992 to 2000 for the Eastern regions. In addition, the study of Dutch regions only tests for industrial composition differences and not other sources of regional differences (Arnold and Vrugt, 2002, 2004). The data period in the Indian study is

number of Canadian provinces allowing for a more systematic assessment of the transmission channels.

The results clearly show that monetary policy has asymmetric effects across the Swedish regions. In most regions, a contractionary policy shock leads, as expected, to a significant fall in employment. These regions tend to have a larger share of employment in the goods sector than the regions where the same policy shock has no significant employment effects. This finding lends support to the interest rate channel whereby changes in the policy interest rate affects interest-sensitive industry output. There is also some support for the exchange rate channel where regions that are adversely affected have higher export intensity. Furthermore, these regions are significantly more interest-sensitive in terms of both the interest and exchange rate and credit channels, the latter proxied by the share of small firms. The credit channel alone, however, fails to explain the differences in responses. Finally, there is a group of regions that, surprisingly, respond positively to the same policy shock, increasing employment when interest rates increase.

From a policy stand point, it is clearly insufficient to evaluate the effect of monetary policy on employment at the national aggregate level. That some regions are negatively affected and others not also underlines the need for better geographical matching processes in labor markets and higher labor mobility. Furthermore, fiscal policy can be better targeted to address the adverse regional effects of monetary policy when policy-makers recognize the different responses the regions experience. The results also shed some light on Euro Area policy-making. As regions respond differently within nations, maybe we should be less concerned with comparing differences in national aggregates in the EMU and more concerned with regions within the union, which may transcend national borders.

The paper is organized as follows. Section two discusses the transmission mechanism in a small open economy and the sources of differential effects. Section three discusses the VAR methodology, sample selection, identification of the structural VAR model, and sensitivity. Section four presents the empirical results and section five offers conclusions.

2 Sources of Regional Differences

The literature on monetary policy transmission effects outlines two key channels through which the policy interest rate affects the real economy: the interest and exchange rate channel and the credit channel (e.g. Bernanke and Gertler, 1995, Christiano et al., 1999). The interest and exchange rate channel affects household interest-sensitive consumption and the cost of capital for fixed investment and inventories. It also contains the effect of the policy interest rate on the exchange rate and therefore

1969 to 1999 (Nachane et al. 2002).

on net exports. The credit channel emphasizes the effects on the ability of firms and households to borrow and depends on the financial market structure. When factors that are affected by these channels, such as industry mix, export intensity and firm size, are distributed asymmetrically across regions, differences in regional responses can occur.

2.1 The Interest and Exchange Rate Channel

The interest rate channel emphasizes that some industries are more sensitive to interest rate changes than others and that, when regions have different industry mixes, an increase in the policy interest rate has a greater effect on the regions with a higher share of interest-sensitive industries. Industries that produce durable goods, investment goods, and other mainly loan-financed goods, and industries such as construction and other highly capital-intensive industries tend to be more interest rate sensitive because consumers can postpone spending on their products when interest rates increase (Carlino and DeFina, 1999, ECB, 2002).

This demand effect on interest-sensitive spending is the key channel in large and fairly closed economies such as the USA and the Euro Area. In small economies with a substantial degree of international trade, the main effects are likely to come from changes in the real exchange rate (see Angeloni et al. 2002). A contractionary policy shock appreciates the exchange rate which increases the cost of domestic goods and services relative to foreign ones and thus leads to a fall in net exports. The service sector, on the other hand, is less affected by the exchange rate effect, and it is also less interest-sensitive (ECB, 2002).

Previous regional studies confirm this role for interest-sensitive production, and to some extent exports. Specifically, Carlino and Defina (1999) find that manufacturing increases the effect of a monetary policy shock on the Gross State Product in the USA, and similar effects are found in India (Nachane et al., 2002). Georgepoulos (2009) finds that a monetary policy shock negatively affect employment in primary-based regions in Canada and, to a lesser degree in manufacturing-based regions. Much of the interest-sensitive production in the Canadian case is exported and is thereby influenced by the exchange rate while the primary-based industry is dependent on seasonal credit. Arnold and Vrugt (2002, 2004) find that the industry mix explains regional differences in output growth, or output volatility, in the Netherlands and Germany, and sectoral composition also explains differences in real output in Indonesian regions (Ridhwan et al., 2011).

Table 1 presents the regional data on employment in the goods and services sector and export intensity in Sweden. The region with the highest share of employment in the goods sector, and thus expected to respond more to monetary policy shocks, has 39 percent of the workforce employed in

this sector. The lowest share is 17 percent. In the services sector, the region with the lowest share of employment, and thus expected to be more interest-sensitive, employs 17 percent of the workforce. The highest share in services is 56 percent.³

Export intensity shows the share of export to turnover in the regions' firms. The region with the highest export intensity exports 59 percent of turnover compared to the region with the lowest export intensity which exports only 9 percent of turnover. A high export intensity should make a region more vulnerable to an appreciation of the exchange rate and therefore respond negatively to a hike in the policy interest rate.

Table 1: Regional industry mix and export intensity, averages (%)

	Goods	Services		Export Intensity
Jönköping	39.1	29.2	Gävleborg	58.6
Kalmar	38.9	26.5	Dalarna	43.6
Kronoberg	35.4	33.5	Västernorrland	41.3
Västmanland	34.1	33.8	Norrbottn	38.9
Blekinge	33.7	28.0	Västmanland	37.2
Gävleborg	33.1	30.4	Örebro	36.0
Södermanland	32.0	31.3	Västra Götaland	35.2
Östergötland	31.7	34.7	Kronoberg	34.7
Halland	31.6	34.9	Blekinge	34.5
Dalarna	31.0	30.7	Kalmar	33.0
Örebro	30.6	32.1	Södermanland	31.6
Värmland	29.6	30.9	Östergötland	31.0
Västra Götaland	29.4	38.6	Västerbotten	30.3
Gotland	29.3	31.0	Uppsala	30.1
Skåne	27.7	39.8	<i>NATIONWIDE</i>	<i>28.0</i>
<i>NATIONWIDE</i>	<i>26.9</i>	<i>39.6</i>	Värmland	27.8
Västernorrland	26.6	33.9	Jönköping	22.7
Västerbotten	26.4	29.3	Skåne	21.8
Norrbottn	25.0	29.5	Stockholm	20.8
Jämtland	24.9	33.7	Halland	15.5
Uppsala	23.2	33.3	Jämtland	9.8
Stockholm	16.5	55.8	Gotland	8.7
<i>Max</i>	<i>39.1</i>	<i>55.8</i>		<i>58.6</i>
<i>Min</i>	<i>16.5</i>	<i>26.5</i>		<i>9.8</i>
<i>Standard deviation</i>	<i>5.19</i>	<i>6.05</i>		<i>11.25</i>

Sources: Gross Regional Product, SCB. Firm exports and turnover, SCB FDB, 1997-2004. Classification according to SNI2002 in which goods production SNI 01-45 includes the primary sector, mining, manufacturing, electricity, gas, heating, and water suppliance, and construction, and services (SNI 50-95) includes hotel and tourism, education and research, consultancy, transportation, communication, and recruitment services.

2.2 The Credit Channel

The credit channel emphasizes the effect that interest rate increases have on the ability to borrow. Studies indicate that credit supply tends to fall after an increase in the policy interest rate and this squeeze in credit supply constrains firm and household ability to borrow (e.g. Bernanke and Blinder, 1992). The impact of such a supply squeeze depends on the available alternatives such as the possibility

³The regional data in Sweden does not disaggregate further into sectors within goods and services for the full time period of this study.

of issuing equity or borrowing in the bond market: large firms tend to have more such financing options available to them than do small firms (Kashyap and Stein, 1997). In addition, small firms tend to be riskier in terms of prospects and viability, so the cost of all types of financing alternatives available for them may be higher after a monetary policy shock (Gertler and Gilchrist, 1993, Oliner and Rudebusch, 1995). A proxy for the credit channel is thus the share of small firms.⁴

Ridhwan et al. (2011) and Nachane et al. (2002) find support for the credit channel but the regional studies of the USA, Germany, and Canada, however, find little evidence that small firms affect regional production or employment (Carlino and DeFina, 1999, Arnold and Vrugt, 2004, Georgepoulos, 2009). Most of the previous studies, however, measure small firms as the number of small firms in proportion to all firms. This is problematic, as a small firm may consist of fewer than 5, 20, 50, or 250 employees. For example, in the Canadian study, there is very little variation in this variable (94.5 to 97.3 percent) which make it difficult to capture any effect of monetary policy on either output or employment. When I compare the number of small firms as a proportion of all firms and the share of employment in small firms in the Swedish regions in Table 2 the differences are clear.

While the number of small firms only varies between 98.8 and 99.5 percent, there are large differences in terms of their share of employment. In the region with the highest share of small firm employment, and thus the region expected to react more to monetary policy shocks, almost 60 percent of the total number of employees in the region works in a small firm. In the region with the lowest share of employees in small firms, and thus the region expected to be less sensitive, small firms employ approximately 36 percent of the total number of employees.

