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Has the impact of key determinants of German exports changed? Results from estimations of Germany's intra euro-area and extra euro-area exports

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Abstract

The question as to whether changes in the external environment may have caused the importance of key determinants of German exports to shift since the 1990s is addressed by estimating Germany's exports to EMU partner countries (intra exports) and to countries outside the euro area (extra exports). Analytically, this is done first by estimating single-equation error correction models across different samples. Second, an estimation applying the Saikkonen (1991) approach is carried out to test whether the long-run export behaviour of intra and extra exports has changed since the 1990s. Finally, simulations are conducted by means of error-correction models in order to reconstruct the adjustment process of both intra and extra exports following demand and price shocks.

Non-Technical Summary

In the 1990s, in particular, the external environment underwent significant changes, eg through increasing globalisation, the elimination of the "Iron Curtain" in Eastern Europe, EU enlargement or the establishment of EMU. This raises the question as to whether the importance of key determinants of German exports – namely, export market trends and the price competitiveness of the German economy – may have shifted across different periods and in different regions.

It therefore seems appropriate to estimate German exports for both a *long* sample, including the period prior to German unification, and a *short* sample, excluding immediate unification effects and changes in the recording of foreign trade data at the beginning of the 1990s, as well as in a regional breakdown by exports to euro-area partners and to non-euro-area countries. For the *long* sample, it turns out that, in the *long* run, exports to the euro area (intra exports) and exports to non-euro-area countries (extra exports) grow only slightly less than German export markets. Furthermore, for both intra and extra exports the long-run impact of price competitiveness is nearly as strong as the influence of export market trends. For the *short* sample, changes in foreign demand lead to an equally strong change in both intra and extra exports in the long-run, whereas the effect of changes in competitiveness is considerably smaller. This result is consistent with observations from a continuous analysis of foreign trade, namely that, in the past few years, the influence of trading partners' economic activity on German exports has far outweighed the effects of price competitiveness.

A further estimation is performed in order to analyse whether export behaviour has changed. The estimations provide evidence that the long-run relative price sensitivity of German exports has been on a downward trend since the 1990s. Export supply or export demand shifts in favour of less price-elastic products, the possibility that the pricing behaviour of German exporters may have changed – eg through increasing intra-firm trade or the advancing globalisation and the establishment or enlargement of unified currency or economic areas – as well as the quite slight changes in price competitiveness vis-à-vis suppliers from the (future) euro-area – since the mid-1990s – may have contributed to this. However, the downward trend in the long-run impact of price competitiveness on extra exports may also be at least partly due to the fact that the corresponding indicator of price competitiveness does not capture all non-euro-area countries.

Nicht technische Zusammenfassung

Vor allem in den neunziger Jahren unterlagen die außenwirtschaftlichen Rahmenbedingungen, z. B. durch den Wegfall des "Eisernen Vorhangs" in Osteuropa, die Erweiterung der EU oder die Errichtung der EWU, bedeutenden Veränderungen. Daher stellt sich die Frage, ob sich die Bedeutung wichtiger Determinanten der deutschen Ausfuhren, nämlich der Exportmarktentwicklung und der preislichen Wettbewerbsfähigkeit der deutschen Wirtschaft, für verschiedene Zeiträume und in unterschiedlichen Regionen verschoben haben könnte.

