International Spillovers and Feedback: Modelling in a Disequilibrium Framework

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Keywords: Macroeconometric modelling, international spillovers, trade feedback, VEC modelling

JEL classification: E27, F15, F17

Non–technical summary:

German unification represented a huge demand shock for the West German economy. However, besides the West German economy, foreign countries also profited from this demand shock at the beginning of the 1990s caused by the fall of the Berlin wall. In particular, the main trading partners of West Germany were able to increase their exports to Germany significantly.

A quantitative analysis of this spillover effects on the main trading partners of Germany and of possible feedback effects to the West German economy is undertaken within a macroeconometric disequilibrium model for the West German economy. This basic model is built on a micro theoretical analysis of firm behaviour and identifies disequilibria existing on the goods and labour markets. For the purpose of studying spillover effects from trade, this model is extended by models of bilateral trade relations with France, Italy, the Netherlands, the United Kingdom and the United States, which model imports from and exports to these countries. These trade equations relating to the five main trading partners of Germany are modelled in a non structural vector error correction (VEC) framework to allow for effects on foreign production, which feed back to the West German economy by increased demand for exports from Germany. The submodels comprises export and import shares in real output, foreign real output relative to the German output and relative capacity utilization rates as endogenous variables. Relative prices are treated as exogenous. Due to the dynamics of the VEC submodels and the inclusion of German and foreign macroeconomic variables, these submodels in connection with the structural model allow for spillovers and feedback effects.

We present a simulation scenario assuming that the huge demand shock of German unification had not taken place. The results indicate large spillover and still relevant feedback effects. Without the positive demand shock caused by German unification, German imports from its five main trading partners would have been smaller by 12.5%. These spillovers, intensified by multiplicator effects, cause in the simulation scenario an average decrease in European trading partners GDP of about 1%. Consequently, German exports to its main trading partners are also lowered by 1.4%. This feedback mechanism contributes to a significant slowdown of economic activity in West Germany as compared to the situation when unification actually took place. These results highlight the close integration between Germany and its main trading partners.

Abstract:

German unification hit the West German economy in a prosperous period and appeared as a huge demand shock at least for the first few quarters. This combination resulted in a major increase of imports from the main trading partners of West Germany, which may have helped to cushion recessionary trends within these countries.

In this paper the modelling of international trade in a disequilibrium framework and the consequences of German unification on trade flows are in the centre of interest. For this purpose, a macroeconometric disequilibrium model for the German economy is extended by submodels for bilateral trade flows vis a vis major trading partners. These submodels treat the trade flows as well as foreign and domestic production and capacity utilization as endogenous in a vector error correction framework. Consequently, the model allows for spillovers, like those resulting from the demand shock of German unification, to effect not only German trade flows, but also real variables in other countries leading to a feedback on Germany.

The paper provides a short overview over the basic model. The modelling approach and estimation results for the trade submodels are presented in some detail and simulation results for the feedback effects are also included.

Zusammenfassung:

Zum Zeitpunkt der deutschen Wiedervereinigung befand sich die westdeutsche Volkswirtschaft bereits seit einiger Zeit in einer expansiven Phase. Die Wiedervereinigung selbst stellte zumindest während der ersten Quartale einen beachtlichen positiven Nachfrageschock dar. Aus dieser Kombination ergab sich ein deutliches Ansteigen der Importe von den wichtigsten Handelspartnern Deutschlands, wodurch in diesen Ländern zum Teil rezessive Entwicklungen abgemildert werden konnten.

In diesem Papier wird der internationale Handel in einem Ungleichgewichtsmodell untersucht, um die Auswirkungen der Wiedervereinigung auf die Handelsströme quantifizieren zu können. Zu diesem Zweck wird ein makroökonometrisches Ungleichgewichtsmodell um die explizite Modellierung bilateraler Handelsströme mit den fünf wichtigsten Handelspartnern Deutschlands ergänzt. In entsprechenden Teilmodellen werden neben den Handelsströmen auch die ausländische Produktion und der Kapazitätsauslastungsgrad als endogene Größen abgebildet. Die Schätzung erfolgt im Rahmen vektorwertiger Fehlerkorrekturmodelle. Diese Modellierung erlaubt neben der Abbildung von Übertragungseffekten auf das Ausland durch zusätzlich induzierte Importe auch, die daraus resultierenden realen Effekte im Ausland und die wiederum hieraus folgenden Rückwirkungen auf deutsche Exporte zu schätzen.

Das Papier stellt kurz das Grundmodell dar, bevor auf die Modellierung und Schätzergebnisse für die Modelle bilateralen Handels eingegangen wird. Schließlich wird im Rahmen einer Simulation eine Quantifizierung der Übertragungs– und Rückwirkungseffekte unternommen.

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1 Introduction

The modelling of the impact of German unification on the West German economy represents a major challenge for macroeconometric modelling. Obviously, unification hit the West German economy in a prosperous period. Radowski, Smolny and Winker (1999) and Winker, Smolny and Radowski (1999) describe a macroeconometric disequilibrium model covering both West Germany and unified Germany from 1990 onwards. Estimation results of this model identify the economic impact of unification on the West German economy as a huge demand shock at least for the first quarters. The combination of an overall positive business situation, i.e. high utilization of capacities already prior to unification, with a huge positive demand shock lead to a sharp increase of imports from the main trading partners of West Germany.

Figure 1: German imports and exports (1991 prices)

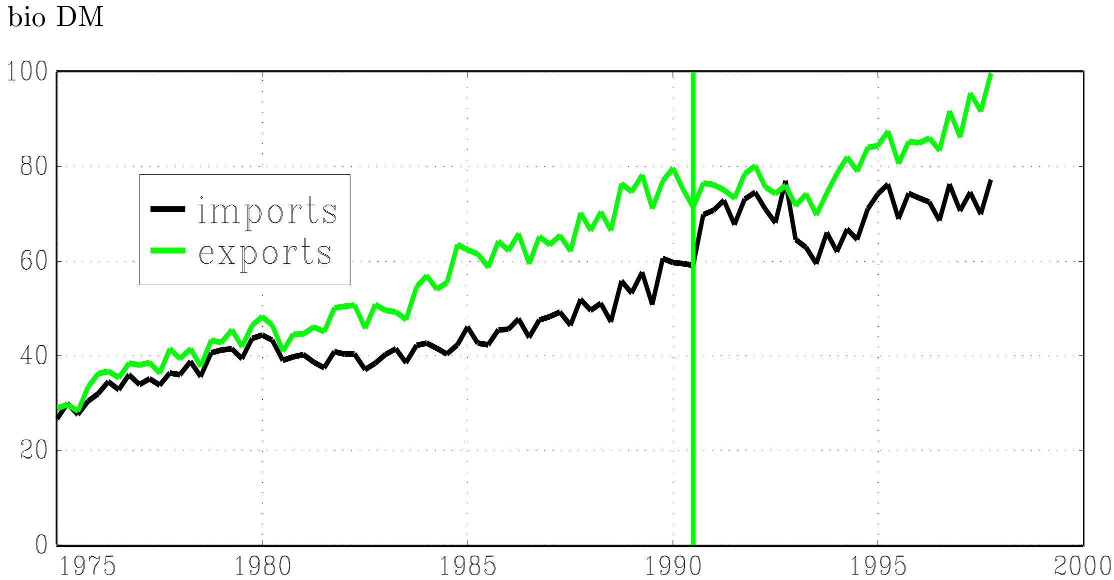


Figure 1 shows the development of German quarterly imports from and exports to its five main trading partners (France, Italy, Netherlands, United Kingdom, United States) in real terms.[1] In particular, imports show a marked increase during the first two years after unification. Table 1 shows the shares of the five main trading partners of Germany in total imports prior and after unification.