3 Monetary Policy Shocks and the VAR Methodology

The VAR model in conjunction with impulse responses are commonly used tools for examining the monetary policy transmission mechanism (see Christiano et al. 1999). The VAR model lets each variable depend on its own previous values and the rest of the system's previous values so that feedback effects are captured within the system. Impulse responses trace out the paths of the system variables after an exogenous, unsystematic, and unanticipated monetary policy shock. The popularity of the VAR model is due to its flexibility and because it lets the researcher impose a minimum number of restrictions to separate the effects of these underlying, structural, shocks (Stock and Watson, 2001). The

⁴Another way of measuring the credit channel is by the share of small banks (see Carlino and DeFina (1999). A large percentage of small banks make the credit channel more sensitive to monetary policy (Kashyap and Stein, 1997). I do not measure this source as the Swedish banking market is highly concentrated among a few large banks; the top five banks cover 90 percent of total bank assets (see Cecchetti, 1999). In addition, there is not much evidence of this role in the Euro Area studies (see Angeloni et al., 2002.)

Table 2: Share of employment in small firms and number of firms, (%)

	Share of employment in small firms, average*	Share of number of small firms, 2006
Halland	59.0	99.3
Jämtland	57.7	99.3
Gotland	56.3	99.5
Jönköping	55.4	98.8
Kalmar	54.4	99.1
Kronoberg	54.0	99.1
Värmland	52.6	99.3
Skåne	51.6	99.1
Västernorrland	50.6	99.2
Västerbotten	49.4	99.3
Södermanland	48.7	99.2
Västmanland	48.6	99.0
Västra Götaland	48.6	99.1
Norrbottn	48.4	99.1
Blekinge	47.5	99.0
Uppsala	47.4	99.3
Dalarna	47.1	99.3
<i>NATIONWIDE</i>	45.5	99.1
Östergötland	44.2	99.0
Örebro	43.6	98.9
Gävleborg	43.5	99.2
Stockholm	35.9	98.8
<i>Max</i>	<i>59.0</i>	<i>99.5</i>
<i>Min</i>	<i>35.8</i>	<i>98.8</i>
<i>Standard deviation</i>	<i>5.42</i>	<i>0.18</i>

A small firm is defined as employing fewer than 200 employees.

Source: Företagarna (see Appendix 6.1). Small firms in the private sector and agriculture as a share of the total number of firms which is comprise of private sector firms, agricultural firms, the public sector, and public sector businesses (e.g. government-owned companies, local government, and government enterprises). *Years: 1995, 1997-2002, 2005-2007

VAR model, however, is sensitive to the choice of sample period, variable selection, and identification scheme, i.e. the choice of restrictions that determine how the economic variables are related.

3.1 Sample Period

The sample period for the Swedish regions spans from 1993:1 to 2007:4. This choice is appropriate given that Sweden experienced a major economic crisis in the early 1990s and adopted a floating exchange rate in 1992:4. Monetary policy thereby became the key steering policy instrument. Around the same time, Riksbanken declared an explicit inflation targeting policy. Thus, with this choice of sample period I avoid the crisis and estimating over different monetary policy regimes.⁵

The choice of sample period also affects the tools available for dealing with the time series properties of macroeconomic data, which typically contain unit roots. A longer time horizon allows any cointegration relationships to be explicitly incorporated into the model, as in the Canadian regional study by Georgopoulos (2009).⁶ However, even for short time periods the Indonesian study as well as a number of studies investigating the Euro Area use cointegration implicitly (Ridhwan et al. 2011,

⁵The regional employment data changes in 2008:1 when new age groups are included.

⁶Tests for cointegration for the aggregate variables have been run but the sample is too short to yield plausible results.

Peersman, 2004, Mojon and Peersman, 2001). Implicit cointegration means assuming the presence of cointegrating relationships by specifying the variables in levels but not testing for cointegration. Without testing, however, it is impossible to know whether or not the variables cointegrate, and even though including a correctly specified equilibrium error increases efficiency, an incorrectly specified equilibrium error will lead to incorrect inference.

Stationarity can also be achieved by removing the long-run trends by differencing, such as in the American and Indian regional studies (Nachane et al., 2002, Carlino and Defina, 1999), or using filters. First differencing, however, tends to aggravate high-frequency noise in the data (Stock and Watson, 1999). In the present paper, I remove the long-run information using the Hodrick-Prescott (HP) filter, a widely used filter that allows trends in the data to be non-linear and that does not suffer as much from the high frequency problem (Stock and Watson, 1999). It is an appropriate choice given the non-linearities in the regional employment trends (see Figure 5 in Appendix 6.2).⁷ In the robustness section, I compare the impulse responses from the HP-filtered data to the impulse responses from implicit cointegration and first differencing.

3.2 Information Set

The information set of the VAR model aims to capture the expected interactions within the economy. For this purpose I define a 5×1 vector of endogenous macroeconomic variables,

$$Y_t = [y_t, \Delta p_t, i_t, ex_t, e_t] \quad (1)$$

where y_t is the real domestic GDP at time t , Δp_t is the inflation rate, i_t the domestic interbank interest rate, ex_t the real exchange rate, and e_t the regional employment.^{8,9} The VAR system also includes as exogenous variables p^*_t , world commodity prices, including both fuel and non-fuel prices, and i^*_t , foreign short-term interbank interest rate. All variables are seasonally adjusted, logged (except for interest rates), and HP-filtered. Figure 4 in Appendix 6.2 presents graphs for the aggregate series.

This variable selection reflects the set-up used in previous small open economy studies in which exchange rates and foreign influences affect the economy (e.g. Bjørnland, 2008, Georgopoulos, 2009). As I do not expect a small country to have significant feedback effects on the foreign variables, the

⁷There is a debate on the properties of the HP-filter, and some have questioned whether the filter produces reliable results (e.g. Cogley and Nason, 1995). However, this claim has also been refuted (see Pedregal and Young, 2001), and the HP-filter remains popular.

⁸Appendix 6.1 contains detailed information on the variables.

⁹The use of the price series instead of the inflation rate introduced an output puzzle in which output increased as a result of increased interest rates. Given that Riksbanken targets the inflation rate, but not the price level, it is plausible to use the interaction between interest rates, inflation, and output.

foreign variables are assumed to be exogenous. This assumption makes sense as the Swedish GDP is approximately 3.5 percent the size of the Euro Area GDP. In addition, by imposing exogeneity on these foreign variables, I restrict the number of parameters to estimate thereby saving degrees of freedom.

The monetary policy variable is the interbank interest rate. First, Riksbanken uses the repo interest rate as its key policy instrument to control short-term interest rates, which is why the interest rate rather than monetary aggregates is a more suitable variable for monetary policy.¹⁰ Second, markets may adjust their interest rates in anticipation of changes in the repo rate (Gerlach and Smets, 1995). For example, when the policy interest rate is expected to rise, the market interest rates may adjust in advance of the change in the repo rate. Therefore, the interbank rate takes into account market expectations.

The set of variables also includes two exogenous variables. The foreign interest rate is included to control for changes in domestic monetary policy due to foreign monetary policy shocks. World commodity prices are included to control for inflationary pressure due to negative supply shocks and forward-looking central bank behavior. For example, when the central bank expects inflation to rise it will raise the policy interest rate to curb the increasing inflation. This forward-looking behavior, if not accounted for, can otherwise generate a price puzzle, i.e. that inflation increases after a monetary policy tightening (Sims, 1992). As a consequence, many studies include the current and lagged values of this variable (see Christiano et al. 1999).

3.3 The Structural VAR Model

Given the information set in Equation 1 I define the structural VAR model using both endogenous and exogenous variables.

$$AY_t = B(L)Y_{t-1} + C(L)X_t + \epsilon_t \quad (2)$$

Equation 2 shows that the contemporaneous effects of the endogenous variables, in my case the domestic and regional variables, are found in the $k \times k$ matrix A . The lagged periods' effects are found in $B(L)$, a $k \times k$ matrix where $B(L) := B_0 + B_1L + \dots + B_pL^p$ and p is the number of lags of the endogenous variables in the model.

$C(L)$ is a coefficient matrix of the exogenous variables, including deterministics, of order $k \times q$ depending on the number of exogenous variables, q , which in my specification is two. $C(L) := C_0 + C_1L + \dots + C_sL^s$ where s is the number of lags of the exogenous variables. ϵ_t is a $k \times 1$ vector of

¹⁰Monetary aggregates also tend to incorporate other shocks, such as demand shocks or financial deregulation (Gerlach and Smets, 1995).

uncorrelated structural errors with unit variances.

I can define one structural shock per endogenous variable and since $k = 5$ in the baseline specification I define the vector of structural shocks in the baseline specification as

$$\epsilon_t = [\epsilon_t^y, \epsilon_t^{\Delta p}, \epsilon_t^{MP}, \epsilon_t^{ex}, \epsilon_t^e] \quad (3)$$

where ϵ_t^y is a domestic output shock, $\epsilon_t^{\Delta p}$ a domestic inflation shock, ϵ_t^{MP} a monetary policy shock, ϵ_t^{ex} a exchange rate shock, and ϵ_t^e a regional employment shock.¹¹ Since the monetary policy shock is the focus, I define the rest of the structural errors only loosely as is common in previous studies (e.g. Bjørnland, 2009).

