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The determinants of German exports – an analysis of intra- and extra-EMU trade

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Abstract
Since the early 2000s German exports and net exports have grown persistently, generating huge current account surpluses. These surpluses have added to immense current account imbalances within and outside the European Monetary Union (EMU). Contributing to the economic policy debate of whether it is foreign demand or 'world-beating' price competitiveness driving German exports, the present paper econometrically investigates the determinants of German intra- and extra-EMU exports for the period 1995 to 2014. The long-term relationship between real exports, foreign activity and the real effective exchange rate is estimated using different explanatory variables in an error correction framework. The results show that German exports are very sensitive to foreign activity. Germany has benefited from growth dynamics of trading partners and high income elasticities of demand for German exports indicate strong non-price competitiveness. With regard to exchange rate effects, we do not detect a significant impact of the real exchange rate on intra-EMU exports. However, our estimations provide a stable relationship between the real exchange rate and extra-EMU exports. We calculate that the real exchange rate only explains 12% to 25% of our predicted export growth. Moreover, taking into account quantity and price effects caused by changes in the real exchange rate, we observe contrary effects on real and nominal exports. Thus, for the German economy it cannot simply be concluded that the real exchange rate is *the* indicator to focus on in explaining German export success.

Keywords: German exports, current account imbalances, competitiveness, single equation error correction model

JEL Codes: C22, E12, F14, F41, F43

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1 Introduction

Having casted off the image of the "sick man of the euro" (The Economist 1999) in the course of the recovery from the Great Recession, the German economy has become the outstanding example in the European Monetary Union (EMU) with above-average growth rates, a low unemployment rate and a high level of net exports. However, from the early 2000s until the financial and economic crisis 2008/09, Germany followed a neo-mercantilist strategy, characterised by low wage growth, weak domestic demand, rapidly rising trade openness, and a high contribution of net exports to GDP growth.[1] The country became highly dependent on foreign activity and moreover, largely contributed to the development of massive and persistent current account imbalances in the euro area and in the world economy, both before and after the recent crises.

In explaining these imbalances and German current account surpluses, the focus has been in particular on international price and cost competitiveness, which many economists have attributed to diverging nominal unit labour costs (ULC) (Flassbeck/Lapavitsas 2013; Lapavitsas et al. 2010; Sinn 2014; Stockhammer 2011; Stockhammer/Onaran 2012). According to these views, current account surplus countries, Germany being the role model, have successfully improved their price competitiveness by wage moderation and/or high productivity growth. Excessive ULC growth has deteriorated price competitiveness and led to the accumulation of current account deficits in the counterpart countries. With respect to economic policy implications dealing with current account imbalances in the EMU, Stockhammer/Onaran (2012) suggest "inflationary rebalancing", which means that in the medium-term, nominal wages in deficit countries should grow in line with the European Central Bank's inflation target of 2%, whereas wages in surplus countries should grow well above this benchmark in order to share the adjustment burden. This would require higher overall inflation targets for the euro area. However, Sinn (2014) considers austerity policy and "open devaluation" as inevitable in order to (re-)install price competitiveness in Southern EMU member states, and also in France, countries which, according to him, have become too expensive since the introduction of the euro. In the core economies, he proposes to let market forces work to generate a demand boom and inflationary growth. The adjustment of inflation rates would thus structurally improve current account imbalances in the euro area. With respect

1 For a definition see Becker/Raza (2007).

to deficit countries, the European Commission (cf. 2010; 2011) and the International Monetary Fund (IMF) (cf. 2013; 2017) also encourage cuts in nominal wage levels with the view that reducing nominal wage growth and implementing supply-side oriented structural reforms will improve price competitiveness and reduce imbalances by promoting exports. EU members characterised by current account surpluses should in turn ensure that their export success also translates into stronger domestic demand in order to increase import demand (EU Commission 2010; 2017). In the Macroeconomic Imbalances Procedure (MIP) introduced in 2011, the EU Commission (2016) refers to a broad set of indicators, two of which assess the external performance of an economy focus on price competitiveness (real effective exchange rate and nominal unit labour cost index).

While the so-far mentioned authors predominately stress the relevance of price competitiveness and in particular of nominal unit labour costs in explaining export and import performances, a growing number of researchers (Danninger/Joutz 2007; Horn/Watt 2017; Schröder 2015; Simonazzi et al. 2013; Stockhammer/Hein/Grafl 2011; Storm/Nastepaad 2014) argue that non-price factors, domestic expenditure and foreign demand dynamics have played a far more important role in determining the development of trade balances and current accounts, particularly in Germany. According to them, demand for German (manufacturing) goods on the one hand and weak German import demand on the other hand, have largely contributed to the accumulation of the country's current account surplus. Even if relative prices were relevant too, it has been questioned whether the focus on nominal unit labour costs is suitable, because they are only one determining factor in firms' price setting (Feigl/Zuckerstätter 2012; Horn/Watt 2017; Storm/Nastepaad 2015). Moreover, if price elasticities were rather small or insignificant, the Marshall-Lerner condition would not be fulfilled and the current account would not react normally to a change in the real exchange rate. This might limit or even reverse the effect of wage and exchange rate policies intended to combat current account imbalances.

Against the background of this debate, the present paper seeks to shed some light on the determinants of German exports. There has been a variety of empirical work on German trade elasticities, but only a few early studies by Stahn (2006) and Stephan (2005) have estimated German exports by distinguishing exports to EMU and to non-EMU countries. The current paper follows this approach and covers a more recent time

period. It investigates the impact of the real effective exchange rate and of foreign demand on German exports to countries in- and outside of the euro area for the period from 1995 to 2014. The regional breakdown allows for identifying structural differences between the two trading regions. We suppose demand patterns and dynamics to be different between German trading partners in and outside the EMU, because the latter includes former Eastern bloc nations, as well as China and Brazil. These economies have rapidly built up their capital stock in the period under consideration and therefore should have increased demand in markets for which German production is highly specialised. Thus income elasticities of demand for German exports to these countries are expected to be very high. EMU member states share historical, cultural and economic commonalities and produce more comparable products or substitutes (Federal Statistical Office Germany 2010). We therefore assume relative prices to be more relevant for trade among EMU members, a result which was found by Stahn (2006) for German exports and by Bayoumi (2011) for an aggregate of euro area member countries. In addition to the econometric analysis, we use our estimated elasticities and the actual growth of the relevant variables and calculate the extent to which foreign demand and the exchange rate contribute to our predicted export growth in order to better identify the driving forces behind German exports in the period under consideration.

The paper is structured as follows: section 2 takes a look at the development of key macroeconomic indicators between 1995 and 2014 and provides an overview of the German economic performance as compared to those of its most important trading partners; section 3 reviews the empirical literature on German export equations before we present and discuss our estimation results and the contributions of demand and relative prices to the development of German exports to the EMU and extra-EMU countries; and section 4 concludes.

