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Abstract

Germany's nominal exchange rate has remained weaker because it is linked to weaker eurozone economies. Germany's real exchange rate also depreciated vis-à-vis eurozone countries after 2000 because German firms and workers controlled unit labor costs. This paper investigates how exchange rate changes affect German exports. Results from Johansen maximum likelihood and dynamic ordinary least squares (DOLS) estimation indicate that the export elasticity for the unit labor cost-deflated exchange rate equals 0.6. Results from panel DOLS estimation indicate that price elasticities are much higher for consumption goods exports than for capital goods exports and for exports to the eurozone than for exports outside of it. These results imply that Germany's internal devaluation after 2000 contributed to a surge in exports to Europe.

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1. Introduction

The top four exporters in 2011 were China, the United States, Germany, and Japan. China, the United States and Japan have all been criticized for trying to depreciate their currencies to increase net exports (see, e.g., Beattie, Cadman, and Bernard, 2012). Of the four leading exporters, only Germany has not been accused of seeking to depress its exchange rate. While Germany has not taken part in the currency wars, its exchange rate has been held down because it is linked to weaker eurozone economies (see Bergsten, 2012). How do exchange rates affect Germany's exports?

Bayoumi, Harmsen, and Turunen (2011) and Chen, Milesi-Ferretti, and Tressel (2012), in valuable studies, investigated export elasticities for the eurozone. Both papers used the imperfect substitutes approach (see Goldstein and Khan, 1985) as their theoretical foundation. Bayoumi *et al.* employed a panel data set with annual aggregate exports from 11 eurozone countries over the 1980 to 2009 period. For three of their four exchange rate measures they reported statistically significant elasticities of about -0.6. For these three measures they also reported that exchange rate elasticities are much higher for exports to other eurozone countries than for exports outside the eurozone. Chen *et al.* employed a panel dataset with annual exports from 11 eurozone countries to individual importing countries over the 1990 to 2009 period. They found an exchange rate elasticity of -0.43.

Imbs and Méjean (2010), in ongoing work, estimated trade elasticities using annual data between 1995 and 2004 and a sectoral version of a conventional constant elasticity of substitution (CES) demand system. In their framework, the price elasticity of exports is an average across both sectors and destination markets. They employed multilateral trade data disaggregated at the 6 digit level of the harmonized system (HS6). They noted that German

goods are differentiated and thus may be less sensitive to exchange rates.   They then reported

that Germany has export elasticities relatively close to zero.

Allard, Catalan, Evereard, and Sgherri (2005) employed the imperfect substitutes

framework and error correction models over the 1991Q1-2004Q3 period to estimate trade

elasticities. For German goods exports, they reported an elasticity of -0.32.[1] They also noted

that the appreciation of the euro after 2000 did not affect Germany's unit labor cost-deflated real

effective exchange rate (reer) very much because Germany succeeded at increasing productivity

and reducing costs. They concluded that the appreciation of the euro between 2001 and 2004

had only a limited impact on German exports because the exchange rate elasticity was small and

because the nominal exchange rate appreciation was offset by productivity gains and cost

reductions.

Figure 1 shows unit labor costs (ULC) in Germany and in other eurozone countries

between 2000 and 2011. For the sake of clarity the figure only shows four countries other than

Germany. The pattern is similar, though, for other eurozone countries. For most of these

countries, ULC increased by 20 to 30 percent over this period. For Germany, however, ULC

increased by less than 3 percent. Germany's ULC-deflated reer thus depreciated significantly

relative to its European trading partners' reers.

This paper investigates how exchange rate changes such as these affect Germany's

exports. Findings using aggregate exports and both Johansen maximum likelihood estimation

and dynamic ordinary least squares (DOLS) estimation indicate that ULC-deflated reer

elasticities are precisely estimated and equal to about -0.6. Results using disaggregated data and

panel DOLS estimation indicate that elasticities are much larger for consumption goods exports

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[1] For services, they reported an export elasticity of -0.86. The elasticity for goods is more important for Germany's overall exports since 80 percent of German exports in 2010 were goods.

than for capital goods exports and much larger for intra-eurozone exports than for exports outside the eurozone.

These results imply that Germany's large internal devaluation after adopting the euro increased capital and especially consumption goods exports from Germany to Europe. Figure 2 shows that German exports to the eurozone increased 61 percent for capital goods and 96 percent for consumption goods between 2000 and 2010.[2] This surge in exports in turn contributed to the eurozone imbalances that are evident in Figure 3.

Figure 4 shows the major recipients of German exports in 2010. The Figure shows that large amounts of exports went throughout the world. In earlier years some of the major importing countries were different. Nevertheless, over the 1980-2010 period large quantities of exports went to both European and non-European countries.

The next section presents evidence concerning how exchange rates affect Germany's aggregate exports. Section 3 investigates how exchange rates affect Germany's exports disaggregated by sector and by whether the importers are eurozone countries or not. Section 4 concludes.

2. The Effect of Exchange Rate Changes on Germany's Exports: Aggregate Evidence

Data and Methodology

Following Bayoumi *et al.* (2011), Chen *et al.* (2012), and Allard *et al.* (2005), we use the imperfect substitutes model to estimate trade elasticities. Export functions can be written as:

$$ex_t = \alpha_1 + \alpha_2 reer_t + \alpha_3 y_t^* + \varepsilon_t . \qquad (1)$$

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[2] Germany's total goods exports increased 75 percent over this period.