The identification issue in the structural VAR-modeling for short-run restrictions refers to how to impose the restrictions on the contemporaneous effect matrix for the endogenous variables. I can rewrite equation 2 in the reduced form by premultiplying with the inverse of the contemporaneous coefficient matrix, $S := A^{-1}$

$$Y_t = D(L)Y_{t-1} + E(L)X_t + u_t \quad (4)$$

where $D(L) := SB(L)$, $E(L) := SC(L)$ and $S\epsilon_t := u_t$. The last term shows that the reduced form errors, u_t , are linear combinations of the structural errors, $Au_t = \epsilon_t$. Thus, I can estimate equation 4, solve it for the endogenous variables and calculate impulse responses due to a shock in one of the structural errors provided that we have imposed enough restrictions on A .¹² Rewrite the reduced form equation 4

$$F(L)Y_t = E(L)X_t + u_t \quad (5)$$

where $F(L) := I_5 - D_1L - \dots - D_pL^p$. Let $F(L)^{-1} := G(L)$ so that the final form is given by

$$Y_t = G(L)E(L)X_t + G(L)S\epsilon_t \quad (6)$$

Since X_t is exogenous, it will not be affected by shocks to the structural errors so I can focus on identifying the short-run dynamics of the endogenous variables. Given my choice of Y_t I set up the

¹¹In the robustness section, I allow for spill-overs from nearby regions in the information set so that $k = 6$ and we have an additional structural error ϵ_t^{ecomp} that is a regional spill-over shock.

¹²There is also the possibility of imposing long-run restrictions on the coefficient matrix for the endogenous variables but here I focus on the short-run since they yield plausible results in the ensuing analysis.

system with the short-run restrictions as follows

$$\begin{bmatrix} y_t \\ \Delta p_t \\ i_t \\ ex_t \\ e_t \end{bmatrix} = G(L) \begin{bmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 \\ 0 & 0 & 0 & 0 & S_{55} \end{bmatrix} \begin{bmatrix} \epsilon_t^y \\ \epsilon_t^{\Delta p} \\ \epsilon_t^{MP} \\ \epsilon_t^{ex} \\ \epsilon_t^e \end{bmatrix} \quad (7)$$

This identification scheme structures the economy in the following way. As advocated by e.g. Bernanke and Blinder (1992), aggregate output and inflation do not respond contemporaneously to monetary policy shocks but monetary policy does respond contemporaneously to shocks in output and in inflation. These restrictions represent the sluggish response of prices and output compared with the responses of financial variables. Since I will impose a shock in the monetary policy error, which is ordered below aggregate output and inflation, the ordering between output and inflation does not matter for the responses to the monetary policy shock. This follows from a generalization of Proposition 4.1 by Christiano et al. (1999 p. 82) (see Bjørnland, 2008).

Monetary policy does not react to the exchange rate within the same period. Instead the exchange rate reacts to monetary policy within the same period and to all other aggregate variables. Allowing the exchange rate to respond to all other aggregate variables is appropriate since it is a forward-looking asset price (e.g. Cushman and Zha, 1997, Kim and Roubini, 2000). However, the assumption that monetary policy does not respond contemporaneously to the exchange rate is not trivial since disregarding possible simultaneous effects between the exchange rate and monetary policy could result in either a price puzzle or that the exchange rate depreciates when the policy interest rate increases, i.e. an exchange rate puzzle (e.g Bjørnland, 2008, 2009). However, the restriction that the exchange rate does not affect monetary policy within the same period is not uncommon in the VAR open-economy literature (e.g. Peersman, 2004, Georgepoulos, 2009). In addition, it is plausible that Sweden, since adopting a flexible exchange rate, does not, at least explicitly, control the value of the krona, and therefore the effect of an exchange rate movement should not feed into the policy interest rate within the same quarter.¹³

The final restriction in the S matrix tells us that regional employment is not affected by monetary policy within the same quarter, nor does it affect the aggregate variables within the same quarter. That monetary policy does not contemporaneously affect regional employment follows the same logic

¹³To allow both the monetary policy and exchange rate to respond to each other simultaneously, one can impose a long-run restriction, so that monetary policy have no long-run effects on the exchange rate (see Bjørnland, 2008). This approach is not used here as the short-run restrictions do not suffer from the price or exchange rate puzzle.

as in the case of aggregate output. This restriction is similar to that of Carlino and DeFina (1999), who do not allow for a contemporaneous interaction between the regional variables and the aggregate variables, including monetary policy.

3.4 Sensitivity and Expected Responses in the Aggregate Economy

As the VAR model does suffer from sensitivity due to the sample period, variable selection, and identification scheme, VAR practitioners often evaluate the model outcome in terms of the absence of a number of puzzles. This means that the empirical results do not lead to unexplainable or contradictory outcomes, such as the price puzzle.

In the standard Mundell-Fleming-Dornbusch model and many of the more recent small-open economy theoretical frameworks with price stickiness, the interest rate works through both the interest rate and the exchange rate channels (see e.g. Lane, 2001, and Corsetti, 2007 for summaries of New Open Economy Macroeconomics models).¹⁴

Typically, contractionary monetary policy increases market interest rates and causes an inflow of capital to the country from abroad, causing the home currency exchange rate to appreciate. This appreciation increases the cost of domestic goods and services relative to foreign ones, causing net exports to fall. Simultaneously, higher interest rates reduce consumption and make borrowing more expensive so that demand for interest-sensitive consumption and investment falls. The two effects cause aggregate demand and thus aggregate output to fall. The fall in aggregate output exerts a downward pressure on prices, and inflation falls. In sum, a contractionary monetary policy shock affects the exchange rate directly but tends to affect output and inflation with some delay.

In general, VAR results on a contractionary monetary policy shock indicate that aggregate output tends to fall, as do employment, profits, and other monetary aggregates. The price level also falls but much slower (Christiano et al. 1999). Studies of small open economies find that the exchange rate overshoots, i.e. it appreciates and then gradually returns to its initial value (e.g Kim and Roubini. 2000). Thus, given that the impulse responses conform to these general results and that there are no puzzles, I assume that the model behaves well and that the identification scheme captures the economy's dynamics following an exogenous contractionary monetary policy shock.

¹⁴The effects in the new frameworks with micro foundations depend, however, on the assumptions on preferences, the form of nominal stickiness, and the financial structure.

4 Empirical Results

This section presents the empirical results, starting with the specification of the aggregate model and the 21 regional ones. It then presents the responses of the aggregate economy to a monetary policy shock, continuing with the responses of regional employment. The regional responses clearly show that there are asymmetric effects and I investigate if differences in industry mix, export intensity, and small firms explain why they differ. To assess the sensitivity of the results, the robustness section tests alternative specifications.

4.1 Specification

ADF tests of the 21 regional employment series in levels indicate that a unit root is present in all but five series that are trend-stationary and one that seems to be stationary with a constant. The aggregate data series in levels also contain unit roots, except for inflation. Once I detrend all the series using the HP-filter, the ADF tests reject the presence of a unit root (see Table 5 in Appendix 6.2).

The lag length in all specifications varies between one and three. The choice of lags is based primarily on the LR-test and secondarily on the SC and HQ information criteria. Fixed lag lengths of one and two have been run for all the specifications as well. There is little difference between them, though for some regions, too short a lag length clearly fails to account for the actual dynamics of those regions. At the same time, a longer lag length than necessary means that I may lose precision in the forecasts (Lütkepohl, 2005). I present the results for a fixed lag length of two in the robustness section. The two exogenous variables, $i*_t$ and $p*_t$ are only significant for one lag, so I include the contemporaneous effect and the first lag in all specifications.

A number of impulse dummies that take the value of 1 for a quarter and 0 otherwise account for outliers: 1994:3, 1995:2, 1996:2, 1997:3, 1999:1, 2000:2, and 2003:1. These were chosen sequentially by adding a dummy for the largest outlier, re-estimating the system, running diagnostic tests, and removing the next largest outlier if necessary.¹⁵ In the robustness section I run all the specifications without including these dummies. Without them, there is a small price puzzle and an initial depreciation of the exchange rate when the interest rate increases, but the general results of the regional impulse responses for employment remain intact. I also account for some outliers at the regional level when necessary in the individual specifications.¹⁶ Except for the dummy in 2005:2, when there is a time series break due to a change in the definition of the employment data, it is more difficult to pinpoint the cause of the

¹⁵In economic terms, these dummies pick up the noise from the aftermath of the early 1990s economic crisis at the beginning of the sample, the IT crash in 2000, and what seems to be a cost shock in 2003.

¹⁶There is one regional dummy each in ten of the 21 specifications, and two regional dummies each in three of them.

dummies at this level, as they can be affected by much smaller changes. However, these dummies do not appear to affect the responses, only the error bands.