The figures clearly indicate that not only the overall volume of imports increased as a result of unification, but also the share of the main trading partners within these imports. Therefore, it can be argued that German unification led to a marked increase

[1] Data are for West Germany prior to the third quarter of 1990. For German exports the bilateral export price indices were used to deflate nominal values for its five main trading partners, whereas the German import price index was used for deflating imports.

Table 1: Import shares from main trading partners

	1976	1989	1991	1997
France	15.6%	12.6%	17.4%	12.6%
Italy	14.4%	9.6%	12.8%	9.6%
Netherlands	17.8%	10.7%	13.7%	10.5%
United Kingdom	6.3%	7.0%	9.0%	7.3%
United States	10.2%	6.8%	8.7%	8.3%
Sum	64.3%	46.7%	61.6%	48.3%

in spillover imports from these countries, which may have helped the trading partners to cushion recessionary trends in this period.

In order to allow for a more in depth analysis of such trade spillovers and possible feedbacks on the German economy, this paper extends the modelling of international trade in the macroeconometric disequilibrium model. The extension should allow for a more detailed treatment of bilateral trade flows as well as for possible feedback on the German economy. In the standard model, German imports and exports are modelled endogenously dependent on relative prices, gross domestic product and domestic and foreign capacity utilization rates. Furthermore, a world trade activity variable covers the globalisation trend in trade. Only imports are disaggregated in imports of raw materials and semi finished goods on the one hand and industrial products on the other. This paper extends this standard model of trade flows in two directions. First, trade flows are disaggregated to the major trading partners of Germany, which are France, Italy, the Netherlands, the United Kingdom, the United States, and the rest of the world. Second, the foreign capacity utilization rates and real economic activity are also treated as endogenous. Consequently, spillovers, like those resulting from the demand shock of German unification, may effect not only German trade flows, but also real variables in other countries leading to a feedback on the German economy.

The modelling of bilateral trade flows is undertaken in a vector error correction model (VECM), since a structural modelling of the economies of five major trading partners is beyond the scope of this contribution.[2] The submodels treat export and import shares in real output, relative real output and relative rates of capacity utilization as endogenous variables, while relative prices are found to be exogenous to the system.[3] The resulting satellite models are linked to the macroeconometric disequilibrium model for the German economy which, in particular, models real output and the rate of capacity utilization for Germany.

Using the combined model, it becomes possible to simulate the spillovers and feedback effects of demand shocks like the one resulting from German unification. The

[2]Heidbrink (1995) undertakes a related approach treating the major trading partners as one aggregate block.

[3]Nevertheless, German prices being endogenous, relative prices are also endogenous.

model also allows to analyze supply side shocks or the impact of different economic policy measures.

The paper provides a sketch of the macroeconometric disequilibrium model, which represents the core model for the German economy, and the standard treatment of foreign trade in section 2. This section also provides the theoretical framework for the bilateral trade models. Section 3 presents the data and estimation results for the bilateral trade models. These models are combined with the core model and used for the simulation presented in section 4, which covers the demand effect of German unification and its spillovers. Section 5 summarizes the findings and provides an outlook to further research.

2 The Modelling Framework

2.1 The Macroeconometric Disequilibrium Model

The macroeconometric disequilibrium model used as core model consists of an econometric implementation of ideas from New Keynesian Macroeconomics. In particular, it is based on strong micro theoretical foundations. It is beyond the scope of this paper to provide a detailed description of the theoretical framework of the model and its empirical implication.[4] Nevertheless, a short remark on one central aspect, namely the modelling of temporary (dis–)equilibria on goods and labour markets is necessary to motivate the specific interest in trade relations and the nonlinear – regime dependent – reactions of the model economy to all kind of shocks.

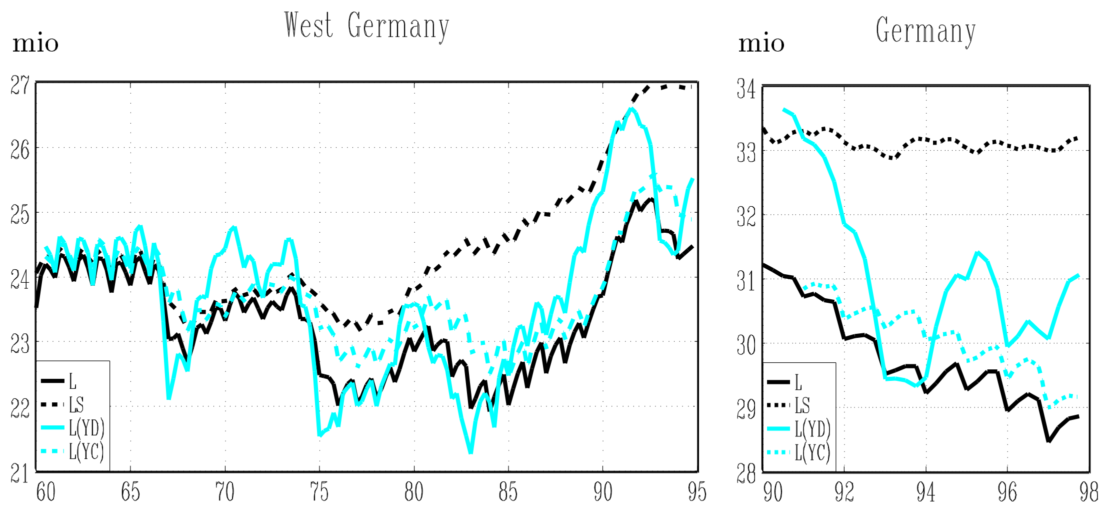
The model is based on a micro theoretical analysis of firms behaviour. Firms act on micro markets, which can be characterized by excess demand or excess supply. Firms can adopt to these conditions using output, prices, investment and production technology as parameters. However, in particular, investment and changes of the production technology takes time. Therefore, disequilibrium situations may persist for some time on micro markets. An explicit aggregation over these micro markets step[5] leads to macro relationships for the labour and goods market, which link demand and supply side. This procedure also supplies estimates of the regime shares, i.e. the probabilities that micro markets are characterized by excess demand or supply. For example, a high share for the "capacity constraint regime" means that a high percentage of firms does not increase employment due to limited capacities in the short run, while the "demand regime" corresponds to a situation where many firms are constrained by expected goods demand.

It is assumed that excess good demand on domestic markets leads to additional spillover imports, while export may be reduced, when there is no priority for serving foreign markets, e.g. due to sunk cost of market entry. This effect is symmetric for foreign countries, i.e. a positive demand shock in France ceteris paribus increases imports from Germany. This provides the rationalke for including capacity utilization rates in

[4]See Radowski, Smolny and Winker (1999), Winker, Smolny and Radowski (1999) and Franz, Göggelmann and Winker (2000) for more details.

[5]For the details see Smolny (1993).

Figure 2: Employment series



trade equations. Besides these models for the goods and labour market, the model also incorporates price and wage formation as well as a small block for public sector activity. In the model version used for the simulation, central bank behaviour is not endogenized yet.