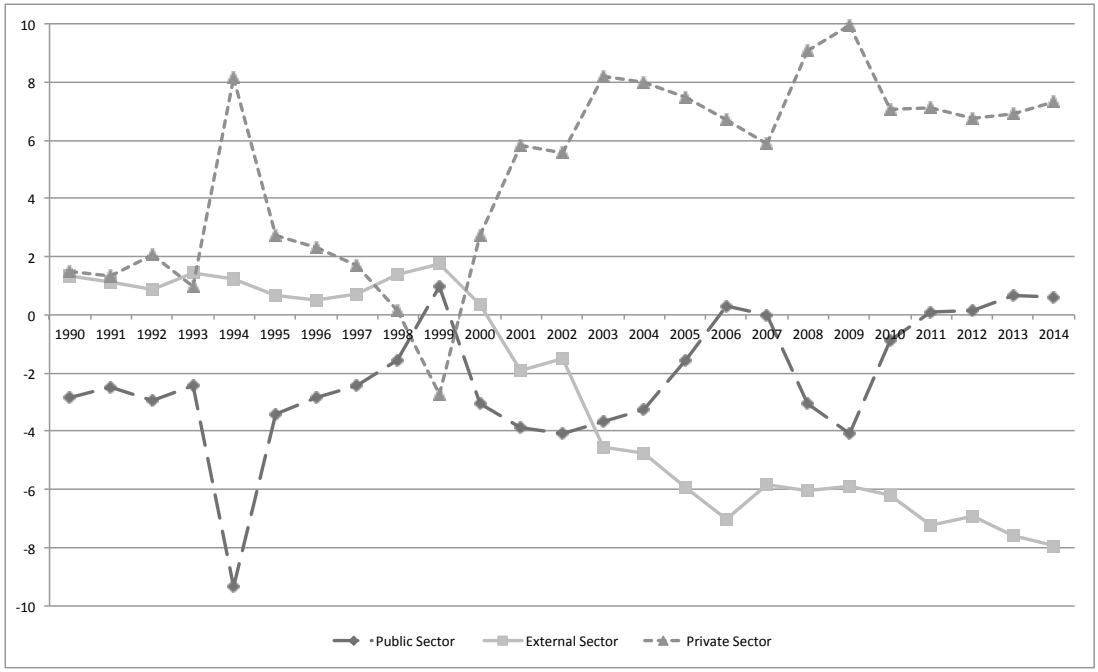
2 Macroeconomic indicators for imbalances of Germany in the world economy

This section first presents the development of the sectoral financial balances in Germany and secondly gives a brief overview of the German economic performance compared to that of the aggregated two trading groups: the EMU members on the one and extra-EMU

countries on the other hand. Hereby, the focus is on the period 1995 to 2014, the one also considered in the econometric estimations in section 3.

At first, Figure 1 shows the characteristic development of sectoral financial balances of a country that has followed a mercantilist growth strategy since the introduction of the euro in 1999. The German private sector as a whole has accumulated net-savings, indicated by a positive financial balance, whereas foreign countries have gone into deficit since 2000, represented by a negative financial balance of the external sector. Weak private domestic investment activities, firms' accumulated retained earnings facilitated by extensive tax reforms in the early 2000s, wage moderation and a shrinking wage share, as well as a restrictive fiscal policy and rising net exports characterised the economic environment from 2000 until the financial and economic crisis 2008/09.[2] Since 1990, the public sector balance has been negative, with the exception of 1999 and 2006/07, but has become positive since 2011 after the government had made use of its stabilising function during the recent crisis.

Figure 1 German sectoral financial balances as percentage of nominal GDP, 1990-2014



Source: European Commission (2015), own calculations.

2 For more details on the causes of these developments and on the German macroeconomic strategy see for instance Detzer/Hein (2014); Dodig et al. (2016); Hein/Truger (2009).

Having sketched the development of the German sectoral financial balances, in what follows, the average growth rates of selected macroeconomic indicators are considered, which are displayed in Table 1. Table 1 covers the overall time period for our examination, 1995-2014, and three sub-periods; the first is from 1995 to 1998; the second from 1999, the year of the introduction of the euro, to 2007, the year preceding the financial and economic crisis; and the third covers the years 2008 to 2014. As destinations for German exports, we include the 23 most important trading partners in- and outside the EMU with a share in German exports of at least 1% (excluding United Arab Emirates; status as of 2014, Federal Statistical Office Germany 2015). Moreover, five additional euro area members with a share of less than 1% in German exports are taken into account.[3] In 2014, these 28 countries covered 85% of German exports of goods. In the periods 1995 and 1998, the shares of exports to the EMU and extra-EMU countries were 44.4% and 40.3% respectively. From 1999 to 2007 and from 2008 to 2014, the share of exports to the EMU declined from 44.1% to 38.9%, whereas the extra-EMU countries increased from 42.7% to 45.9% over the same period.

From Table 1, we get that the German economy has grown more slowly as compared to the two trading groups. In particular, the extra-EMU aggregate including China, Brazil and former Eastern bloc economies with high rates of growth outperformed Germany and the EMU. Since the recent economic crisis, overall growth rates have been declining, particularly in the EMU. Although the growth contribution of net exports to GDP has been reduced and Germany has switched towards more domestic demand, during the whole period under consideration, Germany's GDP growth was exceptionally dependent on foreign trade.[4] Notably, in the period after the introduction of the euro until the economic crisis, domestic demand has contributed little to GDP growth, while net exports have added more than 0.8 percentage points on average to GDP growth. A similar pattern can be observed in the development of net exports as a share of nominal GDP, which has mostly been higher for Germany compared to its trading partners.

3 The EMU aggregate consists of the following countries, whereas (a) signifies the five additional EMU-countries with less than 1 % share in German exports: Austria, Belgium, Finland (a), France, Greece (a), Ireland (a), Italy, Luxemburg (a), Netherlands, Portugal (a), Slovakia and Spain. The extra-EMU aggregate consists of: Brazil, China, Czech Republic, Denmark, Hungary, Japan, Norway, Poland, Romania, Russia, South Korea, Sweden, Switzerland, Turkey, United Kingdom and the United States of America.

4 See Schröder (2015) for an analysis on the contribution of expenditures and expenditure switching to the imbalances in the EMU.