With these specifications there is no instability (i.e. no roots outside the unit circle), no heteroscedasticity, and no non-normality. There is no autocorrelation in most of the models though five of the 21 regional models retain some autocorrelation in the third or fourth lag. Table 6 in Appendix 6.2 summarizes the tests.¹⁷

4.2 Aggregate Economy Responses

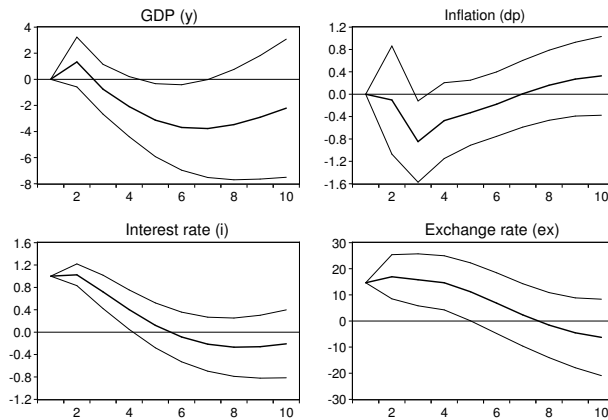


Figure 1: Response of aggregate economy to a 100-basis-point monetary policy shock

Figure 1 shows the impulse responses to a monetary policy shock of 100 basis points at the aggregate level for ten quarters.¹⁸ The upper and lower lines around the thick solid response line are the 90 percent error bands.¹⁹ The y-axes measure deviations from the trend, in percent for output, inflation, the exchange rate, and employment, and percentage points for the interest rate.

The graphs reveal that, as the interest rate initially increases, the exchange rate overshoots, peaking in period 2, after which it begins to depreciate toward its initial value. Inflation falls, but the fall is not significant until after around three quarters. Output increases initially but insignificantly. The increase in output seems to occur with the second lag and is not present when the lag length is one. After about a year, output falls significantly and then starts to return to its initial level. Thus, the model specification and information set seem to capture the sluggish response of inflation and output

¹⁷Further diagnostic tests are available from the author upon request.

¹⁸A longer time horizon added very little information and due to increased uncertainty over the longer time frame, the error bands quickly grew very large.

¹⁹90 percent error bands using Monte Carlo simulations with 2500 replications.

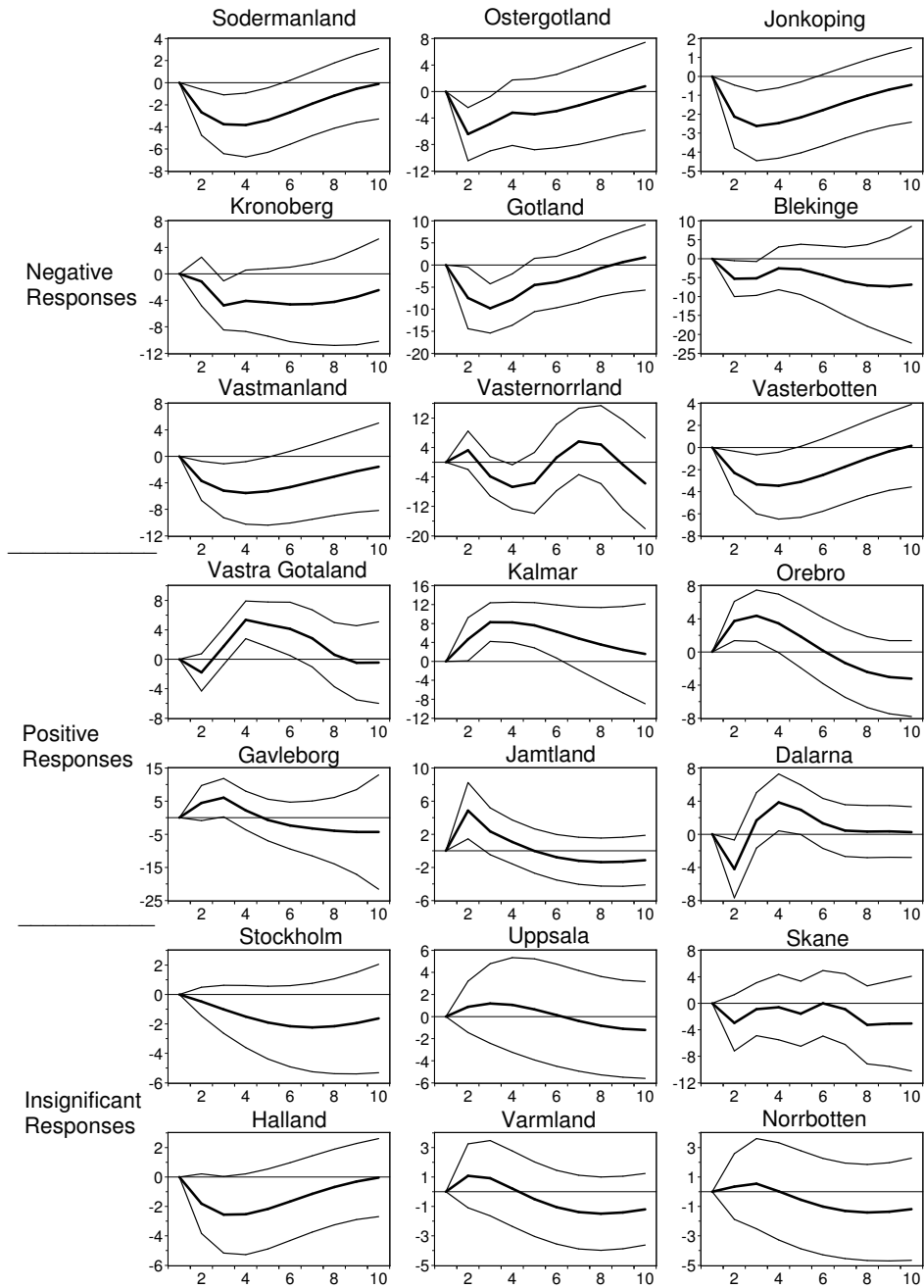


Figure 2: Regional employment responses to a 100-basis-point monetary policy shock

as well as the overshooting of the real exchange rate.²⁰

These results are very satisfactory, as they concur with the theoretical predictions and with the outcomes of other open-economy studies (e.g. Kim and Roubini, 2000). Given this, I have some evidence that I have identified exogenous monetary policy shocks in this system and that the underlying model works. Furthermore, these aggregate results hold for all regional specifications, though with some initial noise in the regional systems that have three lags. However, this is not surprising due to the number of parameters to estimate in the case of three lags.

4.3 Asymmetric Regional Responses

Figure 2 shows the employment responses in the regions due to a 100-basis-points monetary policy shock. The regions clearly experience asymmetric effects. While employment, as expected, falls significantly in response to a contractionary monetary policy shock in nine of the 21 regions, five regions experience a significant increase in employment and one experience a significant cyclical pattern with an effect that seems mainly positive.²¹ In the remaining six regions, the employment responses to the monetary contraction are not significant.

Table 3: Estimated effect of a 100-basis-point monetary policy shock

	Max (%)	Average(%)	Cumulative (%)	Max period	Duration
Gotland	-9.83	-8.37	-25.11	3	3
Västernorrland	-6.70	-6.70	-6.70	4	1
Östergötland	-6.44	-5.66	-11.31	2	2
Västmanland	-5.53	-4.92	-19.69	4	4
Blekinge	-5.28	-5.25	-10.50	2	2
Kronoberg	-4.77	-4.77	-4.77	3	1
Södermanland	-3.84	-3.42	-13.68	3	4
Västerbotten	-3.46	-3.03	-9.09	4	3
Jönköping	-2.62	-2.34	-9.38	3	4
Dalarna	3.85 (-4.19)	3.85 (-0.17)	3.85 (-0.34)	4 (2)	1 (2)
Örebro	4.36	4.04	4.04	3	2
Jämtland	4.85	4.85	4.85	2	1
Västra Götaland	5.36	4.74	14.22	4	3
Gävleborg	6.04	6.04	6.04	3	1
Kalmar	8.29	7.02	35.12	3	5

Only periods when the response is significant are included. Cumulative effect is the cumulative impact of the deviation of employment from trend which is the sum of the response over the significant duration.

*Dalarna is classified as a positive response. The effect when the initial negative effect is included is indicated within parentheses.

When I evaluate the significant periods only, the responses also differ in terms of magnitude, timing, and duration (see Table 3). The maximum effect ranges from -9.8 percent to +8.3 percent, occurring

²⁰Villani and Warne (2003) find similar effects and durations using a bayesian cointegrated structural VAR on quarterly Swedish data 1975:1 to 2001:4. Similar results are also obtained by Lindé et al. (2009) using a VAR model on quarterly Swedish data 1986:1 to 2002:4.

²¹The initial negative effect seems to be sensitive (see robustness section), and the accumulated response of Dalarna show that with a sustained monetary policy shock the positive response over the long horizon remains. Thus I classify this region as positive in the remainder of the analysis.

between the second and the fourth quarter after the shock. The average effects over the significant periods range from -8.7 to +7.02 percent and the effects last one to five quarters. Furthermore, the cumulative effect, calculated as the sum of the responses over the significant periods, is sizeable.