An upshot of some central model features is given by the employment series in figure 2. The two plots show the developments of the different employment series derived from the theoretical model for West Germany up to 1994, and for Germany from 1990 onwards. From the left hand plot, the tremendous increase in labour supply `LS` during the 1980s can be clearly detected. It accelerated after unification up to 1992. A part of this further increase of almost 2 million people can be attributed to intra-national labour mobility after unification. Although starting prior to unification, demand determined employment `L(YD)` in West Germany received a major boost by the enormous demand increase from East Germany. In the peak period 1991 it almost reached labour supply. By contrast, capacity employment `L(YC)` falls short of labour supply by more than 1.5 millions. Although growing faster than labour supply since the mid 80s, capacities in West Germany failed to catch up with labour supply and increased goods demand in the aftermath of unification. Hence, capacities have become the major limiting factor to employment in West Germany `L` up to 1992.

The recession in 1992/93 is marked by a strong decrease of demand determined employment, which finally strengthens the restrictions imposed by capacities. Data availability does not allow to extend the estimation of `L(YD)` for West Germany beyond 1994. Therefore, the analysis continues with the right hand plot showing estimates for unified Germany. Labour supply in Germany `LS` remained fairly stable from 1989 onwards. However, this corresponds to an increase of the labour supply in West Germany by about 2 million and a similar decrease in East Germany. Furthermore, capacity employment `L(YC)` shrinks in Germany mirroring both a slight decrease for West Germany and the increase in labour productivity in East Germany.

Demand side effects are almost irrelevant in West Germany during the early years of unification when repressed consumption in East Germany could finally be realized out of savings and public transfers. As capacities were still growing when this unification shock settled down, the resulting lack of demand contributed significantly to the bad labour market performance in the 1992/93 recession.

2.2 A Model of Bilateral Trade

In the basic model, total imports and exports are modelled endogenously. While imports of raw materials and semi–finished goods are treated separately, no disaggregation of exports is undertaken. The explanatory variables for the trade equations in the basic model comprise relative prices, output in Germany, world trade, and the degree of capacity utilization both in Germany and foreign countries. Since foreign output is not modelled explicitly, feedback effects are not covered. This potential drawback can be handled in two ways. Either one tries to build up structural disequilibrium models similar to the specification for Germany (Heidbrink, 1995), or one uses reduced form models for bilateral trade flows, domestic and foreign output as well as domestic and foreign rate of capacity utilization as endogenous variables. Since the first approach requires tremendous resources and such a structural model is not required for modelling spillovers and feedback of trade on the German economy, we follow the second approach.

The number of endogenous variables should be kept at a minimum in vector autoregressive or vector error correction models, respectively given the limited number of observations. Therefore, only trade flows, output and rates of capacity utilization are included as endogenous variables in five satellite models of bilateral trade between Germany and its most important trading partners. In fact, as discussed in section 3, only import and export shares in German GDP, foreign GDP relative to German GDP and relative rates of capacity utilization are employed. This approach is necessary, as German GDP and rate of capacity utilization are already determined within the basic model. Other variables, which are expected to influence trade flows, like relative prices or world trade volume, are included as additional exogenous variables in these models. Thereby, it is implicitly assumed that relative prices adjust only to changes in domestic prices.

Due to the restriction to models of bilateral trade with the major trading partners, i.e. France, the Netherlands, Italy, the UK and the US, indirect feedback effects, i.e. feedback effects from bilateral trade through the influence on a third country, are not covered by the model. For example, the unification shock will increase German imports from France, thereby increasing French GDP. Consequently, not only exports from Germany to France might increase, but also, e.g., exports from Italy to France. Eventually, the resulting increase in Italian GDP will affect German exports to Italy. However, such indirect effects can be assumed to be of second order only. Furthermore, it is possible to assess the importance of such indirect effects comparing the results of the model disaggregated by trading partners with a model using only an aggregate of the trading partners, which should cover indirect effects within this aggregate.

The trade with countries not modelled explicitly via bilateral trade equations is endogenized using the standard equations of the core model, i.e. an error correction specification depending on relative prices, output in Germany, world trade and an aggregated rate of foreign capacity utilization.

3 Data and Estimation Results

German output and capacity utilization rate are already determined within the macroeconometric disequilibrium model for Germany. Since this model provides the core model, which should be linked with the satellite models of trade, the latter should not redefine German output and capacity utilization rate. Therefore, the satellite models determine only the development of relative values, i.e. the share of exports and imports in German output, the relation of foreign output to German output and the relation of the foreign rate of capacity utilization to the German one. Such a satellite model can be immediately combined with the structural model of the German economy to obtain a simulation model with the required features.

Hence, the endogenous variables considered in the reduced form models of bilateral trade are[6]

x_i share of exports to country i in German GDP (real),
m_i share of imports from country i in German GDP (real),
y_i relation of GDP of country i to German GDP (real),
q_i standardized difference of rate of capacity utilization in country i compared to Germany.

Moreover the model comprises as exogenous variables

p_i^x German export price index in USD relative to the export price index of country i in USD,
p_w^x German export price index in USD relative to industrial countries export price index in USD,

and two dummy variables for effects related to German unification in 1990 as well as seasonal dummies. All relative variables except of q_i are calculated as differences of logarithms, and q_i is defined as the difference of standardized rates of capacity utilization

$$q_i = \frac{Q_i - Q_i^{\min}}{\sigma_{Q_i}} - \frac{Q - Q^{\min}}{\sigma_Q},$$

where Q_i is the rate of capacity utilization in country i, Q the German rate of capacity utilization, the superscript min denotes historical minima and σ the empirical standard deviation. The coefficient of q_i reflects domestic and foreign spillover demand on imports and rationing effects on exports simultaneously.

Table 2 shows the results of augmented Dickey–Fuller unit root tests for these four variables and the five major trading partners of Germany, namely France (F), Italy (I), the Netherlands (NL), the UK (UK), and the US (US). All estimations are based on quarterly data from the first quarter of 1975 to the fourth quarter of 1997 with the

[6] The data sources are described in the appendix.

Table 2: Results of ADF–Tests on Nonstationarity

	x_i		m_i		y_i		q_i	
F	-1.978	(8,C)	-1.619	(8,C)	-2.184	(8,T)	-2.915	(3,T)
I	-2.489	(8,T)	-3.054	(4,T)	-1.400	(8,C)	**-3.511**	(3,C)
NL	-2.188	(8,C)	**-3.496**	(8,C)	-1.279	(7,C)	-2.070	(2,C)
UK	-1.115	(6,C)	-2.069	(7,C)	**-3.867**	(8,T)	**-3.105**	(3,C)
US	-2.672	(7,T)	-2.329	(9,T)	-2.765	(4,C)	**-3.196**	(3,C)

Critical values (5%): -2.893 (with constant C) and -3.459 (with constant and trend T)

exception of the Netherlands, where data are available only for 1977.1 to 1996.4. Bold face numbers indicate a rejection of the null of nonstationarity at the 5% level using the critical values of MacKinnon (1991). The numbers in parentheses show the lag length used for the ADF–regression, which is determined by maximizing Akaike's information criterion. Finally, a `C` indicates a constant in the ADF–Regression, while a `T` indicates a deterministic trend. Although ratios of trending variables are considered in the trade satellite model, the test results propose the use of an error correction framework in order to account for potential nonstationarity.[7] Consequently, the trade equations are estimated in a vector error correction model using Johansen's procedure to test for the existence of cointegrating relationships. The lag length for the dynamic part of the error correction models is also determined by Akaike's information criterion.[8]

For the UK, Q_{UK} measures the share of firms operating under full utilization of existing capacities. This definition differs from those used for all other countries and might explain, why the four variable system did not work well for the UK. Consequently, for the UK, the variable q_{UK} was excluded from the system.