Table 1 Macroeconomic indicators for imbalances, average growth rates, 1995-2014

	Germany	EMU	Extra-EMU
1995 - 2014			
Real GDP growth, %[1)]	1.31	1.64	2.73
Growth contribution of net exports to nominal GDP growth, percentage points[2)]	0.44	0.21	0.10
Net exports as share of nominal GDP, %[1)]	3.65	2.50	1.19
Growth of nominal unit labour costs, %	0.76	1.69	3.28
Inflation (growth rate of CPI), %	1.49	1.95	3.70
Growth rate of the nominal effective exchange rate, %	0.07	0.15	-0.88
Growth rate of the real effective exchange rate, (CPI-based) %[3)]	-0.92	0.01	0.47
1995 – 1998			
Real GDP growth, %[1)]	1.61	2.49	2.83
Growth contribution of net exports to nominal GDP growth, percentage points[2)]	0.21	0.09	-0.13
Net exports as share of nominal GDP, %[1)]	0.95	2.95	0.84
Growth of nominal unit labour costs, %	-0.20	0.94	4.84
Inflation (growth rate of CPI), %	1.42	1.99	5.70
Growth rate of the nominal effective exchange rate, %	-1.48	-0.69	-0.95
Growth rate of the real effective exchange rate, (CPI-based) %[3)]	-3.14	-1.17	2.69
1999 – 2007			
Real GDP growth, %[1)]	1.69	2.59	3.20
Growth contribution of net exports to nominal GDP growth, percentage points[2)]	0.82	0.12	0.13
Net exports as share of nominal GDP, %[1)]	3.65	2.36	0.85
Growth of nominal unit labour costs, %	-0.06	1.96	3.53
Inflation (growth rate of CPI), %	1.51	2.16	3.67
Growth rate of the nominal effective exchange rate, %	0.68	0.49	-1.24
Growth rate of the real effective exchange rate, (CPI-based) %[3)]	-0.34	0.57	0.20
2008 - 2014			
Real GDP growth, %[1)]	0.60	-0.19	1.99
Growth contribution of net exports to nominal GDP growth, percentage points[2)]	0.07	0.39	0.21
Net exports as share of nominal GDP, %[1)]	5.44	2.42	1.93
Growth of nominal unit labour costs, %	2.22	1.66	2.29
Inflation (growth rate of CPI), %	1.51	1.76	2.88
Growth rate of the nominal effective exchange rate, %	-0.04	0.08	-0.39
Growth rate of the real effective exchange rate, (CPI-based) %[3)]	-0.71	-0.20	0.19

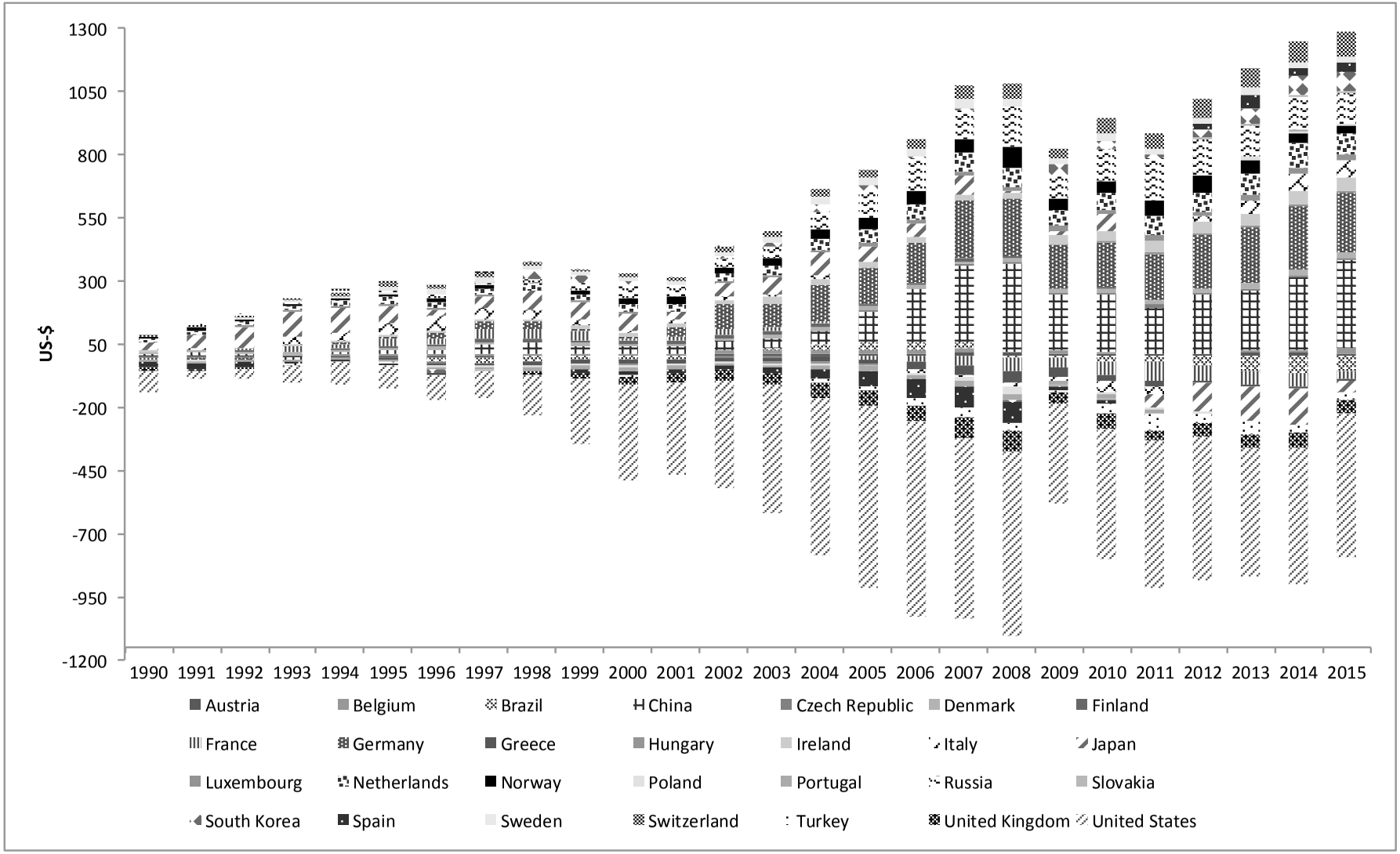
Source: OECD (2015a), IMF (2015), World Bank (2015) from Macrobond; own calculations; Note: Greece weights since 2000; [1)] 1995-2013; [2)] extra-EMU 1996-2014; [3)] excluding Romania and Russia; Brazil since 1996. Information on data construction is provided in the appendix.

In 2014, the share of German net exports in GDP exceeded the long-term average and was well above EMU and extra-EMU averages. However, austerity policy in the course of the economic crisis has deteriorated domestic demand and import expenditure growth in many EMU member countries (Schröder 2015), so that their net export share in and growth contribution to GDP have increased. A similar development applies to the extra-EMU aggregate, whose reliance on export growth has increased as well. Taking a look at Figure 2, which represents net exports of the here-considered economies, it is evident that trade deficits have been reduced since the recession and, despite lasting imbalances among them, there has been a shift towards positive net exports. However, this only implies that deficits have been shifted towards economies that are not taken into account here. Thus global imbalances remain. The development of Germany's nominal ULC reflects its mercantilist growth strategy. From 1995 until 2007, the average growth rate was negative and inflation fell short of the European Central Bank's target of below, but close to, 2%. Only since 2008 has ULC growth been positive, almost equal to the extra-EMU average and stronger than the EMU average. Deep wage cuts in EMU deficit countries, in order to follow the above-mentioned goal of (re-)installing price competitiveness, have decreased ULC growth[5] (Dodig 2016; Hein et al. 2011).