Here ex_t represents real exports, $reer_t$ represents the real exchange rate, y_t^* represents foreign real income, and all variables are measured in natural logs.

Equation (1) can be written in vector error correction form as:

$$\Delta ex_t = \beta_{10} + \varphi_1(ex_{t-1} - \alpha_1 - \alpha_2 reer_{t-1} - \alpha_3 y_{t-1}^*) + \beta_{11}(L)\Delta ex_{t-1} + \beta_{12}(L)\Delta\ reer_{t-1} + \beta_{13}(L)\Delta y_{t-1}^* + v_{1t} \qquad (2a)$$

$$\Delta rer_t = \beta_{20} + \varphi_2(ex_{t-1} - \alpha_1 - \alpha_2 reer_{t-1} - \alpha_3 y_{t-1}^*) + \beta_{21}(L)\Delta ex_{t-1} + \beta_{22}(L)\Delta\ reer_{t-1} + \beta_{23}(L)\Delta y_{t-1}^* + v_{2t} \qquad (2b)$$

$$\Delta y_t^* = \beta_{30} + \varphi_3(ex_{t-1} - \alpha_1 - \alpha_2 reer_{t-1} - \alpha_3 y_{t-1}^*) + \beta_{31}(L)\Delta ex_{t-1} + \beta_{32}(L)\Delta\ reer_{t-1} + B_{33}(L)\Delta y_{t-1}^* + v_{3t}\ . \qquad (2c)$$

The φ's are error correction coefficients that measure how quickly the endogenous variables respond to disequilibria, the L's represent polynomials in the lag operator, and the other variables are defined above. If exports move towards their equilibrium values, φ_1 will be negative and statistically significant. Johansen maximum likelihood methods are used to estimate the system.

Equation (1) can also be estimated using dynamic ordinary least squares. Provided that there is one cointegrating vector, DOLS yields consistent and efficient estimates of the long run parameters. It also performs favorably in smaller samples. DOLS involves estimating an equation of the form:

$$ex_t = \alpha_1 + \alpha_1 reer_t + \alpha_2 y_t^* + \sum_{k=-K}^{K} \beta_{1,k}\Delta reer_{t+k} + \sum_{k=-K}^{K} \beta_{2,k}\Delta y_{t+k}^* + \varepsilon_t \qquad (3)$$

where K represents the number of leads and lags of the first differenced variables and the other variables are defined above.

Quarterly data on aggregate exports, the German CPI-deflated and ULC-deflated real effective exchange rates, and income in the rest of the world are obtained from the IMF's International Financial Statistics (IFS). Exports are deflated using German export prices obtained from IFS.

A consistent time series for the ULC-deflated reer is only available up to 2009. Consistent time series for the other variable are available at least through 2011. The sample period when using the unit labor cost-deflated reer thus extends from 1980 to 2009 and the sample period when using the consumer price index-deflated reer extends from 1980 to 2011. Since we are using quarterly data, this implies that we have more than 100 observations in every case.

We calculate rest of the world income (y_t*) by employing a geometrically weighted average of income changes in Germany's top ten export destinations. The index is constructed using the following formula:

$$y_t* = y_{t-1} * \prod_{i=1}^{10} (y_{i,t} / y_{i,t-1})^{w_{i,t}} \qquad (4)$$

where i represents one of the 10 largest importing countries, y_i is income in country i, and w_i is the share of German exports going to country i relative to German exports going to the ten largest export markets. The weights are calculated using annual data on German goods exports obtained from the CEPII-CHELEM database. The annual data are converted to quarterly data using linear interpolation. The index is set equal to 100 in 1980q1.

We employ augmented Dickey-Fuller tests to examine whether the series are integrated of order one. The results indicate that they are. We then use the Schwarz criterion to determine how many lags to use in equation (2) and whether to include time trends in the cointegrating equation. Finally, we use the trace statistic and the maximum eigenvalue statistic to test the null of no cointegrating relations against the alternative of one cointegrating relation. Results from both tests at the 5 percent level point to the existence of one cointegrating relation.

Results

Table 1 presents the results from estimating equation (2). The first row presents the results using the CPI-deflated reer and the second row presents the results using the ULC-deflated reer. In both cases, the trade elasticities are of the expected signs and statistically significant.

The income elasticity is approximately equal in both cases. In the first row, the results indicate that a 10 percent increase in income in the importing countries would increase Germany's exports by 23.5 percent. In the second row, the results indicate that a 10 percent increase in income in the importing countries would increase Germany's exports by 26.4 percent.

The exchange rate elasticity is much larger for the CPI-deflated reer than for the ULC-deflated reer. For the CPI-deflated exchange rate, a 10 percent appreciation would lead to a 15.1 percent reduction in exports. For the ULC-deflated exchange rate, a 10 percent appreciation would lead to a 6.0 percent reduction in exports.

Since the sample period in the first row extends to 2011, it includes the 25 percent drop in exports that occurred during the global financial crisis and the subsequent recovery. Figure 5 presents the residuals. Actual exports fell 13 percent more than predicted at the end of 2008 and then quickly recovered. This suggests that the trade collapse during the global financial crisis was a temporary disequilibrium phenomenon.