Es erscheint daher angemessen, die deutschen Exporte sowohl für eine *lange* Stichprobe, die den Zeitraum vor der deutschen Vereinigung einschließt, und eine *kurze* Stichprobe, die direkte vereinigungsbedingte Effekte und Veränderungen in der Erfassung von Außenhandelsdaten zu Anfang der neunziger Jahre ausschließt, als auch regional differenziert nach Exporten in die EWU-Partnerländern und in Länder außerhalb des Euro-Raums zu schätzen. Für das *lange* Sample zeigt sich, dass die Ausfuhren in den Euro-Raum (Intra-Exporte) und die Exporte in Nicht-EWU-Länder (Extra-Exporte) langfristig nur wenig schwächer als die deutschen Absatzmärkte wachsen. Darüber hinaus ist der langfristige Einfluss der preislichen Wettbewerbsfähigkeit sowohl für die Intra- als auch für die Extra-Exporte nahezu genauso stark wie der Einfluss der Exportmarktentwicklung. Für das *kurze* Sample führen Veränderungen der Auslandsnachfrage langfristig zu einer ebenso kräftigen Veränderung der Intra- und Extra-Ausfuhren, während die Wirkung der Wettbewerbsposition erheblich geringer ist. Dieses Ergebnis steht mit unseren Beobachtungen aus der kontinuierlichen Analyse des Außenhandels in Einklang, dass in den letzten Jahren der Einfluss der Konjunkturentwicklung bei den Handelspartnern auf die deutschen Exporte die Effekte der preislichen Wettbewerbsfähigkeit deutlich überwogen hat.

Anhand einer weiteren Schätzung wird analysiert, ob sich das Exportverhalten verändert hat. Die Reagibilität der deutschen Exporte auf Veränderungen der relativen Preise wird seit den neunziger Jahren tendenziell schwächer ausgewiesen. Dazu könnten Verschiebungen des Angebots oder der Nachfrage zugunsten weniger preiselastischer Produkte, die Möglichkeit, dass sich das Preissetzungsverhalten der deutschen Exportuere verändert hat – z. B. durch die Zunahme des Intra-Firmenhandels oder die fortschreitende Globalisierung und die Errichtung oder Erweiterung von gemeinsamen Wirtschafts- oder Währungsräumen – sowie die – seit der Mitte der neunziger Jahre – nurmehr recht geringen Veränderungen der preislichen Wettbewerbsposition gegenüber den Anbietern aus dem (zukünftigen) Euro-Raum beigetragen haben. Allerdings könnte der Rückgang des langfristigen Einflusses der Wettbewerbsposition auf die

Extra-Exporte zumindest teilweise auch dadurch bedingt sein, dass der zugehörige Indikator der preislichen Wettbewerbsfähigkeit nicht alle Länder außerhalb des Euro-Raums umfasst.

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1 Introduction

The latest appreciation of the euro seems to have had so far relatively little adverse impact on German exports – which has come as a surprise to many observers. This raises the question as to whether the influence of price competitiveness on exports may have changed over time. It can be assumed that changes in the external environment, particularly those that have come about since the 1990s through increasing globalisation, the elimination of the "Iron Curtain" in Eastern Europe, EU enlargement or the establishment of European monetary union, have also had an impact on German exports. To answer this question, Germany's exports are estimated over different periods. A further estimation is carried out to assess whether export behaviour has changed since the 1990s. Moreover, Germany's exports are analysed broken down by region. As the changes in the external environment involve both trade with EMU partners and the exchange of goods with non-euro-area countries, the regional analysis focuses on Germany's exports to all euro-area partner countries combined (intra exports) and to "third countries", the aggregate of the countries outside the euro area (extra exports). Finally, simulations are conducted in order to reconstruct the adjustment process of both intra and extra exports following demand and price shocks.

2 Overview of the literature

In the literature, numerous empirical analyses are available for Germany's exports: for total exports, for an aggregate of selected countries, on a bilateral trade basis, or in a sectoral breakdown. In all cases, the key determinants are economic activity in export markets and an indicator of price competitiveness. An increase in economic activity or an improvement in price competitiveness is expected to lead to an increase in exports. Price competitiveness can be improved, *ceteris paribus*, by a decrease in export prices or domestic prices, an increase in foreign prices or a nominal depreciation of the domestic currency. Since the sign of the estimated coefficient of the relative price elasticity depends on how the competitive indicator is defined, the focus here is on absolute price elasticities. Disaggregated analyses are preferable because goods with relatively low price elasticities can dominate the estimation of the aggregated exports, thereby distorting it downwards.[1] Consequently, it would also be possible for exports of largely less price-elastic goods into given regions to put downward pressure on the price elasticity of total exports.