This short analysis has stressed that the EMU and extra-EMU aggregates, with faster ULC growth and a higher contribution of domestic demand to GDP, have outperformed Germany with respect to GDP growth. The German growth strategy, characterised by a high share of net exports in GDP and a high contribution to growth by net exports, has made the country highly dependent on the external sector and economic performance of the trading partners. Particularly, this has become clear in 2008/09 when real GDP dropped by 5.6% and net exports shrank by 24.5% (IMF 2015; OECD 2015) in the course of the crisis. The real depreciation, as measured by the CPI-based real effective exchange rate and relatively low ULC growth, hint to improved price competitiveness in the period 1999 to 2007, which is in line with the arguments raised by advocates of the German competitiveness miracle. However, moderate wage growth and the positive private, and now public, sector balance are rather indicative of weak consumption demand and investment activity. This has resulted in modest import demand and which in turn has contributed to the accumulation of the German current account surplus.

5 Horn/Watt (2017) show that for the period 2000 to 2016 wages and not productivity dominated ULC movements.

Figure 2 Germany and trading partners, net exports to the rest of the world, 1990 – 2014, in billion US-Dollar



Source: OECD (2015), own representation. Note: Slovakia since 1992, Hungary since 1993, Greece, Russia since 1994, Brazil since 1995, Romania not included.

3 Estimating demand for German intra- and extra-EMU exports

Before turning to our own estimations of German intra- and extra-EMU exports, we take a closer look at the empirical literature on key determinants of German export demand. Table 2 provides an overview of studies which together cover a long time horizon from 1960 to 2016 and reports the long-term income and price elasticities of demand for exports, the econometric method and region.

Generally, the results show a high sensitivity of German exports to foreign activity although the coefficients strongly vary with the observation period, chosen variables, region or method. High income elasticities of demand for exports reflect strong non-price competitiveness and are characteristic of countries with product differentiation and specialisation in high-technology and complex products (McCombie 2011). Storm/Nastepaad (2015) identify non-price competitiveness as main contributors to Germany's export success. However, from Table 2 we also get that the impact of the real exchange rate, approximated by various cost or price indices, has mostly been found significant. It is important to note that again the magnitude highly depends on period and underlying variable.[6] Models including a real exchange rate based on relative ULC often provide lower price elasticities than models with an exchange rate based on a broader price index, such as the CPI or GDP deflator that also cover other cost factors and the mark-up. At first sight, this seems to support the argument that relative ULC might be less sound in explaining the performance of German exports.

Carlin et al. (2001) have examined the impact of ULC-based relative costs on the export market share for 14 OECD countries and concluded that German exports have been relatively insensitive to costs. Although the country has experienced an increase in relative prices, it has been able to enhance its export market shares. Apparently, Germany is an example of the 'Kaldor paradox', which was recently approved by Storm/Naastepad (2015). Storm/Nastepaad (2015) have estimated an insignificant ULC elasticity of only 0.14. As compared with other studies, the price elasticity is very small. The authors assume a share of relative ULC in gross output prices of only 25%. They calculate an average ULC elasticity based on different former research and argue that in the period 1996 to 2008 the development of relative ULC accounted for less than 1% of the actual

6 Bayoumi et al. (2011) show the great divergence across different price measures in- and outside the euro area.

Table 2 Long-term elasticities of demand for German exports

Author (publication)	Frequency and period	Method	Region	Explained variable	Foreign demand	$\left(\frac{p_d}{p_f e}\right)$	Deterministic trend/ trade intensity
Clostermann (1998)	Quarterly 1975:1 – 1995:4	SEECM	RoW	G	world trade volume **0.79**	P_x/GDP deflator **-0.74**	
Bundesbank (1998)	Quarterly 1975:1 – 1997:2	SEECM	RoW	G	world trade volume **0.88**	deflators of total sales **-0.70**	
Strauß (2000)	Quarterly 1974:2 – 1999:4	SEECM	RoW	G + S	industrial production **1.55**	CPI **-0.58**	linear **0.002**
					GDP **1.34**	CPI **-0.39**	linear **0.003**
Strauß (2003)	Quarterly 1974:2 – 1999:4	SEECM	RoW	G +S	industrial production **1.34**	CPI **-1.00**	world trade intensity **0.41**
Meurers (2003)	Quarterly 1975:1 – 1999:4	JOH	RoW	G	industrial production **1.65**	P_x/CPI **-0.69**	
Allard et al. (2005)	Quarterly 1992:3-2004:3	SEECM	RoW	G	GDP **2.24**	ULC_m/GDP deflator **-0.32**	
				S	GDP **1.0**	CPI/GDP deflator **-0.81**	$start_{1991:1}$, $break_{2001:3}$ **0.003** **0.002**
Stephan (2005)	Quarterly 1981:1 – 2003:2	SEECM	Intra-EMU	G	industrial production **2.03**	CPI **-1.05**	
					fixed capital formation **0.72**	$REEV_{PIFC}$ **-0.37**	trade **0.57**
					investment in machinery and equipment **0.71**	$REEV_{PIMEQ}$ **-0.69**	trade **0.39**
Stahn (2006)	Quarterly 1980:3 - 2004:3	SEECM	Intra-EMU	G + S	export market trend **0.88**	deflators of total sales **-0.92**	
	Quarterly 1993:1 – 2004:3	SEECM	Intra-EMU	G + S	export market trend **0.98**	deflators of total sales **-0.32** (in)	
	Quarterly 1980:3 - 2004:3	SEECM	Extra-EMU	G + S	export market trend **0.81**	deflators of total sales **-0.63**	
	Quarterly 1993:1 – 2004:3	SEECM	Extra-EMU	G + S	export market trend **0.99**	deflators of total sales **-0.30**	

Table 2 continued

Danninger/ Joutz (2007)	Quarterly 1993:1 – 2005:4	JOH	RoW	G	global export demand/global investment **2.36**	ULC_m **-0.27**	
					global export demand **0.77**	value added **-4.0**	ULC_m **-0.19**
Stockhammer (2011)	Annual 1970 – 2005	SEECM	RoW	G + S	GDP **2.02**	P_x/P_m **-0.78**	
Storm/Nastepad (2012)	Annual 1960 – 2000	OLS Cochrane-Orcutt AR(1)	RoW	G + S	world trade **0.99**	ULC **-0.12**	
Breuer/Klose (2013)	Quarterly 1995:1 – 2012:4	SURE system ECM	RoW	G + S	world demand **1.75**	GDP deflators **-0.82**	
					world demand **2.17**	ULC **-0.77**	e **-1.06**
					world demand **2.47**	CPI **0.36** (in)	e **-0.82**
Lebrun/Ruiz (2014)	Quarterly 1995:1 – 2013:3	Fully Modified OLS	RoW	-	export market trends **0.75**	deflators of total sales **-0.24**	linear **0.003**
Onaran/Galanis (2014)	Annual 1971 – 2007	SEECM	RoW	-	GDP **1.78**	P_x/P_m **-0.43**	
Storm/Nastepad (2015)	Quarterly 1996:2 – 2008:4	OLS Prais-Winsten AR(1)	RoW	-	GDP **2.79**	ULC **0.14 (in)**	
Onaran/Obst (2016)	Annual 1960 – 2013	SEECM	RoW	-	GDP **2.14**	P_x/P_m **-0.38**	
Horn/Watt (2017)	Quarterly 1980:1 – 2016:2	SEECM	RoW	G	global trade **1.1**	export goods deflators **-0.51**	