The VECMs are estimated using the maximum likelihood procedure proposed by Johansen (1988,1991,1992). The likelihood ratio tests indicate the existence of exactly one cointegration relationship for each system. Table 3 summarizes the estimated long–run relationships with normalization on x_i. For example, $x_F = -3.8750 + 1.0910 m_F + 2.1365 y_F - 0.2743 q_F$. The complete estimation results for the VECMs are provided in the appendix. Due to the logarithmic notation, the interpretation of the coefficients for m_i and y_i as partial effects is straightforward. Under the assumption that German GDP remains constant, the estimated parameter for m_i indicates to what extent imports

[7]Using the Phillips–Perron test leads to a clear rejection of the null of nonstationarity for most variables. However, for stationary variables, Johansen's cointegration procedure should indicate a number of cointegration vectors equal to the dimension of the process, while the results of estimation presented in the appendix hint at only one cointegration vector. Therefore, the assumption of nonstationarity is maintained.

[8]For the Netherlands a lag length of two is maintained despite of the marginally higher value of the information criterion, because it implies more reasonable short–run adjustment features. However, the long–run relationships do not differ substantially if a lag length of one is used instead.

Table 3: Cointegration Vectors

	m_i	y_i	q_i	const.
F	1.0910 (3.588)	2.1365 (2.467)	-0.2743 (-2.054)	-3.8750
I	1.3367 (6.473)	1.8187 (5.032)	0.3099 (3.687)	0.0313
NL	0.8779 (7.547)	1.0179 (7.779)	0.0320 (3.163)	-0.2744
UK	1.4520 (14.474)	1.1186 (3.792)	–	2.703
US	1.5886 (2.698)	2.8081 (1.537)	0.4325 (2.742)	-3.5631

t–statistics in parenthesis

and exports move jointly in the long run mirroring the importance of intraindustrial trade. A value of 1.0910 for France, for example, indicates that imports from France and exports to France grow almost one to one in the long run.[9] Similarly, the parameter for y_i represents the long run impact of growth in the foreign GDP. Again in the case of France, the coefficient 2.1365 shows that trade grows faster than output reflecting the trend of economic integration. The interpretation of the parameter of q_i is more complicated. Theoretically, an increasing domestic excess demand in country i, mirrored by an increase in q_i, initially raises the demand for exports from Germany to country i. At the same time, demand increases in Germany with a positive impact on German GDP and imports from country i. Consequently, the ceteris paribus assumption with regard to GDP is not admissible in this case, since a change in the rate of capacity utilization is always related to changes in output. Therefore, we prefer to consider effects of changes in the rate of capacity utilization on bilateral trade only in the complete model.

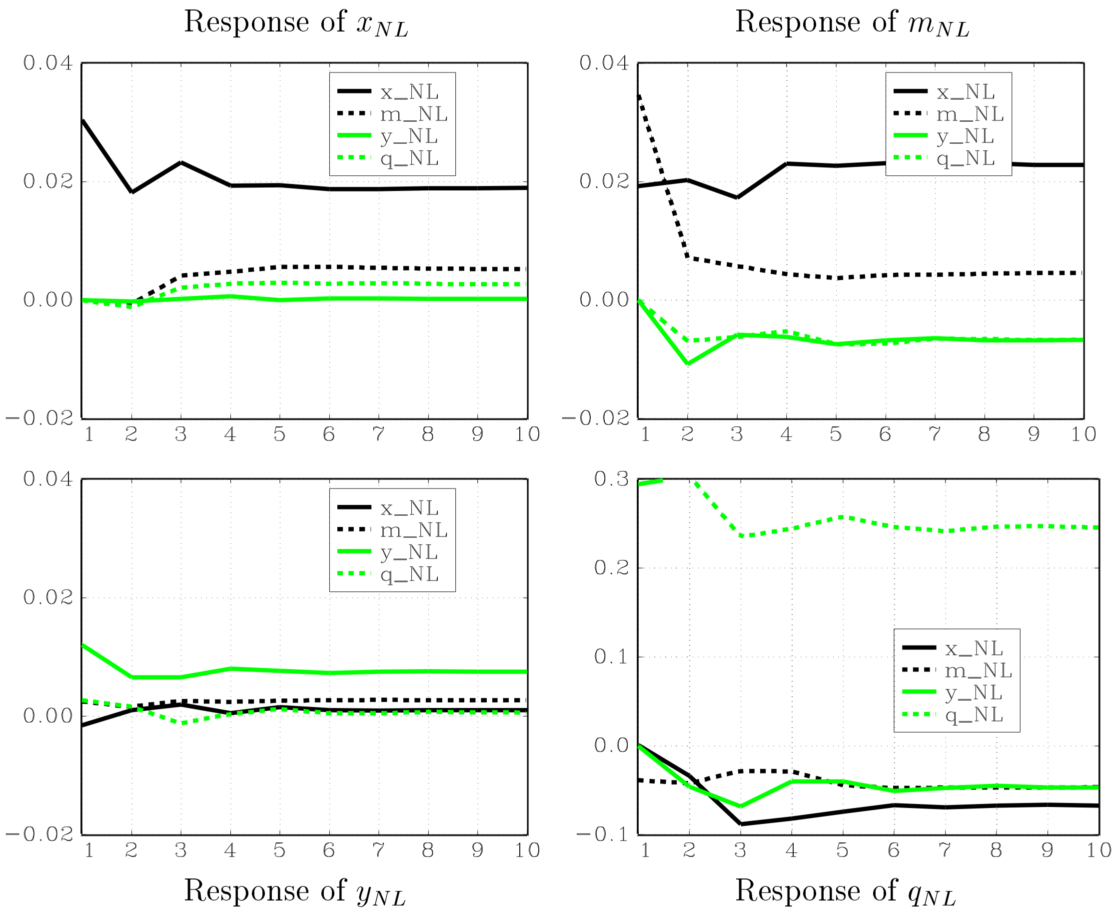
Before turning to the simulation results of this complete model in the next section, a few further insights in the estimated satellite models can be gained by the consideration of the impulse response functions for the VECMs. For example, Figure 3 shows the response of the four endogenous variables to one standard deviation shocks in these four variables for the Netherlands.

The interpretation of these impulse responses has to take into account two caveats. First, the exhibited impulse responses depend on the chosen orthogonalization of the error terms. Here, the ordering x_{NL}, m_{NL}, q_{NL}, y_{NL} is chosen.[10] Second, the impulse

[9]Under the ceteris paribus assumption, these parameters can be interpreted as partial elasticities. However, due to the simultaneous estimation approach, no causal interpretation is allowed.

[10]The ordering of the dependent variables was determined relating to their degree of endogeneity. Single equation regressions indicate for example, that foreign GDP is better explained by the other variables than bilateral exports.