Even though the size of the effects depends on the size of the monetary policy shock, which in my case is fairly large, the magnitude of the response to the shock clearly differs among regions. Overall, when Riksbanken unexpectedly contracts the economy, employment in the Swedish regions responds very differently, in terms of direction, magnitude, timing, and persistence.

It is also of interest to evaluate how the effects are distributed geographically. Figure 3 reveals that most of the the positive responses occur along the western side of the country near the Norwegian border while most of the negative responses follow the eastern coast. Despite this, there appears to be no clear-cut geographic pattern in how the regions respond.



Figure 3: Geographic overview of regional responses

4.4 Causes of Asymmetric Regional Responses

Inspection of the responses and the sources of monetary transmission channels presented in section 2 reveals no salient pattern explaining the differences in responses. To estimate what causes the asym-

metric effects, I divide the regions into three groups, as in Figure 2. The negative responses are those that experience a fall in employment, the positive experience an increase, and the insignificant do not experience a significant change in employment.

For the negative and insignificant responses, I test for differences in the distribution of the share of employment in the goods sector and services sector, export intensity, and two subjective rankings of interest rate sensitivity. For the positive, I do not test these differences as I have no clear priors in terms of the chosen factors why they should cause an increase in employment.

The first of the two subjective rankings that I test is the *Equal rank*, which is simply the average of the rank order of the region when sorted according to highest interest sensitivity in terms of largest goods sector, highest export intensity, and largest share of small firms. In this ranking, 1 is the highest rank and 21 is the lowest rank. The second ranking is the *Weighted rank*, which adds extra weight to export intensity, as I expect the exchange rate channel to be strong in Sweden and as the response of the exchange rate to a monetary contraction is highly significant.²²

Table 4 shows that the regions that respond negatively compared with those that have insignificant responses all have averages that are as theoretically expected. The regions that respond negatively tend to have, on average, a higher share of employment in the goods sector, a smaller share in services, more export intensity, and a larger share of small firms. They also rank higher in terms of both compounded measures of interest sensitivity.

Statistical tests confirm that the difference between the two groups is highly significant for the goods sector and the two rankings. This means that, also for Sweden, there is evidence that different share of interest-sensitive industry causes asymmetric responses. Furthermore, a region that responds negatively tends to rank as more interest sensitive, having a larger share of employment in the goods sector, higher export intensity, and more small firms. Individually, export intensity is weakly significant. Thus, there is some evidence that the exchange rate channel also matters for a highly export-dependent country such as Sweden. The small firm proxy on its own, however, is not significant. Thus, as in most previous regional studies, I find little support for the credit channel.

Table 4 also shows that there are no noteworthy differences between the negative and the positive group, except for higher export intensity. Both the American and Canadian studies find similar positive short-run responses though these are not significant for the Canadian provinces and effects disappear in the US states in the long-run. While one can expect insignificant responses for the regions with low shares of small firms, low export intensity, and small goods sectors, it is more difficult to explain the positive responses. One possibility is that the regions are net importers, so that the resulting

²²The weight is 0.4 as the average share of aggregate export to GDP was 40 percent during the sample period.

Table 4: Regional responses and sources of asymmetric effects, averages

	Insignificant n=6	Negative n=9	Positive n=6	Critical Value (U-value) column (2) vs. column (3)
Small firms	49.15 (7.69)	50.53 (4.00)	49.12 (5.80)	0.314
Goods	25.60 (5.42)	32.03 (4.17)	31.32 (4.61)	3.306***
Services	37.35 (9.71)	31.62 (2.45)	32.01 (4.00)	-1.295
Export intensity	25.81 (8.28)	30.22 (9.57)	36.01 (15.89)	1.392*
Equal rank	13.83 (3.83)	9.67 (2.78)	10.17 (2.76)	-2.478**
Weighted rank	13.90 (3.58)	9.79 (2.80)	9.91 (2.84)	-2.882**

Standard errors in parentheses. ***, **, and * denote significance at 1, 5, and 10 percent level. U-value from robust rank order test, which is a non-parametric test that does not assume equal variances. Critical values for small samples are obtained from Feltovich (2005). The tests are one-sided as I expect small firm, goods, and export intensity to be lower, and services and ranks to be higher higher in the negatively significant group than in the insignificant group. T-tests of unequal averages with unequal variances using Welch approximation for degrees of freedom yield the same results but fails to find significance for export intensity.

appreciation caused by the policy rate increase lowers the cost of production and therefore increases employment. However, there is no suitable regional data to test this conjecture. Nonetheless, when I compare averages in the regional share of employment in the production sectors where the nation as a whole are net importers, for available years, the average is higher in the positively responding regions compared to the insignificant (3.78 and 2.85 respectively). However, this difference is not significant.²³

4.5 Robustness

To assess the robustness of the results I compare the above baseline regional specifications with a number of alternative specifications, namely inclusion of spill-over effects, no dummies, fixed lag length, and a shorter sample. To assess the effect of HP-filtering on the results, I compare the baseline specifications with impulse responses using implicit cointegration and first differencing.

In the first alternative specification, I remove all dummies, aggregate and regional, and run all models using the same lag length as in the baseline. In the second specification, I include the average of the nearby regions' share of employment in the baseline specification to account for spill-over effects from other regions. As the regions differ in size, the number of employed is divided by the size of the region's workforce. As the companion regions introduce new dynamics, I allow the lag length and

²³I have also compared averages between positively responding regions and insignificantly responding regions in public sector employment, and import turnover according to firm size for those regions where there is data, but there is little difference.

regional dummies to differ from the baseline. Furthermore, since the nearby regions' employment is also a real variable, I do not allow this variable to respond contemporaneously to the aggregate variables or to the regional variable. Instead, any spill-over effects will show up in the lag structure. The same restriction is imposed by Carlino and DeFina (1999) for the US economy to deal with potential spatial autocorrelation between regions.

The third specification uses a shorter sample beginning in 1997:1 thereby removing the years following the early 1990s economic crisis. In this specification, I allow for a different lag length, as in most cases one lag is now sufficient and the system quickly becomes unstable with more. The largest aggregate dummy in 2003:1 and a few regional dummies are also included. Finally, I impose a fixed lag length for all regions in the baseline specification. The choice of two lags comes from the aggregate baseline, which has two lags where, in particular, the Swedish interest rate reacts in the second lag.

Using these alternative specifications, it is clear that the responses differ little from the baseline in terms of direction, whether negative, insignificant or positive. However, the timing, duration, and to some extent, the magnitude do differ. This is not surprising, as I allow for different dynamics in the lag specification when necessary. Figures 6 to 7 in Appendix 6.2 show the four alternative specifications for the regional employment versus the baseline.

To assess the effect of HP-filtering the data, I run two alternative specifications where in one I use the data in levels, to allow for implicit cointegration, and in the other I use first differencing to remove non-stationarity. To make it more comparable, I use the same specification in terms of lags and dummies as for the baseline and only change the transformation of the data series.²⁴ In general, the direction of the responses remain the same and implicit cointegration and the HP-filter corresponds well. However, first differencing yields more noisy and short-lived responses, implying that first differencing may remove too much information and does not deal well with the non-linearities in the data. Figures 8 to 9 in Appendix 6.2 show the implicit cointegration and first differencing specifications for the regional employment versus the HP-filtered baseline.

To assess the robustness of the aggregate results, I run one specification without dummies and one with a shorter sample length for the HP-filtered baseline. I also run one specification with implicit cointegration and one with first differencing. When I remove the dummies, there is a small price puzzle and the exchange rate initially depreciates somewhat. This initial noise is probably due to a combination of increasing interest rates to curb inflation in the early 1990s, following the crisis, and a large depreciation of the exchange rate that followed the floatation of the exchange rate in 1992. The short sample length is similar to the baseline and shows that the dummies seem successful in removing

²⁴I have also run specifications using the preferred lag length and dummies with similar results.

the noise after the crisis.

The choice of data transformation for the aggregate series yield the same results as the baseline but with more noise in the first differencing and a more short-lived effect. Figure 10 in Appendix 6.2 shows the robustness results for the aggregate model.

5 Conclusions

Studies of regional responses to common monetary policy shocks analyze whether there are asymmetric effects across geographical entities. This paper uses a structural VAR model with exogenous foreign variables and finds that monetary policy has asymmetric effects on employment in the Swedish regions. For most regions, an increase in the interest rate causes a significant fall in regional employment. For another group of regions, the employment response is insignificant. Similar to other studies on the transmission mechanism, one of the causes of these differential effects seem to stem from the interest rate channel and emphasizes the role of interest-sensitive output. There is also some evidence that the exchange rate channel matters for a small open economy, such as Sweden. In addition, one group of regions, surprisingly, responds positively to the same policy shock by increasing employment when interest rates increase.