In the following table-form overview of the literature, estimation results for overall exports are presented first. Then empirical findings for exports by region and by sector will be given. The overview will focus on the impact of price competitiveness on exports, since my estimation results show that the most important change in the influence of key determinants of German exports since the 1990s can be found for this variable.

To summarise, the authors generally attempt to use as long a sample as possible. This gives a perceptible weight to pre-German unification economic developments. Moreover, a long sample has the advantage that potential data problems owing to a small number of data points can be avoided.[2] Therefore, in line with most studies, the regressions in this paper are carried out first for a *long* sample, including the pre-German unification period. However, changes in the external environment, eg the elimination of the "Iron Curtain" in Eastern Europe and the enlargement or establishment of unified economic or currency areas, mostly occurred in the 1990s. Even in recent studies, a change in the export behaviour for this period is not yet examined. Therefore, in this paper the regressions are subsequently run for a *short* sample which exclusively covers the post-1990 period. Thirdly, a further estimation is carried out to assess whether *changes* in the export behaviour occurred in the 1990s.

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[1]See Goldstein and Khan (1985), p 1070.

[2]However, scant mention is made of the possibility of parameter instability at the time of German unification in the literature. Hooper et al (1998) are a notable exception.

Table 1: Overview of estimation results for German exports

Authors	Estimation period	Estimation model	Export region or sector	Indicator of relative prices	Relative price elasticity
Overall exports:					
Döpke/Fischer (1994)[4]	1970–1992	VECM Trend, capacity utilisation		REER[3] (consumer prices)	./.[5]
Lapp et al (1995)[6]		ECM Export demand		REER (export unit values)	0.9
Clostermann (1996)[7]	1975–1995	ECM Export demand		Export prices/ foreign deflator of total sales	0.9
				Export prices/ foreign producer prices	0.8
Deutsche Bundesbank (1997)[8]	1975–1995	ECM Export demand		Export prices/ foreign deflator of total sales	0.9
Deutsche Bundesbank (1998a)[9]	1975–1997	ECM Export demand		REER (deflators of total sales) against	
				18 countries	0.7
				EU competitors	0.4
				non-EU competitors	0.3
Deutsche Bundesbank (1998b)[10]	1975–1996	ECM Export demand		REER (consumer prices, deflators	0.7
				of total sales,	0.7
				producer prices,	1.0
				unit labour costs,	0.9
				terms of trade)	0.7

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[3]REER stands for "real effective exchange rate".
[4]See Döpke and Fischer (1994), pp 59–60.
[5]Indicates that a cointegrating relationship between exports and the relative price variable could not be found.
[6]See Lapp et al (1995), pp 6–7 and p 13 ff.
[7]See Clostermann (1996), pp 28–29.
[8]See Deutsche Bundesbank (1997), p 58.
[9]See Deutsche Bundesbank (1998a), p 57.
[10]See Deutsche Bundesbank (1998b), p 49.

Table 1 (continued)

Authors	Estimation period	Estimation model	Export region or sector	Indicator of relative prices	Relative price elasticity
Overall exports:					
Strauß (2003)[11]	1974–1999	ECM Export demand, real global exports/real global GDP		REER (consumer prices)	1.0
		VECM Export demand, real global exports/real global GDP		REER (consumer prices)	1.1
Strauß (2004)[12]	1975–2000	VECM Export demand		Foreign producer prices (domestic currency units)	0.8
				Export prices	0.3
		Export supply		Foreign producer prices (domestic currency units)	0.4
				Domestic producer prices	1.0
Meurers (2004)[13]	1975–1999	VECM Export demand		Foreign export prices/foreign consumer prices	0.7
		Export supply		REER	0.8
Camarero/Tamarit (2004)[14]	1981–1998	Panel 12 OECD countries		Export prices/ trade-weighted export prices	0.8

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[11] See Strauß (2003), p 186 ff .
[12] See Strauß (2004), pp 118–119.
[13] See Meurers (2004), p 547.
[14] See Camarero and Tamarit (2004), p 362.