Note: German data prior to 1991 for West-Germany; AR(1): autoregressive model of order 1; CPI: consumer price index; e: nominal exchange rate; ECM: error correction model; G: goods; GFCF: gross fixed capital formation; in: insignificant elasticity; JOH: Johansen approach; OLS: ordinary least squares; P_d: domestic prices; P_x: export prices; P_m: import prices; $REEV_{PIFC}$: real effective external value based on prices of investment in fixed capital; $REEV_{PIFC}$: real effective external value based on prices of investment in machinery and equipment; RoW: rest of the world; S: services; SEECM: single equation error correction model; ULC: unit labour costs; ULC_m: unit labour costs in manufacturing.

increase in real exports. Echoing the results of Danninger/Joutz (2007), two economists from the IMF, who have investigated the improvement of Germany's export market share since the 2000s vis-à-vis other industrialised economies, discover that the German competitive advantage due to low production costs has played a minor role. They have also obtained comparably low price elasticities based on relative ULC in manufacturing and argue that Germany's external performance has rather benefited from trade relations with fast growing trading partners and from a trend towards regionalised manufacturing in the export sector. In contrast, Breuer/Klose (2013), who have investigated German exports with respect to different price indices and have decomposed the real exchange rate into a relative price term and the nominal exchange rate, have found a significant impact of relative ULC on exports which in magnitude is comparable with price elasticities provided in studies that include broader price measures.

Given these contradictory results, we want to compare directly the impact of the ULC- based exchange rate to an exchange rate based on a broader price index, the CPI. As mentioned before, the CPI covers additional input costs and the mark-up and is therefore expected to explain more of the increase in German exports than relative ULC. Similar to Storm/Nastepaad (2015), we estimate the effect of the real effective exchange rate and calculate its share in explaining German export growth for a more recent time period. However, unlike Storm/Nastepaad, we apply the commonly used error correction method to determine the long-term relationship between exports, income and the real exchange rate in levels and not in growth rates.[7]

Furthermore, we are interested in structural differences in the equations for intra- and extra-EMU exports. Since there are only a few studies making this regional distinction for German exports (Stahn 2006; Stephan 2005), we seek to provide further and more recent estimation results.[8] Taking a look at Stahn's (2006) estimates for the long sample, the real exchange rate is significant and exports to the EMU react more sensitively to changes in relative prices than exports to non-EMU countries (-0.92 and -0.63 respectively). This is in line with the analysis by Bayoumi et al. (2011) which test extra- and intra- EMU exports for the aggregated euro area. Shortening the time period, Stahn (2006) proves exports to be less price elastic. The effect of the exchange rate on

7 In a recent study Boggio/Barbieri (2016) show that "export growth depends on levels of competitiveness factors […] rather than on their growth." (p.17)

8 Anderton et al. (2005), Bayoumi et al. (2011), Dieppe/Warmedinger (2007), Herrmann/Joebges (2008) have estimated intra- and extra- EMU imports or exports for the aggregated euro area.

intra-EMU exports even becomes insignificant. The author concludes that this is evidence of the dominance of EMU export market growth in determining German exports in the 1990s whose income elasticities are close to unity in the short and about 0.8 in the long sample. Taking export market trends as a proxy for foreign demand, Stahn (2006) has obtained income elasticities that do not differ much between the two trading regions. This is not what we expect insofar that varying structures in the demand pattern should be reflected in different income elasticities. Therefore we further investigate this issue in our own estimations.

Econometric Procedure, Unit Root and Cointegration Analysis

Following the majority of the empirical research presented in Table 2, we use error correction models to estimate the long-run relationship between exports, foreign demand and the real effective exchange rate. If two or more time series are co-integrated they can be modelled in an error correction framework representing meaningful economic behavioural relationships (Engle and Granger 1987).

Thus in a first step, Unit Root (UR) tests examine whether the time series are integrated of order one (I(1)). Provided the series have a UR, in a second step, they are tested for co-integration. Primarily, the static two-step Engle-Granger approach is applied to find out whether the dependent (exports) and independent variables (GDP, gross fixed capital formation (GFCF), real effective exchange rate (REER)) form a long-run relationship.[9] As a second step, error correction models are used to estimate the long-term relationship between the dependent and the explanatory variables in levels and the short-run dynamics simultaneously. All variables are transformed into logs and so the coefficients can be interpreted as elasticities.[10] The estimation starts with four lags. Further lagged differences are added until autocorrelation is eliminated from the residuals. The Akaike information criterion is used for choosing lag length and impulse dummiesto account for outliers.[11] Since the co-integration relation is estimated non-linearly, the coefficients/elasticities can be interpreted directly and we obtain the correct t-statistics (Stephan 2005, chap. 4).

9 A graphical representation of the development of exports, imports, foreign and domestic GDP and the ULC-based REER differentiating between the two trading groups can be found in the appendix.
10 EViews 8.0 was used for the econometric analysis.
11 Impulse dummies take on a value of one for the corrected quarter and zero otherwise.

The Augmented Dickey Fuller tests indicate that all the time series under consideration are I(1). With regard to German exports of goods the two-step co-integration tests finds a long-term relationship between real exports, GDP or GFCF respectively. However, when adding the ULC-based REER the relationship does not necessarily persist. In these cases, the CPI-based REER is chosen instead, for which the tests suggest a cointegration relationship. All test results are provided in the appendix (Table 5, Table 6).

Finally, we conduct different stability and specification tests for our estimation models. Besides the adjusted R^2 and the standard error of the regression, we present the Durban-Watson statistic as an indicator for autocorrelation, [12] the Jarque-Bera test for normal distribution of residuals (H_0: normally distributed residuals), the Cusum and $Cusum^2$ stability tests for checking parameter stability and two specification tests – the White test for heteroskedasticity and Ramsey RESET (Regression Specification Error Test) as a test for non-linear functional form and general miss-specification test. In both cases, H_0 must not be rejected.