Figure 3: Impulse Responses for the Netherlands



responses show reactions of relative values conditional on constant German GDP and capacity utilization rate. Since this assumption cannot be maintained within an open economy model like the macroeconometric disequilibrium model used in this paper, these impulse responses obtained for a partial model have to be interpreted with care. The reaction of the complete model to exogenous shocks is described in section 4 by means of simulation.

Given these caveats, we see from the left upper panel, that German exports to the Netherlands mainly react to own shocks. The influence of shocks in the other equations seems to be small. German imports, on the other side, react positively both on shocks in the import equation itself (short run) and the export equation (persistent effect), while shocks in relative GDP and relative rate of capacity utilization have a small negative impact as shown in the right upper panel. The dependence of relative GDP on other shocks appears to be small. Even shocks in relative GDP itself have only minor effects (lower left panel). Finally, we avoid an interpretation of the response of the relative rate of capacity utilization for the reasons outlined above.

4 Simulation of Trade Feedbacks

In order to simulate spillover effects of trade and a possibly resulting feedback, the satellite VEC models for bilateral trade have to be integrated with the macroeconometric disequilibrium model for the German economy, which has been sketched briefly in section 2. For this purpose, German GDP and rate of capacity utilization, which are determined in the basic model, are used for the calculation of relative variables in the VECM equations. On the other hand, bilateral trade flows, determined in the VEC models are integrated with the macroeconometric disequilibrium model. This integration was implemented by endogenizing the bilateral trade flows taken from the VEC models as as $m_i \cdot y$ and $x_i \cdot y$, where y denotes German GDP, m_i and x_i are the imports respective export shares. The structural trade equations from the original model specification are replaced by structural equations for raw materials and semi finished goods and for the intraindustry imports and exports not related to the five main trading partners of Germany. Finally, the total German trade flows are calculated by adding the bilateral imports from and exports to the five main trading partners to the rest of the imports and exports, determined in the basic model.

Taken together, the macroeconometric disequilibrium model and the trade satellite models determine bilateral trade flows, GDP, and rates of capacity utilization for the five main trading partners of Germany and Germany itself. In this section we present a simulation, which analyzes the spillover and feedback effects in international trade caused by the German unification.[11]

German unification certainly marks one of the largest economic shocks experienced in Europe during the last twenty years. Therefore, it is of special interest to analyze the impact of this event on other European countries and the US via spillovers from trade. The importance of these effects was already indicated by table 1, which showed a marked increase of the share of imports from Germany's main trading partners after unification. Furthermore, this shock also lends itself for studying potential feedback mechanisms from trade, e.g. on German output.

The simulation scenario is set up as follows. It is assumed that the demand effects of German unification on the West German economy would not have taken place, i.e. the "exports" from West to East Germany, which amounted to 150 bio. DM in 1991 and increased to more than 200 bio. DM in 1994, are set to zero.[12] Furthermore, in the VEC models, German GDP is replaced by West German GDP and the dummies for the third and fourth quarter of 1990 are set to zero. Again, all simulation results are reported relative to a baseline simulation without shocks for the period 1990/3 -

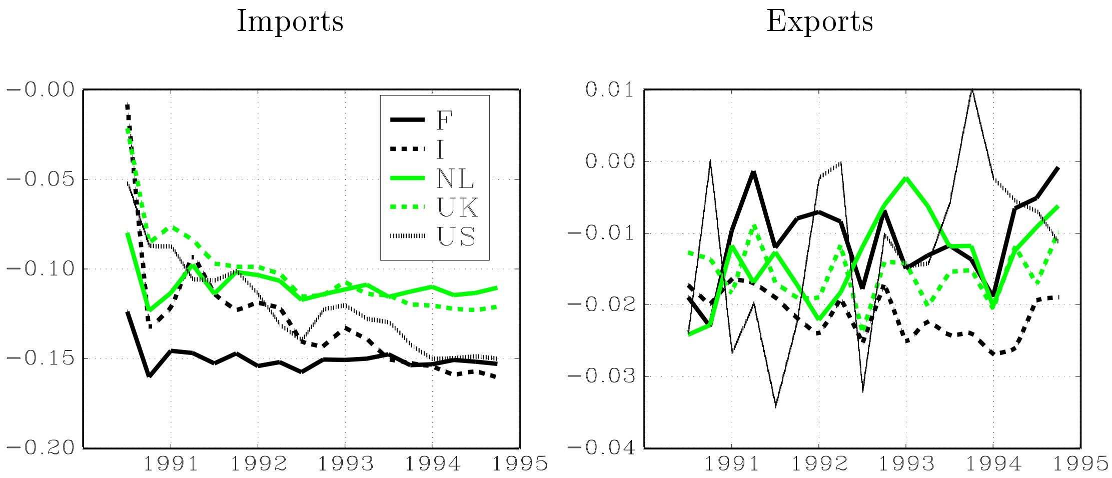
[11] Another simulation assumes a smoothing of the recessionary tendencies at the beginning of the 1980s for the five main trading partners of Germany. The simulated positive shock to GDP of the five main trading partners of Germany in an average size of 2.21% from the first quarter 1980 to the third quarter of 1984 causes an increase of exports to these countries in the same period of less than 2%. Indeed, this effect is quite small compared to the increase of German exports to its five main trading partners by about 30% from 1979 to 1984 in the baseline scenario. The simulated negative spillovers on German imports and the positive effects on German GDP are somewhat more important in their relative meaning.

[12] Thereby, the West German exports to East Germany prior to unification, which amounted to 7 bio. DM in 1988, are neglected.

1994/4.

Figure 4 shows the effect of the assumed negative demand shock on bilateral trade. The simulation scenario has a direct negative impact on German imports through two main channels. First, removing the huge demand shock of unification, West German GDP is reduced by 1.35% on average as compared to the baseline. The rate of capacity utilization drops on average by 2.19 percentage points. Second, no spillover imports from foreign countries are generated by East German demand in the simulation scenario. Consequently, German imports are affected negatively as shown in the figure.

Figure 4: Effects of Demand Shock on German Imports and Exports (difference of log imports/exports between simulation and baseline)