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Table 1 (continued)

Authors	Estimation period	Estimation model	Export region or sector	Indicator of relative prices	Relative price elasticity
Overall exports:					
Hooper et al (1998)[15]	1970–1996/97	VECM Export demand		Export prices/ foreign deflator of total sales	0.2–0.3
				REER (unit labour costs)	0.9–1.1
Exports by region:					
			Non-EU		0.4
			USA		1.2
			France		2.1
Stephan (2002)[16]	1985–2001	ECM Export demand, trend	Euro area	REER against euro area (consumer prices)	1.0
Kappler/Radowski (2003)[17]	1974–2001	ECM Export demand	France	REER	0.7
			Italy		./.
			UK		1.4
			USA		0.7
Exports by sector:					
Milton (1999)[18]	1982–1997	Distributed lags, annual percentage changes, cyclical gap or domestic activity	8 sectors machinery clothing	Sectoral REER (sectoral producer prices)	range: 0.0 −1.1
	1988–1997		chemicals clothing		0.5 −2.4

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[15] See Hooper et al (1998), pp 47–48 and p 106.

[16] See Stephan (2002), p 14.

[17] See Kappler and Radowski (2003), p 189 ff.

[18] See Milton (1999), p 237, 242. Krakowski et al (1993), p 64, who choose a double logarithmic approach, also detect a large exchange rate influence for machinery (absolute value of 1.0) for a somewhat shorter sample period (1980–1992). Döhrn (1993), p 112, finds a similarly high elasticity of the export volume with respect to the real sectoral exchange rate for this sector (0.8 in absolute terms for the 1978–1992 period). However, it must be noted for sectoral estimates that, especially in the case of capital goods, the time span between the receipt of the order and delivery can be considerable. Long estimation periods could therefore indicate changes in the lag structure, which would mean that the exchange rate elasticity of exports might, under some circumstances, be underestimated. For instance, estimating incoming foreign orders received by machinery manufacturers instead of their exports shows that they, too, react sharply to exchange rate changes: the exchange rate influence for the 1978–1992 period is 1.3 in absolute terms and, for a 1985–1994 sample, as high as 1.6. See Döhrn (1993), p 110, and Döhrn and Milton (1998), p 80.

Most studies analyse German overall or bilateral exports. However, some of the most important changes in the external environment since the 1990s have exclusively affected the euro-area countries – eg the establishment of EMU - whereas other changes – eg the elimination of the "Iron Curtain" in Eastern Europe or the catching-up process of Asian emerging market economies – impacted solely on non-euro area countries. As a consequence, German exports to both EMU member countries and countries outside the euro area, as well as the corresponding key determinants, may have developed differently. Therefore, in this paper German exports to euro-area countries and to countries outside the euro-area are estimated. However, empirical analyses focusing on export aggregates broken down by region are still rare. For instance, Hooper et al (1998) examine exports to non-EU countries taken together, while Stephan (2002) focuses on exports to euro-area partner countries.

In their methodology, many authors exclusively estimate export demand equations.[19] They often use single-equation error correction models which capture both long-run and short-run influences of the determinants. This approach is also applied here.

Economic activity in importing countries is usually measured by the volume of world trade, real GDP or manufacturing output, as well as, in some isolated cases[20], the demand for investment. By contrast, this paper uses export market trends within and outside of the euro area, calculated on the basis of countries' imports of goods and services. This measure has the advantage that the estimated elasticity indicates whether German exports have grown to the same extent as export markets.

In contrast to the foreign economic activity variable, various indicators of price competitiveness are chosen in the literature (terms of trade, indicators based on consumer prices, deflators of total sales, producer prices, unit labour costs, export prices, wholesale prices or export unit values). The estimation results for the impact of price competitiveness on overall exports appear to be, for the most part, influenced less by the methodology applied and more by how the indicator of price competitiveness is constructed. Most studies find that price competitiveness has a noticeable influence on exports, with a coefficient having an absolute value of just under 1.0.