Data

In the present paper, quarterly data for the period 1995q1 to 2014q1 is used[13]. For most EMU members longer time series are available, but not for all extra-EMU countries. Missing data was interpolated. Nominal exports of goods were deflated by an index of export prices. With respect to EMU exports (X_{EMU}), a chained price index was constructed by using the index of export prices to EU members prior to the introduction of the Euro in 1999 and to EMU members afterwards. A chained index of export prices to non-EU and extra-EMU countries was created for exports to the extra-EMU aggregate ($X_{Extra\text{-}EMU}$, $M_{Extra\text{-}EMU}$). The time series for exports were seasonally unadjusted whereas the explanatory variables were seasonally adjusted. The data was seasonally adjusted because for some countries only adjusted time series are available and seasonal patterns differ between countries[14]. Centred seasonal dummies account for the seasonal pattern in real exports. Foreign demand is approximated by an export-weighted geometric GDP index for both EMU and extra-EMU countries. Additionally, to check the robustness of

12 DW≈2 means no or little autocorrelation, DW≈4 perfectly positive autocorrelation and DW≈0 perfectly negative autocorrelation.
13 If only annual data was available, the time series has been transformed into quarterly data in EViews.
14 The time series have been seasonally adjusted in EViews with Census X-12.

the results, a disaggregated activity variable based on gross fixed capital formation[15] was chosen, as a large part of German exports consist of capital goods and the variable was often used in previous estimations (Table 2). We expect a positive relationship between exports and foreign activity since growing export markets should increase the former. The REER, based on relative ULC, and the nominal effective exchange rate (NEER) approximate the development of relative prices. We estimate the effect of an increasing REER on exports (real appreciation) and assume a negative relationship between real exports and the REER. ULC are chosen as a proxy since we assume prices to be determined by adding a mark-up on ULC in incompletely competitive goods markets. Moreover, relative ULC is the indicator mostly referred to in the debate on international price competitiveness, as pointed out earlier. Moreover, a REER based on the broader CPI[16] ($REER_{CPI}$), was created. As mention above, the CPI does not only account for additional input costs and the mark-up, but also serves as an indicator for international inflation differentials. Moreover, there is better data availability than for ULC. Data sources and the construction of variables can be found in the appendix.

Export Equations

In Table 3 we present the estimation results of the six models for German goods exports to the EMU and the extra-EMU, each that reproduce the cointegration relationship between German goods exports (X_{EMU}, $X_{Extra\text{-}EMU}$), foreign demand (GDP^{EMU}, $GFCF^{EMU}$, $GDP^{extra\text{-}EMU}$, $GFCF^{extra\text{-}EMU}$) and a real effective exchange rate based on CPI or ULC ($REER_{CPI,}$ $REEV_{ULC}$). In case of a significant trend belongs to the cointegration relationship, it is displayed in Table 3 too. The adjustment coefficient that has to be negative and significant for a cointegration relationship to prevail, is also reported. The deterministics and short-term dynamics are not reported because we are interested in long-run relations. Table 4 presents the respective test statistics for our models. First of all, it has to be acknowledged that our observation period is quite short and was characterised by two economic crises – the burst of the dot-com bubble in March 2000 and the deep financial and economic crisis starting in 2008/2009 – that produced many outliers.

15 China had to be excluded from the index due to a lack of data. Therefore new weights have been calculated in order to obtain the correct activity and price variable.
16 Due to a lack of data the non-harmonised CPI had to be chosen.

Table 3 Long-term estimation results for German exports to the EMU and extra-EMU countries and test statistics

	Model 1 EMU	Model 2 EMU	Model 3 EMU	Model 1 extra-EMU	Model 2 extra-EMU	Model 3 extra-EMU
Adjustment coefficient	**-0.68** (-6.05)	**-0.81** (-8.14)	**-0.72** (-5.79)	**-0.42** (-5.43)	**-0.52** (-5.33)	**-0.45** (-4.9)
ln GDP_{t-1}	**2.97** (18.84)			**1.76** (22.8)		
ln $GFCF_{t-1}$		**1.38** (25.64)	**1.18** (18.42)		**0.95** (6.32)	**1.18** (7.19)
ln $REEV_{ULCt-1}$	**0.11** (0.59)	**0.61** (3.66)		**-0.70** (-4.92)	**-0.74** (-6.29)	
ln $REEV_{CPIt-1}$			**-1.13** (-1.55)			**-0.68** (-4.76)
trend	**-0.002** (3.47)	**0.007** (13.69)			**0.006** (7.47)	**0.006** (6.37)
Adjusted R^2	0.86	0.89	0.9	0.71	0.69	0.65
S.E. of regression	0.020	0.017	0.022	0.024	0.020	0.026
Durban-Watson	2.1	2.01	1.84	2.33	2.18	2.07
Jarque-Bera	[0.70]	[0.86]	[0.89]	[0.3]	[0.44]	[0.64]
White test	[0.86]	[0.79]	[0.12]	[0.66]	[0.53]	[0.22]
RESET test	[0.90]	[0.45]	[0.83]	[0.11]	[0.03]	[0.001]
CUSUM/$CUSUM^2$	stable	stable	stable	stable	stable	stable

Note: t-values are presented in parenthesis. The marginal significance levels are reported in square brackets.

GDP: gross domestic product; GFCF: gross fixed capital formation; $REER_{ULC}$: unit labour cost based real effective exchange rate; $REER_{CPI}$: consumer price index based real effective exchange rate; S.E. of regression: standard error of regression.

However, our estimation models explain the data quite well. According to the Durban-Watson and Jarque-Bera criteria, our residuals are free from autocorrelation and almost normally distributed. The CUSUM tests indicate parameter stability. In Model 2 on extra-EMU exports the RESET test rejects H_0 at the 5% level and in Model 3 the RESET test indicates model misspecification of general type. However, we further consider the estimation output given that the outcome is in line with other empirical findings, but the test results should be kept in mind.

The estimation models have a negative and highly significant adjustment coefficient. The error correction mechanism ensures that 42% to 80% of the adjustment has taken place after one quarter. In accordance with previous research, our point estimates vary largely depending on the incorporated variables.

The impact of foreign demand on German exports

The activity variables are highly significant, have the correct sign but vary strongly with the chosen variable. With regards to German goods exports to the EMU, the income elasticities (ε) ranges from 1.18 to 2.97. The more fluctuating GFCF expresses the long-term relationship between exports and demand of the EMU better than GDP. This is in line with Stephan (2005) who has also compared a set of different explanatory variables. However, our income elasticity with respect to EMU GFCF is somewhat higher also in comparison to the results found by Stahn (2006). For German exports to the group of extra-EMU countries, ε varies from 0.95 to 1.76. For extra-EMU exports, a long-run relationship between exports and GDP was modelled more easily. This might be due to the fact that in this group of countries GDP has grown more dynamically than in the EMU (Table 1). Approximating foreign demand by GFCF, our income elasticity of demand for extra-EMU exports is comparable to those provided by Stahn (2006). Comparing intra- and extra-EMU income elasticities, we cannot confirm our initial assumption that structural differences of the two regions are reflected in the income elasticities for the here-considered observation period. Taking a look at Model 3 on EMU exports and Model 3 on extra-EMU exports that incorporate the same explanatory variables, we notice that our income elasticities coincide.

However, overall we confirm other studies and highlight that German exports are dominated by foreign demand. The models incorporating GFCF approve that German exports are very sensitive to foreign demand for capital goods (Stephan 2005). Moreover,

if we take income elasticities as indicator for specialisation in goods for which world demand is growing fastest (McCombie 2011), German manufacturers, with their specialisation in highly complex and high-quality products and relations to dynamically growing trading partners, seem to have a strong competitive advantage. Storm/Nastepaad (2015) have used an alternative method by conducting a constant market share analysis and come to similar conclusions. German non-price competitiveness is reflected by the high structural effect and according to the authors exporters have "concentrated on building up manufacturing non-price competitiveness" (Storm/Nastepaad 2015, p. 14).