Table 2a presents DOLS results for the model including the CPI-deflated reer and Table 2b presents DOLS results for the model including the ULC-deflated reer. In all cases the trade elasticities are of the expected signs and statistically significant. In Table 2a the exchange rate elasticities vary from -0.67 to -1.0. These results indicate that a 10 percent exchange rate appreciation would reduce exports in the long run by between 6.7 and 10 percent. In Table 2b

the exchange rate elasticities vary from -0.60 to -0.64, indicating that a 10 percent appreciation would reduce long run exports by between 6.0 and 6.4 percent.

It is instructive to compare the exchange rate elasticities in Tables 1 and 2. The value of -1.51 in the first row of Table 1 is much higher than any of the other estimated exchange rate elasticities. Stock and Watson (1993) reported that the distribution of the Johansen estimator has more outliers than the distribution of the DOLS estimator. This high value is likely an outlier. On the other hand, the coefficient on the ULC-deflated reer is almost the same in every specifications. It varies from -0.60 to -0.64. The associated standard error equals 0.03 in four of the cases and 0.06 in the fifth case. The exchange rate elasticity for the ULC-deflated reer thus appears to be precisely estimated and robust.

Further evidence that the model using the ULC-deflated reer is well specified comes from the error correction coefficient on Table 1. It is negative and statistically significant, indicating that exports return to their equilibrium value. Its value indicates that the gap between the current value and the equilibrium closes at a rate of 32 percent per quarter. By contrast, for the CPI-deflated reer the gap closes at a rate of only 9 percent per quarter.

The sample periods in Tables 1 and 2 include the great trade collapse that began in 2008Q3. To test whether this influenced the results, we also try truncating the sample in 2008Q2. The results are similar to those reported in Tables 1 and 2. Thus the findings reported here are robust to the collapse in exports during the global financial crisis.

3. The Effect of Exchange Rate Changes on Germany's Exports: Panel Data and Disaggregated Evidence

Data and Methodology

Close to 50 percent of Germany's exports have consistently been in the categories of 1) capital and equipment goods and 2) consumption goods.[3]   This section uses panel data techniques to estimate trade elasticities for these two categories and also for total goods exports. Panel data sets are constructed including German exports to its major importing countries over the 1980-2010 period.   Countries that were minor importers over part of the sample period are excluded because these countries can have large percentage changes in imports due to idiosyncratic factors rather than due to the macroeconomic variables in equation (1). The major importing countries over the whole sample period are Austria, Belgium (and Luxembourg), Denmark, Finland, France, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

We use panel DOLS techniques to obtain trade elasticities. The estimated models take the form:

$$ex_{i,j,t} = \beta_0 + \beta_1 rer_{j,t} + \beta_2 y_{j,t}^* + \sum_{k=-p}^{p} \alpha_{1,k} \Delta rer_{j,t-k} + \sum_{k=-p}^{p} \alpha_{2,k} \Delta y_{j,t-k}^* \qquad (5)$$

$$+ u_{i,j,t},$$

$$t = 1, \cdots, T; \qquad j = 1, \cdots, N.$$

Here $ex_{i,j,t}$ represents real exports of sector i (either consumption goods, capital goods, or total goods) from Germany to country j, $rer_{j,t}$ represents the bilateral real exchange rate between

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[3] As defined by CEPII, capital and equipment goods come from the following product categories: aeronautics, agricultural equipment, arms, commercial vehicles, computer equipment, construction equipment, electrical apparatus, electrical equipment, precision instruments, ships, specialized machines, and telecommunications equipment. Consumption goods come from the following categories: beverages, carpets, cars, cereal products, cinematographic equipment, clocks, clothing, consumer electronics, domestic electrical appliances, knitwear, miscellaneous manufactured articles, optics, pharmaceuticals, photographic equipment, preserved fruit and vegetable products, preserved meat and fish products, soaps and perfumes (including chemical preparations), sports equipments, toiletries, toys, and watches.

Germany and importing country j, and $y_{j,t}^{*}$ represents real income in country j. In some specifications country j fixed effects, time fixed effects, and homogeneous or heterogeneous linear trends are included. We estimate the panel DOLS model using heteroskedasticity-consistent standard errors and also using the Mark-Sul (2003) two step technique with standard errors based on 1) the Andrews- Monahan (1992) pre-whitening approach and 2) parametric corrections.

We obtain data on exports and real income from the CEPII-CHELEM database. Exports are measured in U.S. dollars and deflated using the German import price index obtained from the US Bureau of Labor Statistics.

We employ two measures of the bilateral real exchange rate. The first is the CEPII real exchange rate between Germany and country j. It is calculated by first dividing gross domestic product in US dollars for Germany by gross domestic product in purchasing power parity for Germany and doing the same for country j. The resulting ratio for Germany is then divided by the ratio for country j. This variable measures the units of consumer goods in Germany needed to buy a unit of consumer goods in country j. The second is the bilateral nominal exchange rate between Germany and country j, deflated using unit labor costs in Germany and in country j. The ULC data come from the OECD.[4] The ULC data have some missing values and some estimated values. In addition, in some cases the ULC-deflated bilateral real exchange rate varies erratically. Thus more weight should probably be attached in this section to the results using the CEPII real exchange rate.