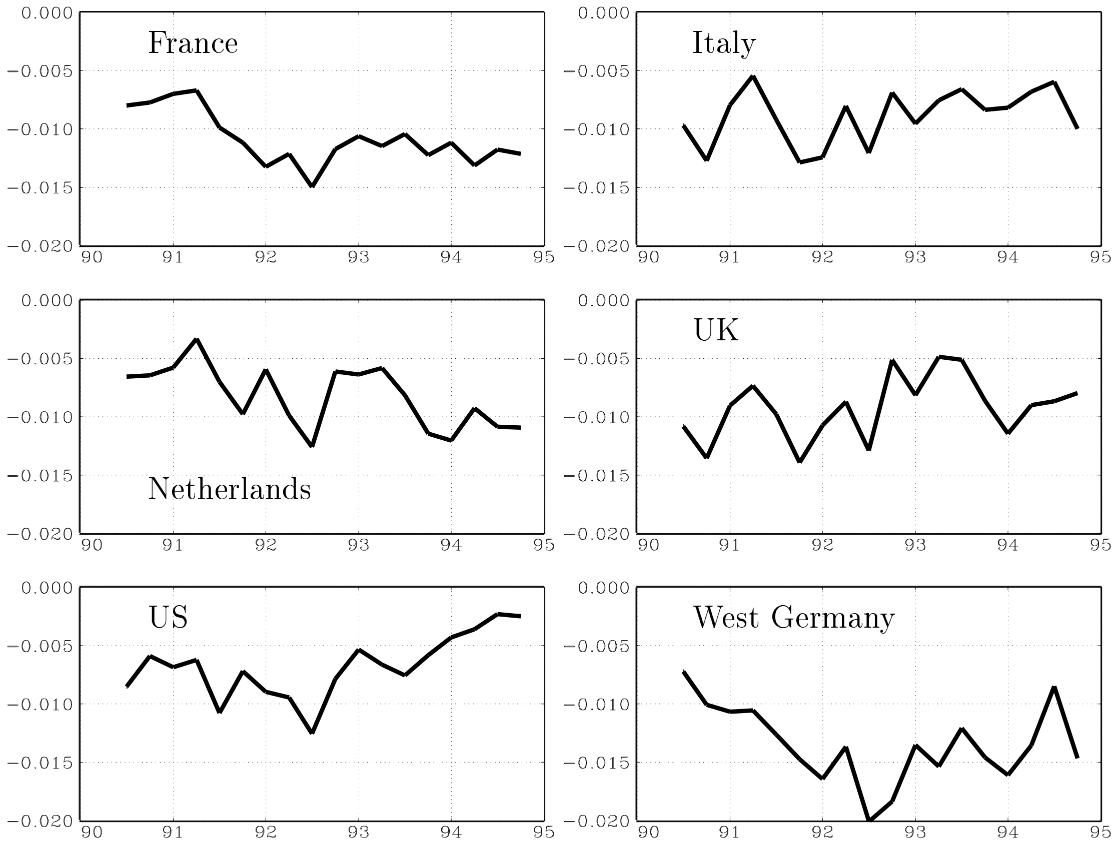
German imports from its five main trading partners are reduced by 12.5% on average compared to the baseline simulation. The strongest impact is on imports from France, which, in mean, are reduced by 15.0%, while a smaller impact is found for the UK. The negative simulated impact on the imports from the main trading partners indicates that unification led to a large amount of spillover imports.

German exports are less affected by the simulated scenario. In fact, effects on German exports are mainly due to feedback from its trading partners. Lower German imports imply lower GDP for the trading partners and, consequently, lower German exports. This aspect is analyzed in more depth using figure 6 below. Figure 5 shows the simulated impact of the negative demand shock in Germany on GDP for the trading partners and West Germany.

Resulting from the strong impact on German imports from France, the decrease of French GDP is most pronounced with 1,09% in mean over the simulation period 1990, third quarter, to 1994, last quarter, while the overall smallest impact (United States) is with 0.68% still of a relevant order of magnitude. Given the importance of exports to Germany for the considered countries,[13] this strong impact on GDP may surprise

[13]The shock in exports to Germany amounts to roughly 0.35% of GDP for these countries.

Figure 5: Effects on GDP of Trading Partners and Germany
(difference of log GDP between simulation and baseline)



at first sight. However, the dynamics indicate some dynamic multiplier effects, which cumulate to the strongest effects after about two years. Furthermore, negative feedback mechanisms may contribute to the large negative impact.

Despite the uncertainty related to policy simulations, in particular when considering a shock of the magnitude of German unification, the effects found in this simulation experiment can be taken as evidence for the real effects German unification had on its main trading partners. German unification had a considerable expansionary effect, wherby France profited the most due to its close trade links with Germany. Given the magnitude of the effects on Germans' trading partners, it is reasonable to expect some feedback from the simulated decrease in their economic activity, in particular with regard to German exports towards these countries. The modelling framework used in this paper already takes into account such feedback effects, since bilateral trade is endogenous and depends on foreign economic activity. In order to asses the impact of feedbacks, we rerun the simulation setting all direct feedback effects to zero, i.e. German export are assumed to be independent of changes in foreign output, capacity utilization and exports to Germany. In figure 6 simulation results for both cases, i.e. with and without feedback mechanisms, are depicted.

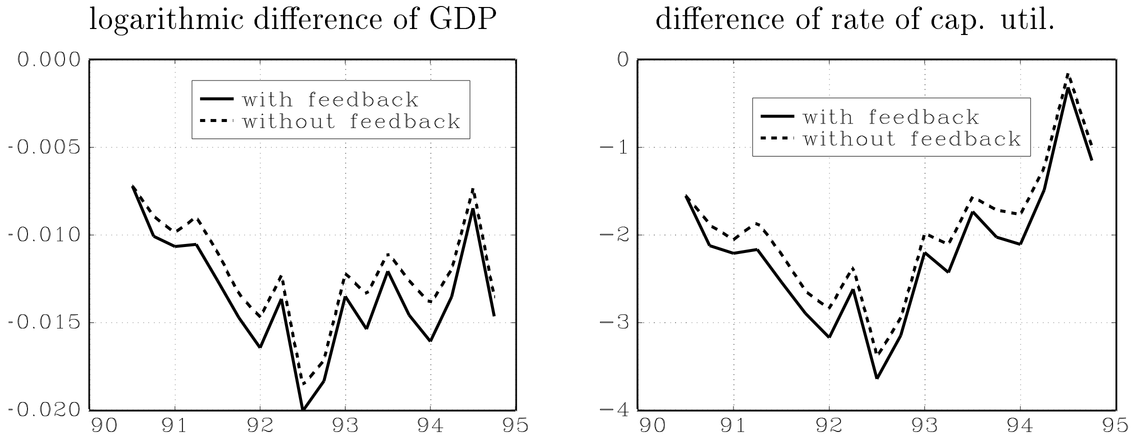
Figure 6: Effects of Demand Shock on German Exports
(logarithmic difference to baseline)

While German exports to its five main trading partners are reduced by 1.41% in mean as compared to the baseline simulation taking into account feedback mechanisms, this effect amounts only to minus 0.14%, if feedback effects are excluded. Of course, feedback effects are most relevant for German exports. Their effect on aggregate indicators such as GDP and rate of capacity utilization in Germany is much smaller as can be seen from figure 7.

Taking into account feedbacks, West German GDP decreases by 1.35% in mean compared to the baseline simulation, while the effect would have been somewhat smaller with 1.21% when neglecting the feedback mechanisms. In relative terms this difference seems to be small, but is relevant in absolute terms for a second order effect (feedback from main trading partners). A similar difference can be found for the rate of capacity utilization, which decreases by 2.19% with feedback effects and by only 1.96% in mean without taking these feedback effects into account.

Finally, the simulation results also indicate that both total and feedback effects of the assumed demand shock are most pronounced in the period 1992/93, which is

Figure 7: Effects on West German GDP and Rate of Capacity Utilization



classified as a demand regime period according to the results presented in figure 2. The non linear specification of the basic model implies that in such a situation a negative demand shock has much stronger implications than in periods with high rates of factor utilization like in the late 1980s.

5 Conclusions

In this paper, spillover and feedback effects of integrated open economies are modelled for the German case employing a macroeconometric disequilibrium model for the German economy coupled to satellite models for bilateral trade with the five most important trading partners. The satellite models are of the vector error correction vintage and cover bilateral trade (exports and imports), foreign GDP and foreign rate of capacity utilization as endogenous variables. Consequently, the combined model extends the already existing model of an open economy to cover explicitly spillovers and feedbacks of trade.