Impact of the real exchange rate on exports

In Model 1 on German exports to the EMU we yield a positive but very small and insignificant price elasticity of 0.11, which is very close to the value for German total exports in Storm/Nastepaad (2015). Model 2 on intra-EMU exports uses the GFCF and the ULC-based REER. Again we yield a positive price elasticity, but unlike our first model here the estimated parameter is far from zero. This result is neither plausible nor in line with other research. Breuer/Klose (2013) in their decomposed treatment of the real exchange rate have found a positive influence of the relative consumer price index but also a stronger negative effect of the nominal exchange rate. Certainly, the ULC-based exchange rate is not the most suitable variable for explaining German goods exports to the EMU. In certain instances, it was not possible to detect a cointegration relationship. Sometimes the cointegration relationship had been destroyed when the variable was added or we obtain the wrong sign. This might be due to the fact that in Germany other costs are more important for firms' price setting than ULC, particularly in the manufacturing sector (Storm/Nastepaad 2015; Feigl/Zuckerstätter 2012; Horn/Watt 2017) and that foreign activity was the main driver of German exports to the EMU (Stahn 2006, p.14). Using a broader price index in Model 3 yields the expected negative sign, however, again the real exchange rate effect on exports is insignificant. We resume, for intra-EMU exports we cannot identify a stable relationship between exports and the real exchange rate. In contrast to our initial assumption that relative prices matter more for intra-EMU exports, the exchange rate effect is mostly found to be insignificant and the estimation results are prone to changes in the underlying cost/price index.

Turning to German exports to the extra-EMU, all estimated price elasticities are significant and range from -0.68 to -0.74. Given that the price elasticities are lower than

one, nominal exports increase by roughly 0.3%, positively affecting the current account, ceteris paribus. Seemingly, there is a quite stable relationship between real goods exports to this group of countries irrespective of whether the exchange rate is based on relative ULC or the CPI. As discussed previously, we would expect a stronger influence of the CPI-based exchange rate. This issue might be attributed to model misspecification as the RESET test indicated and must be investigated in another work. However, overall, our estimated values are broadly in range of the estimates provided by Stahn (2006) for extra-EMU exports in the long sample. However, compared to other studies on German total exports using an ULC-based exchange rate (Allard et al. 2005; Danninger/Joutz 2007; Storm/Nastepaad 2015), our elasticity is somewhat higher.

In order to better evaluate the impact of demand and the exchange rate, in what follows, we calculate their shares in our predicted export growth and compare it to former research results.

The contributions of demand and prices to export growth

Table 4 displays the contributions of foreign demand and the real effective exchange rate to our predicted export growth. The underlying assumption of our calculation is that only these two factors explain exports and other factors are omitted so that the shares add to 100%. This is not very realistic, but in the first place we want to figure out the relative strength of the two influencing variables in determining German exports because they are at the centre of the economic policy debate described before.

Table 4 Percentage shares of real income and the real effective exchange rate in predicted growth of German exports, 1995q1 – 2014q1

Destination	Actual export growth, volume in %	Model	Explanatory variables (x_1, x_2)	Predicted increase in exports, volume in %	Share of x_1 and x_2 in predicted exports, in %	
					x_1	x_2
EMU	96.2	1	GDP, $REER_{ULC}$	102.2	100.0	in.
		3	GFCF, $REER_{CPI}$	36.5	100.0	in.
Extra-EMU	204.2	1	GDP, $REER_{ULC}$	135.2	87.5	12.5
		2	GFCF, $REER_{ULC}$	72.3	75.2	24.8
		3	GFCF, $REER_{CPI}$	77.9	86.7	13.3

Note: in.: insignificant elasticity; x_1: activity variable; x_2: real effective exchange rate; actual growth of variables in volume terms is provided in the appendix Table 7.

With the exception of Model 1 on EMU exports, which fits the actual export growth quite well, Table 4 shows that our predicted export growth underestimates the actual development. However, we get an indication of the relative relevance of the two explanatory variables and confirm that German exports to both trading regions are dominated by the development of foreign demand. Since our estimation models on intra-EMU exports yield insignificant price elasticities, the share of the real exchange rate in our predicted export growth is zero and the activity variable covers the total explanatory power. Regarding exports to the extra-EMU trading partners we estimated significant price elasticities. Although German exports to the trading region react quite sensitive to changes in the real exchange rate, it explains only 13% to 25% of our predicted exports. Given the fact that we exclude other determining factors, these shares are higher than those calculated by Danninger/Joutz (2007). They show that total demand explains 65% of their predicted export growth whereas the exchange rate based on relative ULC only amounts to 1.8% and the rest is explained by domestic value added. According to Storm/Nastepaad (2015), relative ULC account for less than 1% of the development in actual not the predicted export growth to the rest of the world. If we calculated the contribution of our real exchange rates to the actual development of exports to the extra-EMU we would obtain shares of 5% to 9%. This further indicates that the real exchange rate has only limited explanatory power and the focus on the exchange rate in explaining the German export success seems misleading.

4 Conclusions

The present analysis of Germany's economic performance and its exports in particular has questioned the obsession with price competitiveness in international trade. In order to adequately analyse the relevance of price competitiveness for the German export success we have estimated the long-term relationship between goods exports, foreign activity and the real exchange rate. Together with the actual development of the relevant variables we have calculated their contribution to the predicted export growth with respect to the EMU and the extra-EMU aggregate. We have shown that estimated elasticities for intra-EMU exports are quite sensitive to the underlying indicator and according to our observation the focus on ULC seems misleading when it comes to the evaluation of the German competitive advantage vis-à-vis trading partners in the EMU. Incorporating ULC in the export equation either destroys the cointegration relationship or results in the wrong sign.

Therefore, in Model 1 and Model 3 on intra-EMU exports we have included a broader price measure, which however, has no significant impact on exports. We have shown that it can be useful to make a regional distinction because the exchange rate effects differ between intra- and extra-EMU exports. In contrast to exports to the EMU, we identify a quite stable relationship between German exports to the extra-EMU and the real exchange rate, irrespective of the chosen cost/price index – relative ULC or CPI. Given that our price elasticities for extra-EMU exports are lower than unity, nominal exports positively affect the German current account, ceteris paribus. So if the Marshall-Lerner condition was not or only barely fulfilled, nominal wage and exchange rate policies would not have the desired effects on the current account. Moreover, having calculated the shares of the real exchange rate in our predicted export growth with respect extra-EMU, we figured out that it only contributed 12% to 25% to German exports. Hence, improved price competitiveness explains the German export miracle only to a quite limited extent and the relevance of relative ULC should not be overrated.