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[19]See Lapp et al (1995), Clostermann (1996), Deutsche Bundesbank (1997), (1998a), (1998b), Strauß (2003), Kappler and Radowski (2003). This corresponds with the assumption that German exporters are "price takers" on the global market. See Sawyer and Sprinkle (1999), pp 10–11. Other papers supplement the factors influencing export demand with export supply determinants. See Döpke and Fischer (1994) or Milton (1999). Some papers also simultaneously estimate export demand and export supply functions. See Strauß (2004) and Meurers (2004).

[20]See Stephan (2002).

By contrast, estimates broken down by region or sector often reveal coefficients for the relative price variable that are noticeably smaller or larger than one or even insignificant.[21]

An important question is which indicator of price competitiveness appears to be the most appropriate. Deutsche Bundesbank (1998b) compares the suitability of various indicators of price competitiveness (based on consumer prices, deflators of total sales, producer prices, unit labour costs and terms of trade). The absolute values of the estimation coefficients range from 0.7 to 1.0. A comparison of pairs of indicators in the estimation made it possible to demonstrate that the external value based on the deflators of total sales was superior to the competing real external value concepts.[22] For this reason, the indicators of price competitiveness vis-à-vis the euro-area partner countries and vis-à-vis non-euro-area countries, calculated on the basis of deflators of total sales, are used as relative price variables in this paper.

The following analysis begins by explaining the underlying data and the regression models. Then estimation results for intra and extra exports are presented, first for a *long* and a *short* sample and then for *changes* in the export behaviour. Finally simulations are carried out to examine the adjustment processes undergone by intra and extra exports after a positive demand shock and a negative price shock.

3   Data and estimation approaches

Exports are regressed on their key determinants: real demand in export markets and an indicator of price competitiveness. Estimations are performed for exports to euro-area partner countries (intra exports) and to non-euro-area countries (extra exports). Moreover, individual estimates of exports to the Unites States are cited for purposes of comparison. Seasonally adjusted quarterly data are used.

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[21]The estimation period chosen or the methodology applied might lead to fairly sizeable differences among the sectoral estimation results. See Milton (1999) and footnote 18.

[22]It was tested bilaterally whether the respective competing indicators are able to contribute additional information to the external value indicator specified. To determine this, another indicator variable was added to the export equation. As a result, the real external value based on the deflator of total sales was the only indicator that contributed additional information to explaining German export trends to each of the alternative indicators. At the same time, none of the other indicators contained any information which was not already included in this variable. See Deutsche Bundesbank (1998b), pp 50–51.

The time series for market growth within and outside of the euro area were calculated on the basis of OECD data. The seasonally adjusted volume of individual countries' imports of goods and services, denominated in US dollars and in 2000 prices, was used. They were weighted with the shares of Germany's exports to each respective region in total exports for 2000. The US import volume was used for the demand trend for German products in the United States.

The indicators of the German economy's price competitiveness against euro-area partners and non-euro-area countries were calculated on the basis of deflators of total sales. Throughout the sample, the 11 other euro-area countries are included as euro-area partners (Germany is not included).[23] The non-euro-area aggregate is composed of Canada, Denmark, Japan, Norway, Sweden, Switzerland, the United Kingdom and the United States.[24] The 1995–1997 period was used for weighting the countries, which includes both exports and imports. The weighting includes not only bilateral trade relations between the German economy and its respective trading partners but also competition in non-euro-area markets.

The regressions are performed for each region across two time periods: a *long* estimation period (from 1980) and a *short* sample (from 1993). The *short* sample includes neither immediate unification effects[25] nor changes in the method of recording EU foreign trade data.[26] Changes in the external environment, eg the elimination of the "Iron Curtain" in Eastern Europe or the establishment of EMU, occurred mostly in the 1990s and therefore have a greater impact on the history of the *short* sample than on the *long* estimation period.

As the trace test rejects the hypothesis that no cointegrating relationship exists for the systems of regionally disaggregated variables, single-equation error correction models can be used to estimate German exports.[27]

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[23]They are: Austria, Belgium/Luxembourg, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain.