We perform a battery of panel unit root tests on the variables. The results, available on request, indicate that in most cases the variables are integrated of order one (I(1)). We

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[4] The website is www.oecd.org.

then perform Kao (1999) residual cointegration tests for the variables. The results, again available on request, indicate that the null hypothesis of no cointegration can be rejected. Since DOLS is designed to estimate cointegrating relationships, our model in equation (5) is appropriate.

Results

Table 3-5 present results using consumption, capital, and total exports, respectively. Columns (1) through (4) in each table present results from estimating equation (5) employing heteroskedasticity-consistent standard errors. Columns (5) through (8) present results using the Mark-Sul estimator. Columns (5) and (7) present standard errors based on the Andrews-Monihan approach and columns (6) and (8) present standard errors based on parametric corrections. The results are robust to these different approaches.

In Table 3 for consumption goods exports the income and exchange rate elasticities are of the expected signs and statistically significant in every specification. The income elasticites range from 2.6 to 3.5, indicating that Germany's consumption goods exports are sensitive to income in the importing countries. Many of these goods are luxury cars and other high-end items, so the high income elasticities make sense. The elasticities for the CEPII real exchange rate vary from 0.8 to 1 and the elasticities for the ULC-deflated rer vary from 0.7 to 0.8. Because of missing observations, the Mark-Sul approach could not be used for the ULC-deflated rer.

In Table 4 for capital goods exports the income and exchange rate elasticities are again of the expected signs. The income elasticities are statistically significant in every specification and the exchange rate elasticities are statistically significant at at least the 10 percent level in 7 out of the 8 specifications. The income elasticites range from 1.5 to 1.9, indicating that Germany's

capital goods exports are sensitive to income in the importing countries. The elasticities for the CEPII real exchange rate equal about 0.3 and the elasticities for the ULC-deflated rer equal about 0.2. These low elasticities probably reflect the fact that Germany's capital goods exports tend to be high quality goods that compete more on quality than on price.

Table 5 reports results for total exports. The income and exchange rate elasticities are of the expected signs and statistically significant in every case. Their values are between the coefficient values for consumption and capital goods exports. The income elasticities are between 1.8 and 2. Unlike Table 2, the elasticities in Table 5 do not change much when trend terms are included. The exchange rate elasticities for the CEPII rer vary from 0.45 to 0.55 and the exchange rate elasticities for the ULC-deflated rer vary from 0.34 to 0.44. One reason why these values in Table 5 are lower than the values reported in Tables 1 and 2 is that the values in Table 5 only apply to goods exports whereas the values in Tables 1 and 2 apply to both goods and services exports.   Allard, Catalan, Evereard, and Sgherri (2005) reported that export elasticities are lower for German goods exports than for German services exports.

Table 6 presents estimates of elasticites for eurozone and non-eurozone countries separately.[5] The income and exchange rate elasticities are again of the expected signs and statistically significant at at least the 10 percent level in all but one case. The exchange rate elasticities are much higher for Germany's exports to eurozone countries than for its exports to non-eurozone countries. Bayoumi, Harmsen, and Turunen (2011) reported much higher exchange rate elasticities for exports from eurozone countries in general to other eurozone countries than for exports from eurozone countries to non-eurozone countries. For consumption goods exports and the CEPII rer, elasticities for exports to the eurozone range from 1.3 to 1.5 and

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[5] Results using the Mark-Sul estimator are not included because the Gauss program stopped due to a non-positive definite matrix.

elasticites for exports outside the eurozone equal about 0.75. For consumption goods exports and the ULC-deflated rer, elasticities for exports to the eurozone vary between 0.9 and 1 and elasticites for exports outside the eurozone vary between 0.6 and 0.7. The elasticities for consumption goods exports to Europe are about 70 or 80 basis points higher. For capital goods exports and the CEPII rer, elasticities for exports to the eurozone range equal 0.64 and elasticites for exports outside the eurozone equal about 0.20. For capital goods exports and the ULC-deflated rer, elasticities for exports to the eurozone equal about 0.30 and elasticites for exports outside the eurozone equal 0.20 or less. For all goods and the CEPII rer, elasticities for exports to the eurozone range from 0.9 to 1 and elasticites for exports outside the eurozone equal about 0.35. For all goods and the ULC-deflated rer, elasticities for exports to the eurozone equal between 0.4 and 0.6 and elasticites for exports outside the eurozone equal about 0.3.

The sample periods in Tables 3 through 6 include the great trade collapse. With annual data, the collapse is evident beginning in 2009. The results are similar when the sample is truncated in 2008. Thus the findings in Tables 3 through 6 are robust to excluding the collapse of exports that occurred during the global financial crisis.

The important implication of the results reported in this section is that Germany's exports to other members of the common currency and especially Germany's consumption goods exports to eurozone countries are sensitive to exchange rate changes. The large devaluation of the German real exchange rate relative to other eurozone countries thus contributed to the surge in German exports to the eurozone after 2000 that is evident in Figure 2.