On the contrary, we demonstrate that German exports are predominantly determined by foreign income demand and have benefitted from growth dynamics of its trading partners in- and outside the EMU. The high income elasticities of demand for exports are reflective of strong non-price competitiveness of German exporters given their specialisation in technologically advanced and high-quality products for which world demand was growing fast. Nevertheless, opposing our initial assumption, differing demand patterns of the two trading regions are not reflected in our income elasticities of demand for German exports.

Finally, the example of the German economy and its export success highlights the relevance of accounting for both price and non-price factors and for a country's capability to meet demand for products characterised by a high income elasticity of demand for exports. The sole focus on price competitiveness is not justified given its limited explanatory power of the German export performance.

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Appendix

Data sources and construction of variables

Section 2

The macroeconomic indicators for the EMU (excluding Germany) and extra-EMU aggregates are calculated as geometric indexes or weighted averages. Growth contribution of net exports of goods and services to nominal GDP growth and net exports of goods and services as share of nominal GDP are weighted averages. The aggregates of real GDP, NEER, REER, CPI (inflation) are geometric indexes. The weights are based on total sales (X+M). Statistical series are on annual basis, except for the ULC which were converted from quarterly data.

Net exports	OECD (2015a), EO 97, net exports of goods and services, value, National Accounts.
Real GDP	IMF (2015), IFS, National Accounts, expenditures/real GDP, volume, constant prices; WB WD, economic policy & debt, National Accounts, US$ at constant 2005 prices, Aggregate Indicators, GDP, Constant Prices, USDI: BR, CN, CZ, RU, SK, GE
Growth contribution of net exports to GDP growth	OECD (2015a), EO 97, net exports, contribution to growth in GDP, estimate
Net exports as share of nominal GDP	WB (2015), WDI, National Accounts, external balance as share of GDP
Inflation, CPI growth rate	WB (2015), WDI, CPI, 2010=100
REER, CPI	IMF (2015), IFS, exchange rate, fund position & intern. liquidity, exchange rates, NEER from INS; OECD, EO, REER, constant trade weights, estimate: TR;
NEER	IMF (2015), IFS, exchange rate, fund position & intern. liquidity, X-Rates, NEER from INS
ULC	see sources of variables in chapter 3

Section 3

For data comparability and consistency for the construction of a variable data was preferably used from one source. If only annual data was available, the time series was transformed into quarterly data in EViews. The variables/time series for the EMU and extra-EMU aggregates are calculated as geometric indexes.

The ULC-based REER for exports is measured as German nominal ULC relative to export-weighted foreign nominal ULC multiplied by the export-weighted nominal effective exchange rate (NEER foreign currency/€). If data for ULC was not available a wholesale price index (Brazil, Russia) or producer price index (China, Russia, Turkey) was used instead. The CPI-based REER was constructed the same way.

Exports of goods	German Federal Statistical Office (destatis), Foreign Trade, Countries, Exports in EUR
GDP, EMU, extra-EMU	IMF (2015), IFS, national accounts, expenditures/real GDP volume; OECD (2015b), MEI, GDP constant prices, 2010 price levels & PPPs, USD: IR; National Statistics Office Romania, GDP, total, constant prices: Ro
GFCF	OECD (2015b), MEI, gross fixed capital formation, index (2010=100); OECD, EO, GFCF, estimate, index: CZ, SK, TR; OECD (2014), EO 96, GFCF, estimate, constant prices, RUB: RU; Eurostat (2015), AMECO, GDP main components (ESA 2010), volumes, GFCF: GR, IR, RO; WB, WDI, economic policy & debt, national accounts, local currency at constant prices, expenditure on GDP, GFCF, BRL: BR
ULC	OECD (2015b), MEI, early estimates of ULC total economy; OECD (2015), EO 97, ULC in total economy, estimate: AT, CH, CZ, BE, IR, NL, PL
WPI	OECD (2015), MEI, Wholesale price index total economy: BR; WB, WDI, exchange rate & prices: RU
PPI	OECD (2015), MEI, domestic PPI, industrial activities: CN, RU, TR
CPI	OECD (2015), MEI, CPI all items; OECD, EO CPI: BR; DG ECFIN, AMECO, consumption, CPI: RO
NEER	IMF (2015), IFS, exchange rate, fund position & intern. liquidity, exchange rates, NEER from INS
Export price index	Federal Statistical Office (2004) (2015), foreign prices, provided by Statistical Office, department Außenhandelspreise.

Table 5 Augmented Dickey-Fuller test

	Levels			First Differences		
Variables	Deterministic	Lags	Test Statistics	Deterministic	Lags	Test Statistics
ln X_{EMU}	C, t, csd	2, 9	-1.58	C, csd	1	-4.58***
ln $X_{extra\text{-}EMU}$	C, t, csd	1, 9	-2.37	C, csd	9	-6.12***
ln $REER_{ULC}$, EMU	C, t	2	-0.81	C	1	-4.93***
ln $REER_{ULC}$, extra-EMU	C, t	1, 3	-3.5	-	1, 3	-6.48***
ln GDP, EMU	C, t	1, 4, 8	-0.14	C	-	-3.62***
ln GDP, extra-EMU	C, t	1,4,5	-2.99	C	4, 8	-5.07***
ln GFCF, EMU	C, t	1, 3, 8	-1.22	C	3	-4.23***
ln GFCF, extra-EMU, excl. China	C, t	1	-2.67	C	-	-5.07***
ln $REER_{ULC}$, extra-EMU, excl. China	C, t (no t)	1, 3	-3.39 (-3.41)	C (no c)	3	-6.53*** (-6.49)***
ln $REER_{CPI}$, EMU	C, t, csd	6	-0.45	C, csd	2	-6.17***

*** (**,*) significance at a 1% (5%, 10%) level; Note: c: constant, csd: centred seasonal dummies, t: deterministic trend.

Table 6 Co-integration test

explained variable	explaining variable	URT residuals	
		lag	t-value
ln X_{EMUt}	ln GDP_t, csd, t	2	-4.69***
	+ ln $REER_{ULCt}$	1	**-2.93**
	ln GDP_t, csd, t, ln $REER_{CPIt}$	2	-4.69***
	ln $GFCF_t$, csd, t	1	-4.47**
	+ ln $REER_{ULCt}$	2	-4.59**
	ln $GFCF_t$, csd, t, ln $REER_{CPIt}$	2	-4.45**
ln $X_{EXTRA-EMUt}$ incl. China	ln GDP_t, t, csd	2	-3.93**
	+ln $REER_t$	4	-4.43**
ln $X_{EXTRA-EMUt}$ excl. China	ln $GFCF_t$, ln $REER_{CPIt}$, t csd	4	-4.31**

***(**) indicate significance at the 1% (5%) level

Table 7 Growth of exports, GDP, GFCF and REER from 1995 q1 to 2014 q1, volumes, in %.

	EMU	Extra-EMU
German exports of goods	96.2	204.2
GDP	34.6	67.2
GFCF	31.0	57.2
$REER_{ULC}$, export-weighted, e	-20.2	-24.2
$REER_{CPI}$, export-weighted	-11.7	-15.3*

*Note: * excluding C*

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