These results have a number of policy implications. First, they show that it is clearly insufficient to evaluate the effect of monetary policy at the aggregate level if policy-makers wish to target aversive effects on employment with fiscal policy. In addition, better geographical labor market matching processes and higher labor mobility smooths the asymmetric outcomes in regional employment when Riksbanken contracts the economy. Second, for Euro Area-policy making, they imply that we may need divert attention from the national level to the regional to understand how to efficiently use economic policy to ease aversive effects of ECB shocks.

Above all, as monetary policy have different effects across regions within a country and as most studies have focused on the national level, there is a need to disaggregate studies of monetary policy, particularly within cross-country currency unions, to the regional level to better understand the transmission channel effects on regional economies.

Acknowledgments

I am grateful to Fredrik NG Andersson, David Edgerton, Klas Fregert, Pontus Hansson, Håkan Holm, Lisbeth La Cour, and participants in the macro seminar group at Lund University. Thanks to Vinnova,

Olof Ejermo and Karin Bergman for data on exports.

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6 Appendix

6.1 Data Appendix

In the following, i is the average Swedish three-month interbank rate (Riksbanken); i^* is the average German three-month interbank rate until 1998 and thereafter the Euro Area average three-month interbank rate (Datastream); ex is the seasonally adjusted real effective exchange rate (CPI-based) (IMF), where an increase means that the real exchange rate appreciates; y is the seasonally adjusted Swedish real GDP in factor prices (Statistics Sweden); dp is the Swedish average quarterly inflation rate (Statistics Sweden) where the CPI series is first seasonally adjusted using an X11-filter and logged before differencing; and p^* is the prices of fuel and non-fuel commodities (IMF).

Regional employment is the number of employed in a region (AKU, Statistics Sweden) and seasonally adjusted using an X11-filter. In the employment data there is a time series break in 2005:2 due to EU harmonization but the break mainly affects unemployment data and not employment data (Statistics Sweden). Graphically, there is no obvious break in the data series and no statistical evidence of the break in most regions. Further breaks occur due to a switch of borders in two regions, but the breaks are not statistically significant.

All variables are expressed in logs and multiplied by 100, except for the nominal interest rates, which are divided by 4 to make them quarterly comparable. The variables are then detrended using the HP-filter ($\lambda = 1600$).

The data on small firms come from Företagarna (1996, 1998, 1999, 2002, 2006, 2007, 2008), and the data on export intensity from Statistics Sweden's database on Swedish firms (FDB, 1997-2004).

6.2 Tables and figures

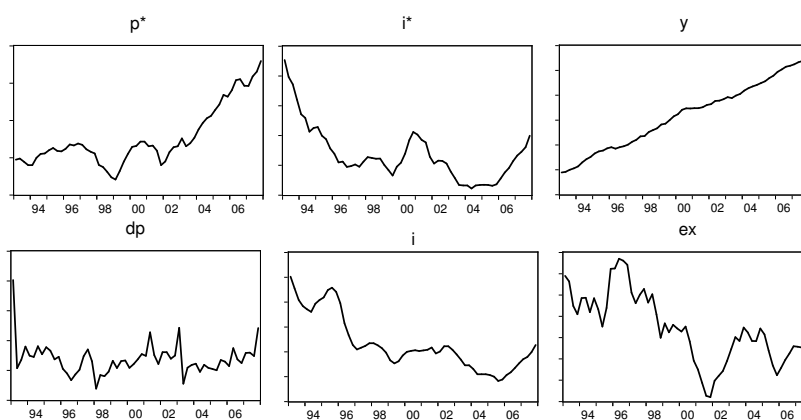


Figure 4: Aggregate data, in logs

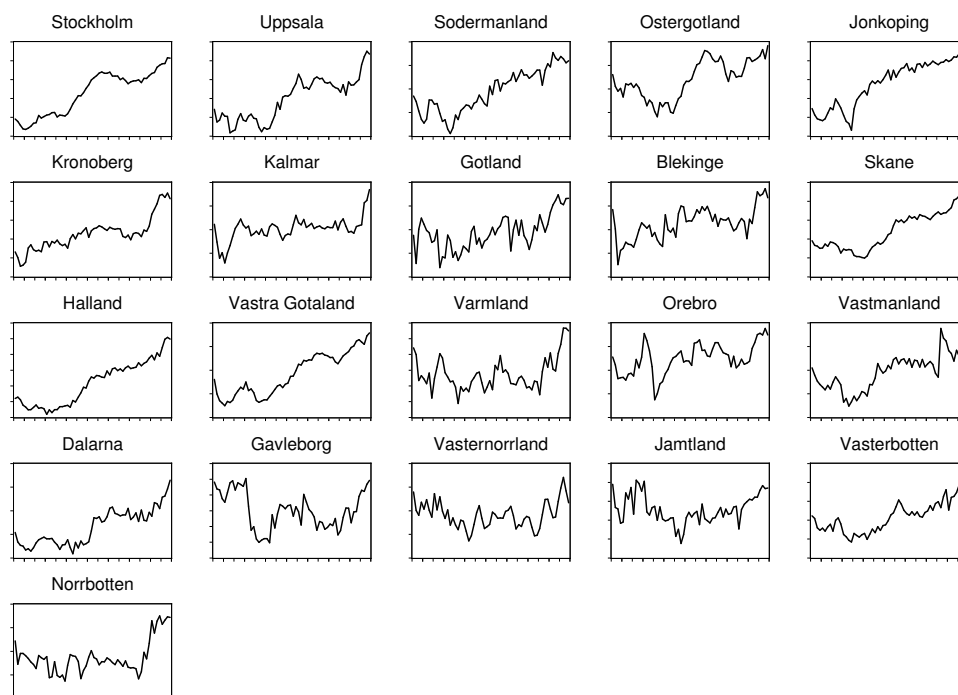


Figure 5: Regional employment, seasonally adjusted, in logs

Table 5: Unit root tests, logs, seasonally adjusted, p-values

AGGREGATE	ADF-test, level			ADF-test, HP-filtered
	Trend+constant	Constant	No deterministic	No deterministic
y	0.58	0.81	1.00	0.015**
dp		0.00***	0.00***	0.000***
i	0.48	0.28	0.28	0.000***
ex	0.39	0.27	0.49	0.000***
j*	0.77	0.09*	0.25	0.022**
p*	0.95	0.99	0.97	0.000***
REGIONAL				
Stockholm	0.26	0.53	1.00	0.025**
Uppsala	0.29	0.93	0.93	0.003***
Södermanland	0.01**			0.000***
Östergötland	0.40	0.84	0.84	0.007***
Jönköping	0.20	0.80	0.95	0.000***
Kronoberg	0.58	0.91	0.96	0.000***
Kalmar	0.33	0.70	0.85	0.000***
Gotland	0.01***			0.000***
Blekinge	0.00***			0.000***
Skåne	0.69	1.00	0.99	0.022**
Halland	0.23	1.00	1.00	0.001***
Västra Götaland	0.02**			0.000***
Värmland	0.15	0.16	0.74	0.000***
Örebro	0.14	0.24	0.77	0.000***
Västmanland	0.07*	0.23	0.65	0.000***
Dalarna	0.29	0.96	0.93	0.000***
Gävleborg	0.61	0.19	0.68	0.002***
Västernorrland	0.94	0.66	0.80	0.013**
Jämtland	0.51	0.01***		0.000***
Västerbotten	0.16	0.88	0.88	0.000***
Norrbottn	0.91	0.94	0.87	0.005***

***, **, and * denote significance at 1, 5, and 10 percent levels.

Table 6: Misspecification tests, p-values

AGGREGATE	Lag length	No serial correlation	Multivariate normality	No hetero-
		LM test at lag 1; 2; 3; 4	Doornik-Hansen	skedasticity
AGGREGATE	2	0.29; 0.75; 0.29; 0.68	0.96	0.62
Stockholm	1	0.58; 0.62; 0.15; 0.47	0.78	0.98
Uppsala	1	0.58; 0.89; 0.13; 0.71	0.74	0.63
Södermanland	1	0.44; 0.64; 0.073; 0.79	0.81	0.95
Östergötland	2	0.20; 0.98; 0.74; 0.92	0.98	0.74
Jönköping	1	0.47; 0.72; 0.28; 0.79	0.63	0.97
Kronoberg	2	0.75; 0.17; 0.38; 0.51	0.91	0.72
Kalmar	2	0.31; 0.87; 0.04**; 0.05**	0.89	0.93
Gotland	2	0.16; 0.49; 0.51; 0.80	0.38	0.92
Blekinge	2	0.25; 0.29; 0.50; 0.14	0.81	0.93
Skåne	3	0.44; 0.51; 0.57; 0.71	0.82	0.53
Halland	1	0.48; 0.29; 0.18; 0.16	0.86	0.74
Västra Götaland	3	0.52; 0.95; 0.58; 0.25	0.47	0.49
Värmland	1	0.45; 0.53; 0.12; 0.51	0.87	0.86
Örebro	1	0.58; 0.73; 0.11; 0.02**	0.15	0.98
Västmanland	1	0.16; 0.61; 0.15; 0.28	0.74	0.98
Dalarna	2	0.32; 0.81; 0.54; 0.59	0.29	0.73
Gävleborg	2	0.18; 0.42; 0.12; 0.74	(0.95)	0.61
Västernorrland	3	0.16; 0.69; 0.58; 0.71	0.91	0.63
Jämtland	1	0.44; 0.35; 0.31; 0.35	0.63	0.52
Västerbotten	1	0.81; 0.51; 0.01***; 0.17	0.32	0.91
Norrbottn	1	0.16; 0.14; 0.04**; 0.18	0.53	0.90