4. Conclusion

Germany is now the world's second largest exporter. Its exports have soared since it joined the common currency in 1999. This paper seeks to understand the relationship between Germany's exports and its exchange rate.

The results indicate that there is a long run equilibrium relationship between Germany's aggregate exports, its real exchange rate, and income in importing countries. In every specification the evidence implies that an appreciation of the German reer would reduce exports. The results using the unit labor cost-deflated reer are precisely and robustly estimated and indicate that a 10 percent appreciation would reduce exports by 6 percent. German exports are also sensitive to income in the rest of the world.

Results using a panel data set indicate that consumption exports are much more sensitive than capital goods exports are to exchange rate changes. German capital goods exports tend to be high quality goods that compete more on quality than on price. Thus the fact that the price elasticity is small is not surprising. The findings also indicate that German exports to the eurozone are much more price elastic than German exports outside the eurozone.

Since Germany experienced a large internal devaluation against other eurozone countries after 2000, one would expect exports from Germany to the eurozone to have increased. Figure 2 shows that there was indeed a surge in exports to the eurozone. This in turn contributed to the huge eurozone imbalances that are evident in Figure 3.

Viewed from the perspective of capital flows, eurozone imbalances developed partly because German banks became more willing to invest in peripheral eurozone countries after the countries joined the common currency (see Gros and Mayer, 2012). However, following the eurozone crisis, German banks and savers have become less willing to invest in Greece, Spain,

Portugal, Italy, and other deficit countries. Current account imbalances between European countries may thus prove unsustainable.

In a flexible exchange rate system, part of the resulting adjustment would come through a nominal appreciation of the German currency relative to the currencies of the deficit countries. This is precluded as long as these countries share a common currency. Exchange rate adjustment must come instead through a decline in wages and prices or an increase in productivity in the peripheral countries vis-à-vis Germany. The evidence presented here indicates that these adjustments will have to be large. Restoring equilibrium in the eurozone is thus likely to be a long and painful process.

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Table 1. Johansen MLE Estimates for German Exports to the World

	Number of Cointe-grating Vectors	Number of Obser-vations	REER Elastic-ity	Income Elastic-ity	Error Correction Coefficients		
					Exports	REER	Income
Germany's Exports (CPI-deflated REER. Lags: 0; Sample: 1980:II-2011:I; No trend; Seasonal dummies for the first, second, and third quarters are included.)	1,1	124	-1.51** (0.64)	2.35*** (0.14)	-0.09*** (0.01)	-0.004 (0.03)	-0.02*** (0.00)
Germany's Exports (ULC-deflated REER. Lags: 0; Sample: 1980:II-2009:3; No trend; Seasonal dummies for the first, second, and third quarters are included.)	1,1	118	-0.60*** (0.06)	2.64*** (0.04)	-0.32*** (0.09)	-0.009 (0.05)	-0.00 (0.02)

Notes: Lag length was selected based on the Schwarz criterion. Number of Cointegrating Vectors indicates the number of cointegrating relations according to the trace and maximum eigenvalue tests at the 5% level. Seasonal dummies are included.
*** (**) denotes significance at the 1% (5%) level.

Table 2a. Dynamic OLS Estimates for German Exports to the World

	(1)	(2)	(3)	(4)
CPI-deflated REER Elasticity	-1.00***	-0.67***	-0.94***	-0.67***
	(0.16)	(0.18)	(0.16)	(0.17)
Income Elasticity	0.74***	2.41***	1.01***	2.40***
	(0.27)	(0.04)	(0.31)	(0.04)
Time	0.01***		0.01***	
	(0.002)		(0.002)	
No. of Lags and Leads	2	2	1	1
Adjusted R-squared	0.98	0.97	0.98	0.98
No. of observations	122	122	123	123
Sample Period	1980:4-2011:1	1980:4-2011:1	1980:3-2011:1	1980:3-2011:1

Notes: DOLS estimates. Heteroskedasticity-consistent standard errors are in parentheses.
Seasonal dummies are included
*** (**) denotes significance at the 1% level.

Table 2b. Dynamic OLS Estimates for German Exports to the World

	(1)	(2)	(3)	(4)
ULC-deflated REER Elasticity	-0.64***	-0.61***	-0.62***	-0.60***
	(0.03)	(0.03)	(0.03)	(0.03)
Income Elasticity	1.36***	2.64***	1.80***	2.64***
	(0.25)	(0.03)	(0.26)	(0.02)
Time	0.01***		0.01***	
	(0.00)		(0.00)	
No. of Lags and Leads	2	2	1	1
Adjusted R-squared	0.995	0.994	0.995	0.994
No. of observations	114	114	116	116
Sample Period	1980:4-2009:1	1980:4-2009:1	1980:3-2009:2	1980:3-2009:2

Notes: DOLS estimates. Heteroskedasticity-consistent standard errors are in parentheses.
Seasonal dummies are included
*** denotes significance at the 1% level.