The presented simulations indicate the order of magnitude of the effects resulting from trade in such a framework. In particular, the simulation covering German unification highlights the close integration between Germany and, at least, its main trading partners on the European continent. Consequently, the increased German imports lead to spillover effects on the considered foreign economies. On average, these spillovers resulted in an increase of GDP by roughly 1% due to additional multiplier effects. These important effects on the trading partners give rise to feedback effects on German exports, as the simulated decrease of foreign GDP also decreases demand for German goods.

Further research will assess the robustness of the findings presented in this paper using alternative specifications for the satellite models and the link to the macroeconometric disequilibrium model. Furthermore, stochastic simulation techniques can be used to obtain confidence bands for the simulated effects.

A Data sources for VEC models

The data used for the VEC models in section 3 are obtained from the Deutsche Bundesbank, the IMF, and the OECD. Data for German output and rate of capacity utilization stem from the macroeconometric disequilibrium model for Germany and are taken from the national accounts of the DIW and the ifo Institute. For x_i, the share of exports to country i in German GDP (real), we used nominal export data in DM from the Deutsche Bundesbank, deflated by the German export price index (from IMF in US–\$) using the base year DM/\$ exchange rate. The same calculation is performed for m_i, the share of imports from country i in German GDP (real), where nominal data from the Deutsche Bundesbank are deflated by the foreign export price indices (from IMF in US–\$) using the base year DM/\$ exchange rate. Data for the rate of capacity utilization are provided by the OECD. For the UK, only the variable "share of firms working at full capacity" is available. The relation of GDP of country i to German GDP (real) is calculated using IMF–data for foreign real GDP (seasonal adjusted). Finally, the relative prices included as exogenous regressors in some equations are derived from IMF data.

B Estimation results for VEC models

All presented VECM estimations include as exogeneous variables shift dummies for the third and fourth quarter of 1990 ($D903$, $D904$) and quarterly seasonal dummies ($D1$,$D2$,$D3$).

Table 4: Results of Cointegration Tests: France

Endogenous Series: x_F, m_F, y_F, q_F Exogenous Series: $p^x_{F,t-1}, p^x_{F,t-2}, p^x_{w,t-1}, D903, D904, D1, D2, D3$				
Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.348383	53.29298	47.21	54.46	None*
0.110853	15.17447	29.68	35.65	At most 1
0.044889	4.717650	15.41	20.04	At most 2
0.007054	0.630044	3.76	6.65	At most 3

* denotes significance at the 5%–level, ** at the 1%–level.

Table 5: Results of Cointegration Tests: Italy

Endogenous Series: x_I, m_I, y_I, q_I Exogenous Series: $p^x_{I,t-1}, p^x_{w,t-2}, D903, D904, D1, D2, D3$				
Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.348295	52.82749	47.21	54.46	None*
0.125790	14.72097	29.68	35.65	At most 1
0.030192	2.756264	15.41	20.04	At most 2
0.000312	0.027740	3.76	6.65	At most 3

* denotes significance at the 5%–level, ** at the 1%–level.

Table 6: Results of Cointegration Tests: The Netherlands

Endogenous Series: $x_{NL}, m_{NL}, y_{NL}, q_{NL}$ Exogenous Series: $p^x_{NL,t-1}, D903, D904, D1, D2, D3$				
Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.286543	54.62401	47.21	54.46	None**
0.205683	27.27576	29.68	35.65	At most 1
0.060615	8.623663	15.41	20.04	At most 2
0.042984	3.558735	3.76	6.65	At most 3

* denotes significance at the 5%–level, ** at the 1%–level.

Table 7: Results of Cointegration Tests: United Kingdom

Endogenous Series: x_{UK}, m_{UK}, y_{UK} Exogenous Series: $p^x_{UK,t-2}, p^x_{w,t-1}, p^x_{w,t-3}, D903, D1, D2, D3$				
Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.237322	37.56645	29.68	35.65	None**
0.094655	12.64181	15.41	20.04	At most 1
0.037260	3.493437	3.76	6.65	At most 2

* denotes significance at the 5%–level, ** at the 1%–level.

Table 8: Results of Cointegration Tests: United States

Endogenous Series: x_{US}, y_{US}, q_{US} Exogenous Series: $p^x_{w,t-1}, D903, D904, D1, D2, D3$				
Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.334260	64.38090	47.21	54.46	None**
0.166199	28.17072	29.68	35.65	At most 1
0.118137	11.99406	15.41	20.04	At most 2
0.009006	0.805143	3.76	6.65	At most 3

* denotes significance at the 5%–level, ** at the 1%–level.

Table 9: Results of VECM estimation for France

	endogenous variable			
Expl. Var.	Δx_F	Δm_F	Δy_F	Δq_F
EC	-0.1455	0.0210	-0.0005	-1.2433
	(-3.680)	(0.480)	(-0.046)	(-4.239)
$\Delta x_F(-1)$	-0.1068	0.3360	0.0623	1.2899
	(-0.868)	(2.473)	(1.750)	(1.414)
$\Delta x_F(-2)$	-0.0161	0.3209	0.0397	-0.1057
	(-0.137)	(2.474)	(1.168)	(-0.121)
$\Delta m_F(-1)$	-0.0986	-0.7147	-0.0615	-1.5190
	(-0.851)	(-5.589)	(-1.834)	(-1.770)
$\Delta m_F(-2)$	-0.2032	-0.1653	-0.0348	-0.5091
	(-1.884)	(-1.388)	(-1.114)	(-0.637)
$\Delta y_F(-1)$	0.2630	0.0568	-0.4144	2.3487
	(0.670)	(0.131)	(-3.647)	(0.807)
$\Delta y_F(-2)$	-0.0871	-0.3584	-0.0801	-0.5791
	(-0.282)	(-1.050)	(-0.895)	(-0.253)
$\Delta q_F(-1)$	0.0229	-0.0151	0.0016	0.0578
	(1.589)	(-0.946)	(0.382)	(0.541)
$\Delta q_F(-2)$	0.0205	-0.0103	0.0052	0.1431
	(1.490)	(-0.675)	(1.312)	(1.402)
$p_F^x(-1)$	-0.3900	0.3634	0.0855	3.7166
	(-1.603)	(1.352)	(1.213)	(2.060)
$p_F^x(-2)$	0.1602	-0.5225	-0.1143	-4.3918
	(0.677)	(-1.997)	(-1.666)	(-2.501)
$p_w^x(-1)$	0.1258	-0.0300	-0.0238	0.6982
	(2.019)	(-0.436)	(-1.318)	(1.511)
Const.	0.0502	0.0342	-0.0371	0.0247
	(2.129)	(1.314)	(-5.436)	(0.141)
$\bar{R}^2$	0.7960	0.7955	0.9149	0.1967

EC is the error correction term from table 3
t–values in parenthesis; VECM includes seasonal dummies and dummies for 1990.3 and 1990.4 (results not shown).