***, **, and * denote significance at 1, 5, and 10 percent levels.

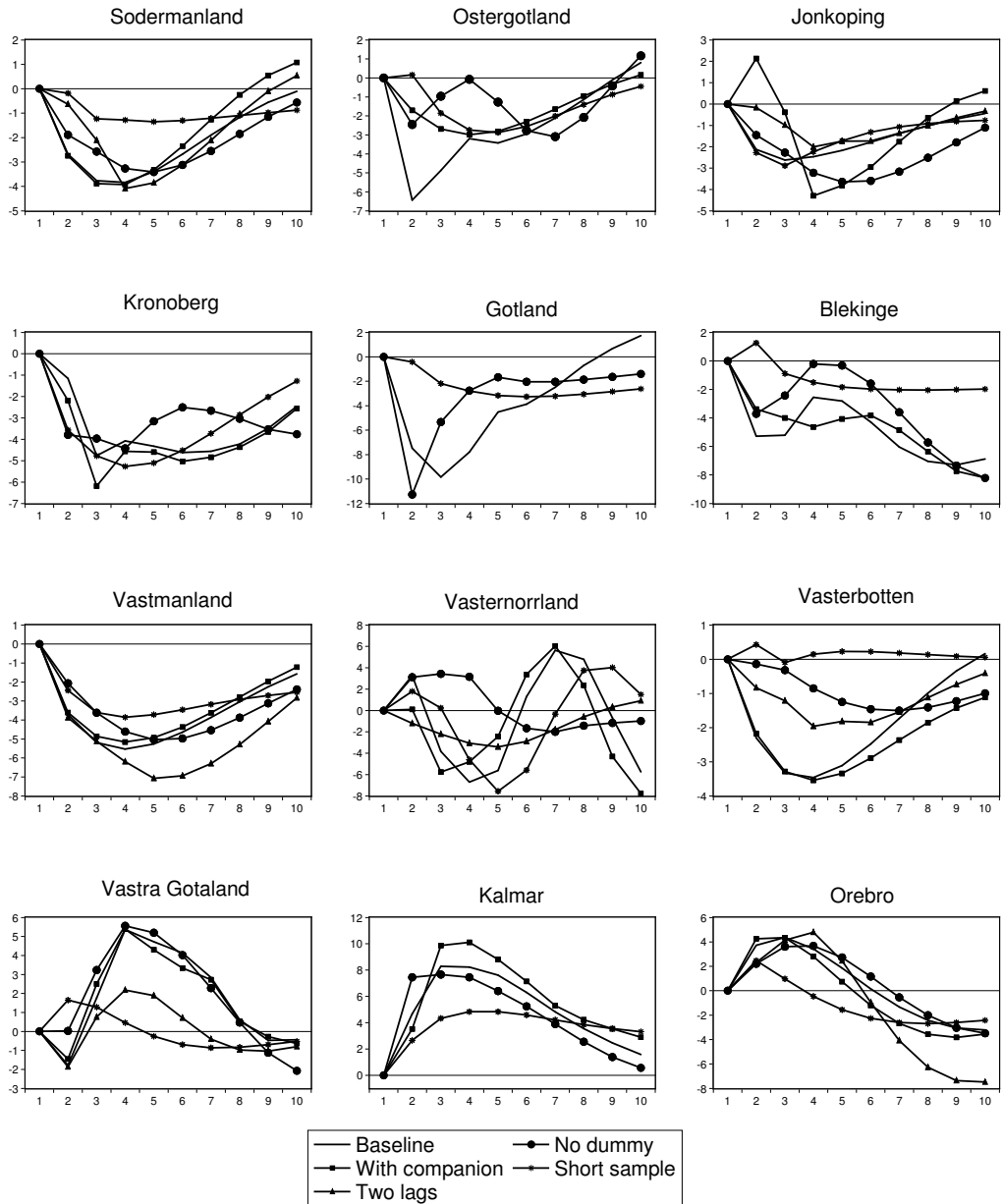


Figure 6: Robustness

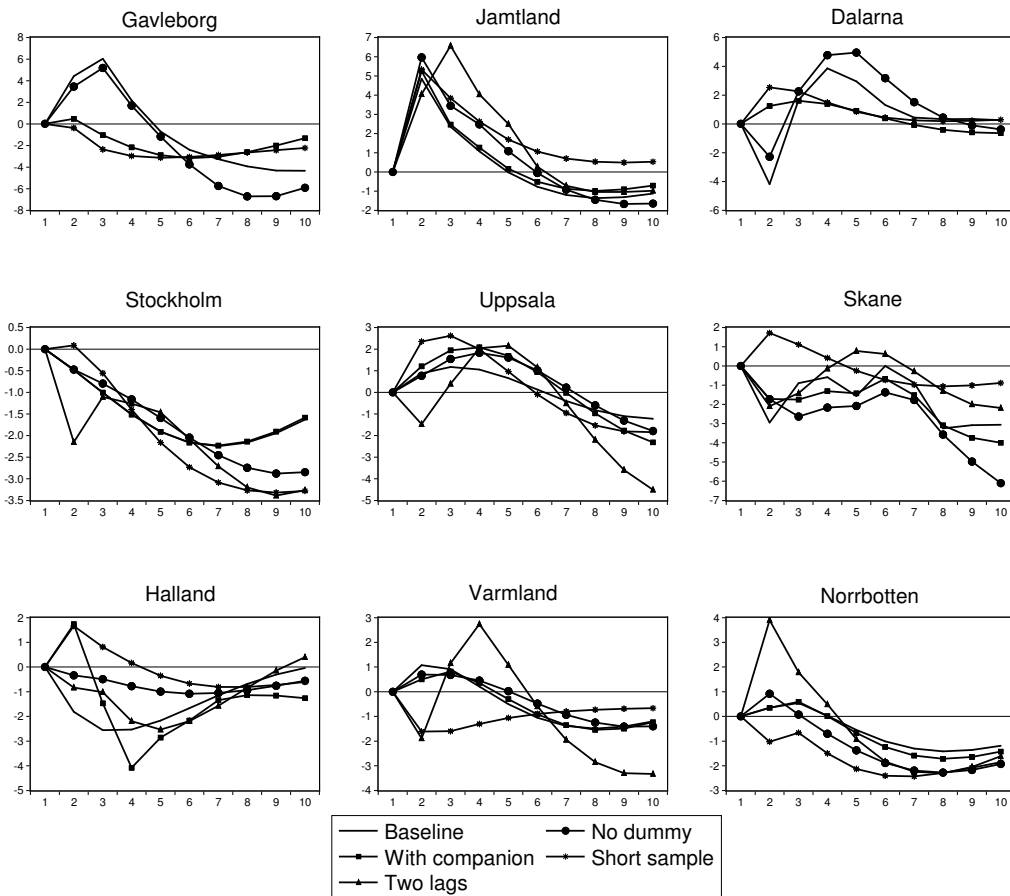


Figure 7: Robustness