Table 3. DOLS Estimates of Germany's consumption goods exports to 14 countries over the 1980-2010 period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real GDP	3.16***	3.21***	3.23***	3.18***	3.45***	3.45***	2.57***	2.57***
	(0.29)	(0.29)	(0.28)	(0.27)	(0.59)	(0.56)	(0.19)	(0.18)
Bilateral RER	-0.89***	-0.97***			-0.88***	-0.88***	-0.84***	-0.84***
(CPI-deflated)	(0.12)	(0.09)			(0.26)	(0.26)	(0.27)	(0.26)
Bilateral RER			-0.69***	-0.81***				
(ULC-deflated)			(0.13)	(0.09)				
Time		-0.021**		-0.022***				
		(0.07)		(0.007)				
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	No	Yes	No	No	No	Yes	Yes
Heterogeneous Linear Trend	No	No	No	No	Yes	Yes	No	No
No. of observations	392	392	378	378	392	392	392	392

Notes: DOLS(1,1) estimates. The data extend from 1980 to 2010. Because of lags and leads in the estimation the actual sample period extends from 1982-2009. Columns (1) – (4) report results with heteroskedasticity-consistent standard errors in parentheses. Columns (5) – (8) report results employing the Mark-Sul estimator. Columns (5) and (7) report standard errors based on the Andrews-Monahan pre-whitening approach and Columns (6) and (8) report standard errors based on parametric corrections.
*** (**) denotes significance at the 1 percent (5 percent) level.

Table 4. DOLS Estimates of Germany's capital goods exports to 14 countries over the 1980-2010 period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real GDP	1.50***	1.65***	1.47***	1.63***	1.94***	1.94***	1.85***	1.85***
	(0.14)	(0.14)	(0.15)	(0.14)	(0.34)	(0.31)	(0.12)	(0.10)
Bilateral RER (CPI-deflated)	-0.29***	-0.34***			-0.29*	-0.29**	-0.25	-0.25*
	(0.11)	(0.09)			(0.15)	(0.13)	(0.18)	(0.15)
Bilateral RER (ULC-deflated)			-0.18***	-0.23***				
			(0.08)	(0.08)				
Time		0.006**		0.006**				
		(0.03)		(0.003)				
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	No	Yes	No	No	No	Yes	Yes
Heterogeneous Linear Trend	No	No	No	No	Yes	Yes	No	No
No. of observations	392	392	378	378	392	392	392	392

Notes: DOLS(1,1) estimates. The data extend from 1980 to 2010. Because of lags and leads in the estimation the actual sample period is from 1982-2009. Columns (1) – (4) report results with heteroskedasticity-consistent standard errors in parentheses. Columns (5) – (8) report results employing the Mark-Sul estimator. Columns (5) and (7) report standard errors based on the Andrews-Monahan pre-whitening approach and Columns (6) and (8) report results based on parametric corrections.
*** (**) [*] denotes significance at the 1 percent (5 percent) [10 percent] level.

Table 5. DOLS Estimates of Germany's total goods exports to 14 countries over the 1980-2010 period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real GDP	1.91***	1.93***	1.93***	1.84***	1.92***	1.92***	2.02***	2.02***
	(0.17)	(0.17)	(0.14)	(0.14)	(0.32)	(0.27)	(0.12)	(0.12)
Bilateral RER (CPI-deflated)	-0.51***	-0.55***			-0.50***	-0.50***	-0.45***	-0.45***
	(0.09)	(0.06)			(0.12)	(0.12)	(0.19)	(0.17)
Bilateral RER (ULC-deflated)			-0.34***	-0.44***				
			(0.07)	(0.05)				
Time		0.001		0.003				
		(0.004)		(0.004)				
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	No	Yes	No	No	No	Yes	Yes
Heterogeneous Linear Trend	No	No	No	No	Yes	Yes	No	No
No. of observations	392	392	378	378	392	392	392	392

Notes: DOLS(1,1) estimates. The data extend from 1980 to 2010. Because of lags and leads in the estimation the actual sample period is from 1982-2009. Columns (1) – (4) report results with heteroskedasticity-consistent standard errors in parentheses. Columns (5) – (8) report results employing the Mark-Sul estimator. Columns (5) and (7) report standard errors based on the Andrews-Monahan pre-whitening approach and Columns (6) and (8) report results based on parametric corrections.

*** denotes significance at the 1 percent level.

Table 6. DOLS Estimates of Germany's exports to 14 countries over the 1980-2010 period

	Consumption Goods				Capital Goods			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real GDP	3.11***	3.15***	3.18***	3.13***	1.47***	1.61***	1.47***	1.62***
	(0.27)	(0.27)	(0.29)	(0.27)	(0.12)	(0.13)	(0.15)	(0.14)
Bilateral RER with eurozone Countries (CPI-deflated)	-1.33***	-1.46***			-0.64***	-0.64***		
	(0.21)	(0.12)			(0.20)	(0.15)		
Bilateral RER with non-eurozone Countries (CPI-deflated)	-0.74***				-0.17*	-0.20**		
	(0.14)				(0.10)	(0.09)		
Bilateral RER with eurozone Countries (ULC-deflated)			-0.89***	-1.03***			-0.30***	-0.25**
			(0.19)	(0.11)			(0.09)	(0.11)
Bilateral RER with non-eurozone Countries (ULC-deflated)			-0.59***	-0.67***			-0.12	-0.20**
			(0.15)	(0.14)			(0.09)	(0.09)
Time		-0.020		-0.02		0.007**		0.007
		(0.006)		(0.007)		(0.03)		(0.003)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes	No	Yes	No	Yes	No
No. of Observations	392	392	378	378	392	392	378	378

Notes: DOLS(1,1) estimates. The data extend from 1980 to 2010. Because of lags and leads in the estimation the actual sample period is from 1982-2009. Heteroskedasticity-consistent standard errors are reported in parentheses. *** (**) [*] denotes significance at the 1 percent (5 percent) [10 percent] level.