Table 10: Results of VECM estimation for Italy

	endogenous variable			
Expl. Var.	Δx_I	Δm_I	Δy_I	Δq_I
EC	-0.0239	0.0817	0.0174	1.8159
	(-0.775)	(1.742)	(1.594)	(5.513)
$\Delta x_I(-1)$	0.0981	-0.0699	0.0191	-1.8087
	(0.908)	(-0.425)	(0.497)	(-1.565)
$\Delta x_I(-2)$	0.2800	0.0328	0.0809	-0.2171
	(2.701)	(0.208)	(2.194)	(-0.196)
$\Delta m_I(-1)$	-0.2283	-0.1933	-0.0415	0.4162
	(-3.004)	(-1.669)	(-1.535)	(0.512)
$\Delta m_I(-2)$	0.0622	-0.2276	-0.0253	-0.4870
	(0.856)	(-2.056)	(-0.981)	(-0.627)
$\Delta y_I(-1)$	0.2287	-0.4219	-0.4303	2.0412
	(0.676)	(-0.819)	(-3.579)	(0.564)
$\Delta y_I(-2)$	-0.5163	-0.0660	-0.1370	5.1036
	(-1.902)	(-0.160)	(-1.419)	(1.757)
$\Delta q_I(-1)$	-0.0113	-0.0007	0.0048	0.0505
	(-1.076)	(-0.044)	(1.272)	(0.448)
$\Delta q_I(-2)$	0.0062	-0.0028	0.0043	0.0741
	(0.609)	(-0.183)	(1.186)	(0.681)
$p_I^x(-1)$	0.0711	0.4413	0.1149	4.5097
	(0.641)	(2.612)	(2.909)	(3.801)
$p_w^x(-2)$	-0.1152	-0.3427	-0.0509	-0.2853
	(-1.552)	(-3.030)	(-1.930)	(-0.359)
Const.	0.0790	-0.0445	-0.0385	0.0958
	(4.065)	(-1.504)	(-5.574)	(0.461)
$\bar{R}^2$	0.8837	0.3263	0.9181	0.4094

EC is the error correction term from table 3
t–values in parenthesis; VECM includes seasonal dummies and dummies for 1990.3 and 1990.4 (results not shown).

Table 11: Results of VECM estimation for the Netherlands

	endogenous variable			
Expl. Var.	Δx_{NL}	Δm_{NL}	Δy_{NL}	Δq_{NL}
EC	-0.1887	0.6452	-0.0193	-0.5398
	(-1.317)	(3.454)	(-0.322)	(-0.385)
$\Delta x_{NL}(-1)$	-0.1984	-0.1854	0.0757	-0.9521
	(-1.167)	(-0.836)	(1.065)	(-0.572)
$\Delta x_{NL}(-2)$	0.1189	-0.1270	0.0846	-1.9117
	(0.858)	(-0.703)	(1.461)	(-1.410)
$\Delta m_{NL}(-1)$	-0.1905	-0.1781	-0.0096	-0.2242
	(-1.575)	(-1.130)	(-0.189)	(-0.189)
$\Delta m_{NL}(-2)$	-0.0418	-0.0382	0.0113	-0.0126
	(-0.452)	(-0.317)	(0.292)	(-0.014)
$\Delta y_{NL}(-1)$	-0.2054	-0.2391	-0.4761	-4.3447
	(-0.641)	(-0.573)	(-3.556)	(-1.386)
$\Delta y_{NL}(-2)$	-0.2092	-0.0626	-0.2137	-3.7087
	(-0.837)	(-0.192)	(-2.047)	(-1.517)
$\Delta q_{NL}(-1)$	-0.0099	0.0054	-0.0002	0.0473
	(0.784)	(0.327)	(-0.004)	(0.383)
$\Delta q_{NL}(-2)$	0.0033	0.0112	-0.0097	-0.2359
	(0.264)	(0.685)	(-1.839)	(-1.918)
$p^x_{NL}(-1)$	0.0691	-0.3227	0.0189	0.0833
	(0.889)	(-3.186)	(0.582)	(0.110)
Const.	0.0065	-0.0106	-0.0292	-0.3000
	(0.431)	(-0.536)	(-4.607)	(-2.019)
$\bar{R}^2$	0.6327	0.6787	0.8858	0.0060

EC is the error correction term from table 3
t–values in parenthesis; VECM includes seasonal dummies and dummies for 1990.3 and 1990.4 (results not shown).

Table 12: Results of VECM estimation for the United Kingdom

	endogenous variable		
Expl. Var.	Δx_{UK}	Δm_{UK}	Δy_{UK}
EC	-0.0194	0.3605	-0.0044
	(-0.294)	(4.656)	(-0.235)
$\Delta x_{UK}(-1)$	-0.2125	-0.1771	0.0653
	(-1.793)	(-1.274)	(1.944)
$\Delta m_{UK}(-1)$	0.0215	-0.1086	-0.0082
	(0.236)	(-1.019)	(-0.320)
$\Delta y_{UK}(-1)$	0.7787	-0.0564	-0.0705
	(2.207)	(-0.136)	(-0.705)
$p^x_{UK}(-2)$	-0.0539	-0.2557	-0.0248
	(-0.569)	(-2.302)	(-0.922)
$p^x_w(-1)$	-0.2415	0.2918	0.0555
	(-1.061)	(1.093)	(0.861)
$p^x_w(-3)$	0.2847	0.0762	-0.0739
	(1.537)	(0.351)	(-1.406)
Const.	0.0183	0.0312	-0.0277
	(1.160)	(1.691)	(-6.205)
$\bar{R}^2$	0.3190	0.3748	0.8415

EC is the error correction term from table 3
t–values in parenthesis; VECM includes seasonal dummies and a dummy for 1990.3 (results not shown).

Table 13: Results of VECM estimation for the US

	endogenous variable			
Expl. Var.	Δx_{US}	Δm_{US}	Δy_{US}	Δq_{US}
EC	-0.0514	0.0350	0.0009	0.3328
	(-2.943)	(1.882)	(0.192)	(3.710)
$\Delta x_{US}(-1)$	-0.3049	0.0787	0.0381	0.1644
	(-2.794)	(0.678)	(1.303)	(0.293)
$\Delta x_{US}(-2)$	-0.1823	0.1518	-0.0274	0.6088
	(-1.665)	(1.304)	(-0.938)	(1.083)
$\Delta m_{US}(-1)$	-0.1684	-0.3105	0.0136	-0.8782
	(-1.562)	(-2.711)	(0.471)	(-1.586)
$\Delta m_{US}(-2)$	-0.0961	-0.1243	-0.0126	-1.2709
	(-0.877)	(-1.068)	(-0.429)	(-2.260)
$\Delta y_{US}(-1)$	0.4336	0.4470	-0.2688	0.9912
	(0.899)	(0.872)	(-2.083)	(0.400)
$\Delta y_{US}(-2)$	0.2799	0.0152	-0.0910	-0.6897
	(0.595)	(0.030)	(-0.723)	(-0.285)
$\Delta q_{US}(-1)$	0.0482	-0.0346	0.0061	0.3932
	(2.164)	(-1.462)	(1.019)	(3.437)
$\Delta q_{US}(-2)$	-0.0071	-0.0221	-0.0053	-0.0458
	(-0.307)	(-0.897)	(-0.859)	(-0.385)
$p_w^x(-1)$	-0.5824	0.3814	-0.0367	2.8247
	(-3.836)	(2.364)	(-0.904)	(3.624)
Const.	0.0480	0.0652	-0.0318	0.0789
	(2.089)	(2.683)	(-5.190)	(0.672)
$\bar{R}^2$	0.4505	0.5534	0.8239	0.2539

EC is the error correction term from table 3
t–values in parenthesis; VECM includes seasonal dummies and dummies for 1990.3 and 1990.4 (results not shown).

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