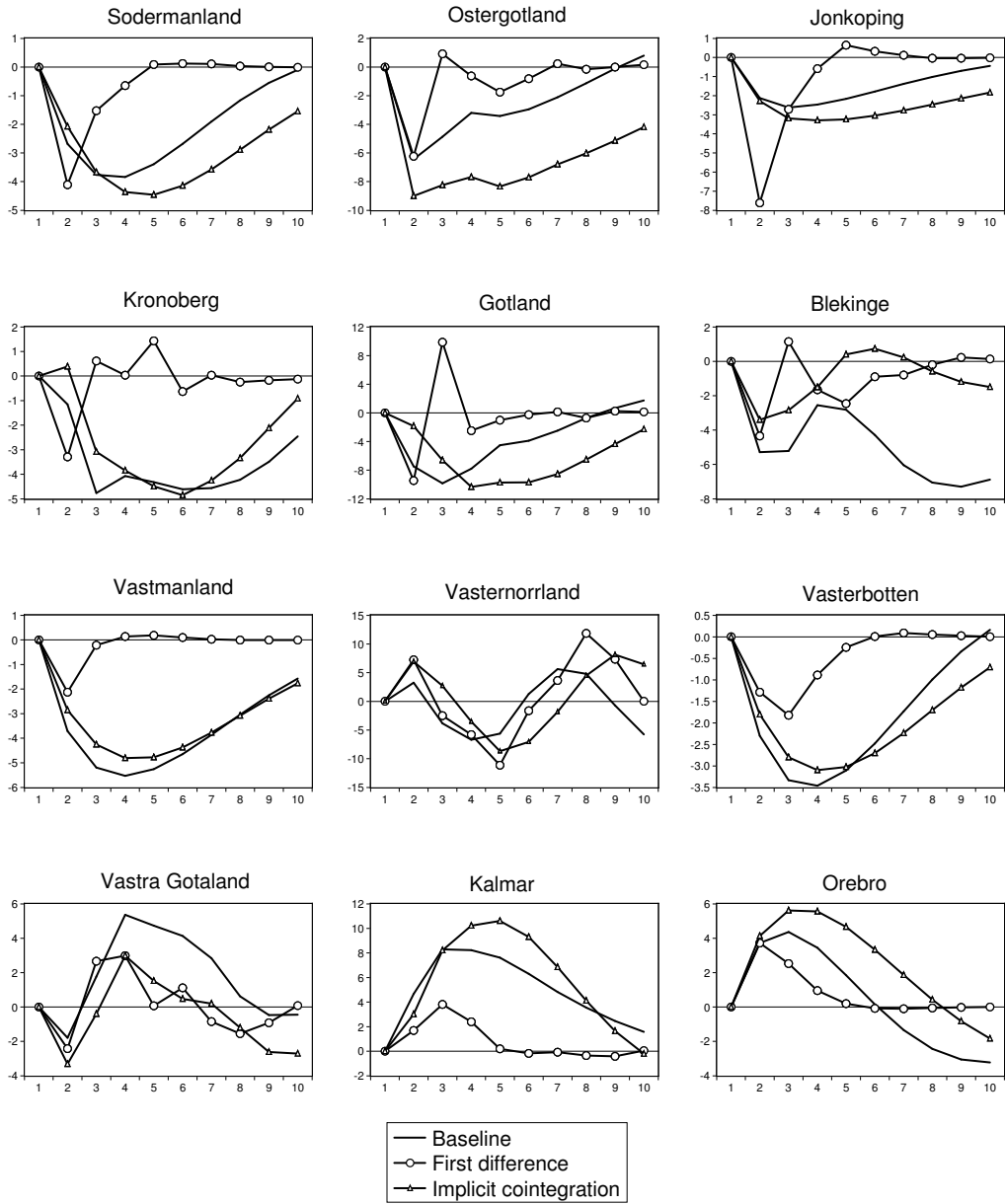


Figure 8: Robustness

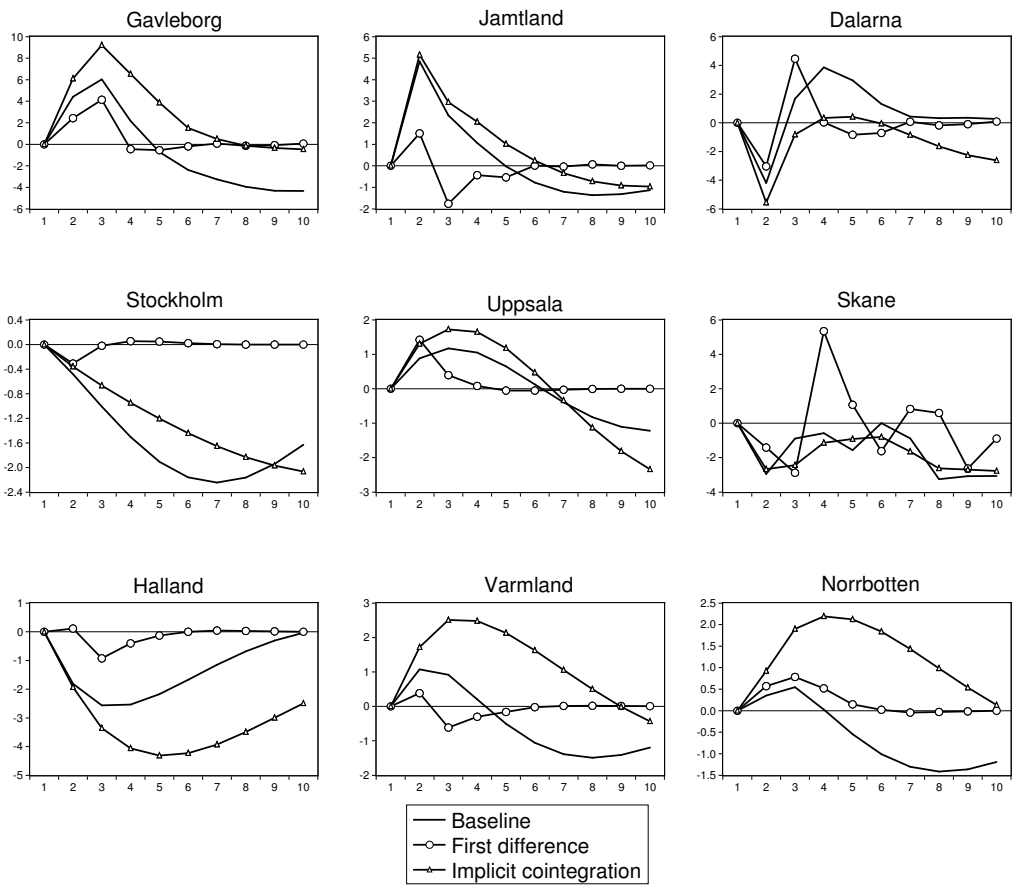


Figure 9: Robustness

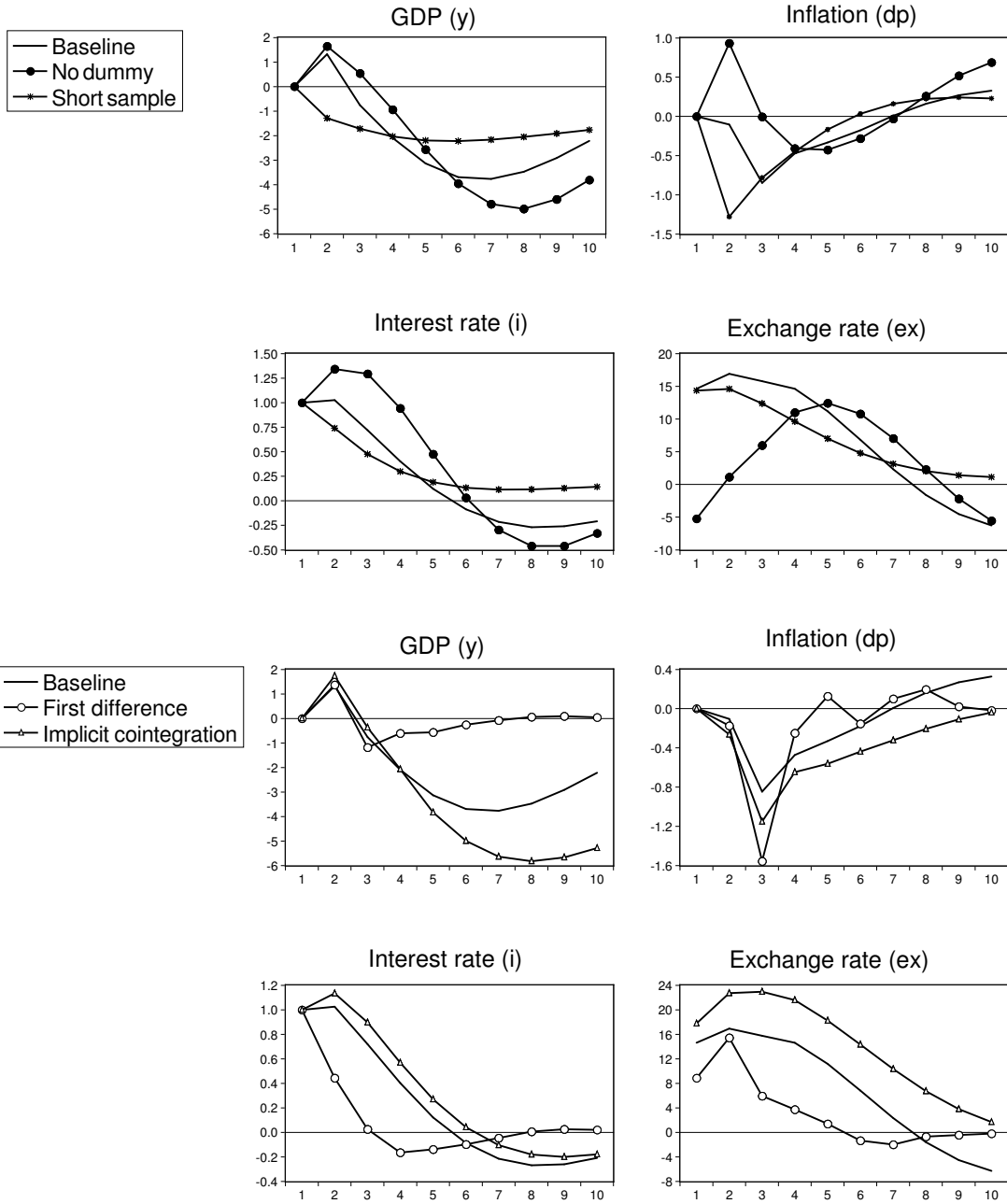


Figure 10: Robustness