Table 6 (Continued). DOLS Estimates of Germany's exports to 14 countries over the 1980-2010 period

	All Goods			
	(1)	(2)	(3)	(4)
Real GDP	1.87***	1.61***	1.90***	1.81***
	(0.15)	(0.13)	(0.14)	(0.14)
Bilateral RER with eurozone Countries (CPI-deflated)	-0.94***	-1.00***		
	(0.19)	(0.13)		
Bilateral RER with non-eurozone Countries (CPI-deflated)	-0.36*	-0.35**		
	(0.08)	(0.06)		
Bilateral RER with eurozone Countries (ULC-deflated)			-0.44***	-0.57***
			(0.11)	(0.07)
Bilateral RER with non-eurozone Countries (ULC-deflated)			-0.28***	-0.34***
			(0.08)	(0.07)
Time		0.002		0.034
		(0.004)		(0.035)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes	No
No. of Observations	392	392	378	378

Notes: DOLS(1,1) estimates. The data extend from 1980 to 2010. Because of lags and leads in the estimation the actual sample period is from 1982-2009. Heteroskedasticity-consistent standard errors are reported in parentheses. *** (**) [*] denotes significance at the 1 percent (5 percent) [10 percent] level.
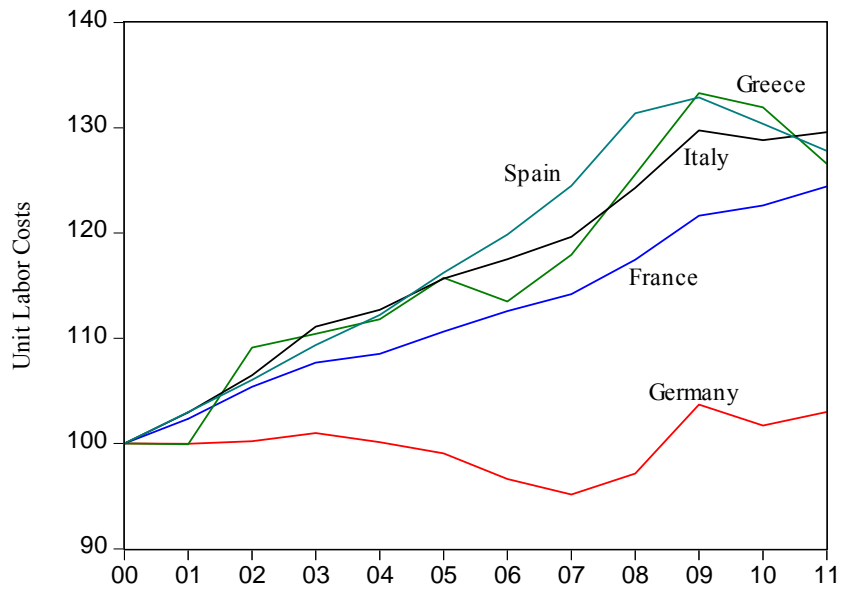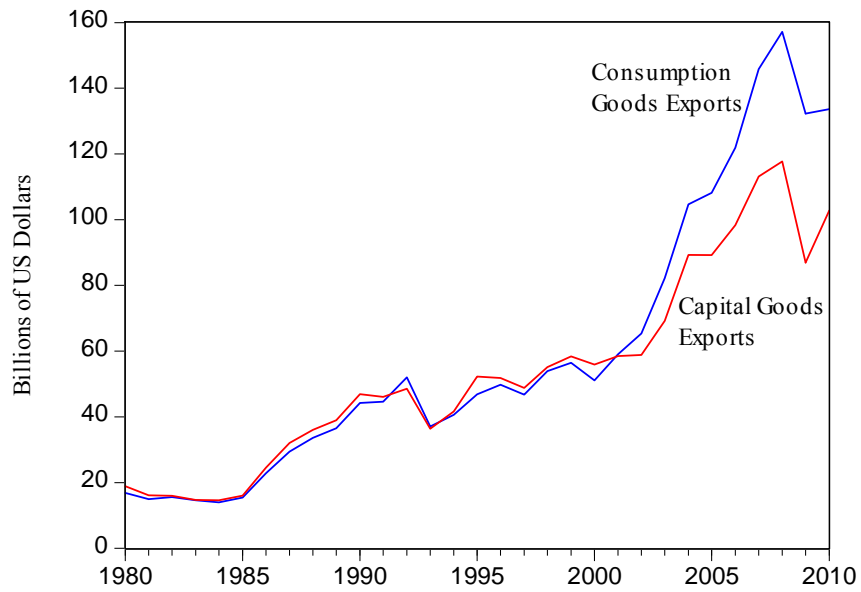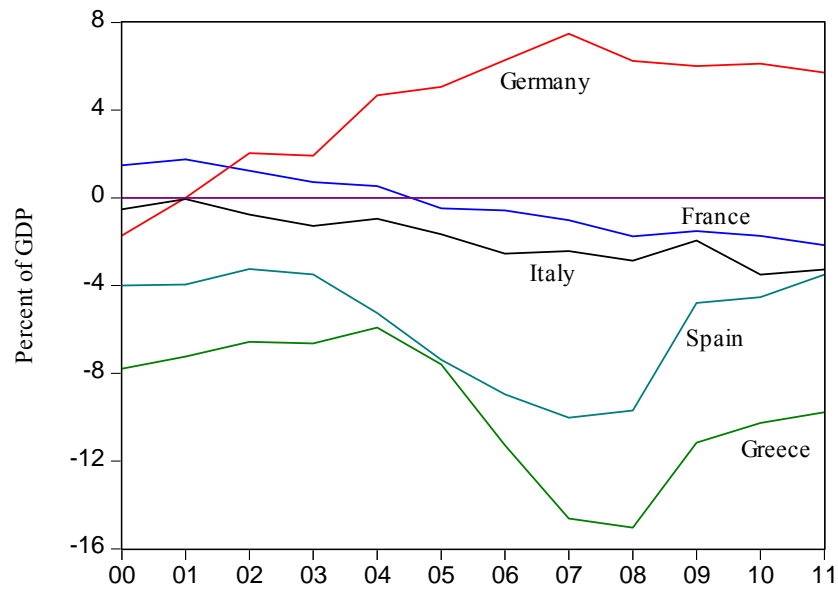
Figure. 1. Unit Labor Costs in Selected eurozone Countries
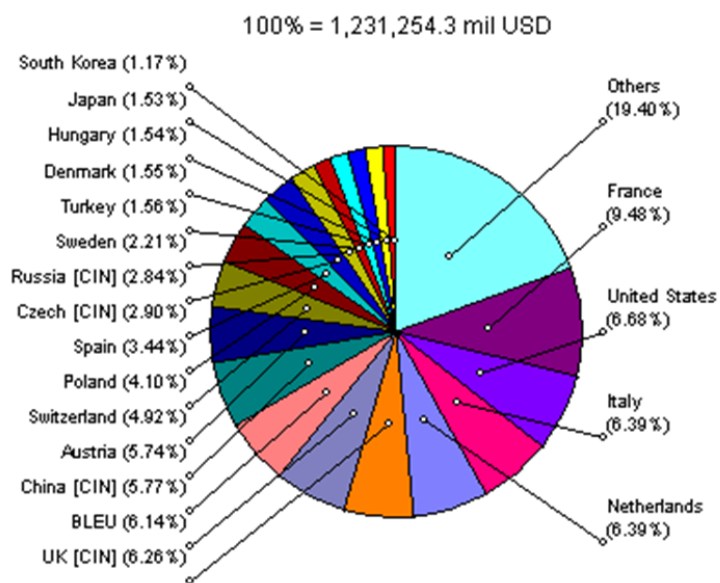*Source*: OECD

Figure 2. German Consumption Goods Exports and Capital
and Equipment Goods Exports to eurozone
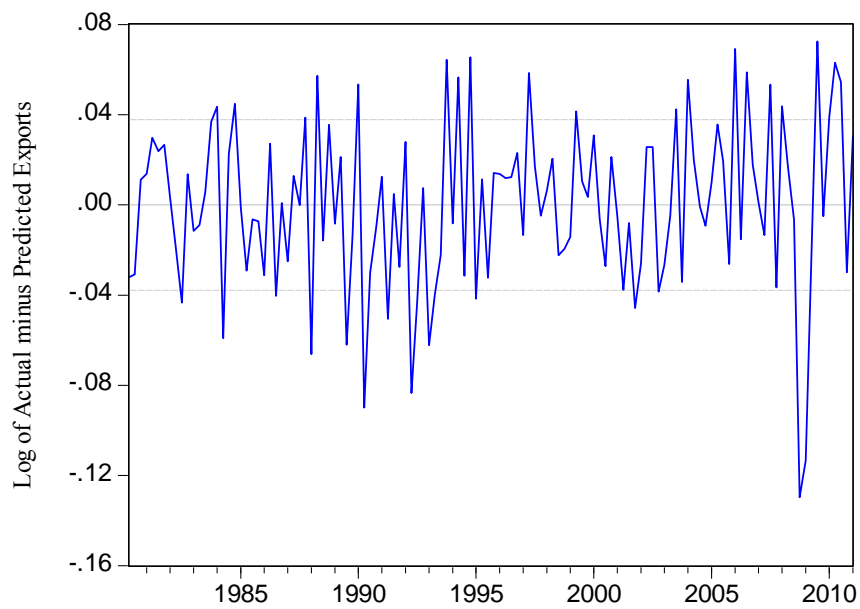*Countries, 1980-2010.*
Source: CEPII-CHELEM Database

*Figure 3. Current Account Balances of Selected eurozone Countries
as a Percent of Each Country's GDP*
Source: International Financial Statistics

Figure 4. Countries Receiving Germany's Exports in 2010
Source: CEPII-CHELEM Database

Figure 5. Residuals from Vector Error Correction Estimates of German Aggregate Exports over the 1980 – 2011 Period
Source: Calculations by the authors