[24]These 8 non-euro-area countries and the 11 euro-area partners form the group of participating countries in calculating the indicator of the German economy's price competitiveness, which is published in the Bundesbank's Monthly Reports.

[25]German unification seems to have a distinct impact on regressions for the period following 1991. The intra-export estimation results resemble those of the *long* estimation period, whereas the extra-export regressions are comparable with the results of the *short* sample. In keeping with this result, Hooper et al (1998), p 13 and pp 47 ff, detected considerable parameter instability at the time of unification while estimating overall exports.

[26]Prior to 1 January 1993, goods exchanged with EC countries for values in excess of DM 1,000 were recorded by customs on the day they crossed the border. Since that date, enterprises have been required to report these goods transactions to the Federal Statistical Office whenever their value exceeds DM 200,000; the transactions are assigned to the invoicing month. See Deutsche Bundesbank (1993), p 64.

[27]Tests for cointegration are presented in the appendix.

Two estimation approaches for the error correction model are presented. In the first approach, the long-run relationship and the short-run adjustment process are estimated simultaneously:

$$\Delta x_t^r = \alpha \cdot (x_{t-1}^r - \beta_0 - \beta_1 y_{t-1}^r - \beta_2 w_{t-1}^r - \beta_3 d_{93-1}) \quad \textit{(Long-run relationship in brackets)} \quad (1)$$

$$+ \gamma \Delta d_{93} + \sum_{i=1}^{4} \lambda_i \Delta x_{t-i}^r + \sum_{j=0}^{4} \mu_j \Delta y_{t-j}^r + \sum_{k=0}^{4} \nu_k \Delta w_{t-k}^r + u_t. \quad \textit{(Short-run influence)}$$

x^r denotes Germany's real exports to region r. Here, nominal goods exports (from the balance of payments statistics) are deflated with the respective regional export prices.[28] β_0 is a constant, y^r the real demand in region r addressed to Germany, w^r the price competitiveness of the German economy in relation to its competitors in region r, d_{93} a dummy variable that is zero prior to 1993 Q1 and one otherwise, Δ the first difference of the logarithmic system variables or the shift dummy and u the residual.[29]

The regional estimation approaches across the *long* estimation period differ in the fact that, in the cointegrating relationship of intra exports, a shift dummy for 1993 Q1 is included, as well as the corresponding impulse dummy as an additional short-run determinant. This way, changes in the method of recording EU trade at that point in time are captured.[30]

In the second approach, a two-step procedure is applied to the error correction model. In the first step, the long-run relationship is estimated following the asymptotically efficient approach of Saikkonen.[31] The inclusion of the leads and lags of the regressors' first differences overcomes

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[28]The prices of exports to euro-area partners include, from 2000, the current 11 euro-area countries and, before 2000, the EU/EC countries in their respective borders. Accordingly, the prices of exports to non-euro-area countries contain non-euro-area countries from 2000 and, prior to 2000, the non-EU/non-EC countries in their respective borders. Since prices for exports to the USA are not available, these exports are deflated with export prices for non-euro-area countries as a proxy.

[29]The estimation approach is restricted such that intra and extra exports are estimated completely independent of one another. Neither substitution effects caused by the relative price competitiveness between competitors within and outside of the euro area nor those caused by differences in export market trends between these two areas – enterprises in the euro area might seek to make up for flagging demand in this area through exports to third countries and vice versa – are included. These aspects may be worth analysing in future research.

[30]East German exports, which are added to West German exports from 1990 Q3 onwards, had been so small that a structural break at that point in time could not be detected.

[31]See Saikkonen (1991). In contrast to other studies – see eg Döpke and Fischer (1994), Strauß (2003), Hooper et al (1998) – the long-run relationship between exports and its determinants is not estimated by applying a VECM, since this model provides implausible results for the *short* sample period because of the reduced number of data points. However, Strauß (2003), p 186 ff, finds that the long-run influence of the relative price variable is only slightly higher if a VECM is applied than if an ECM is applied.

the problem of endogeneity, which – according to the Johansen test – evidently plays a role for the *short* sample estimations of extra exports. The number of the leads and lags is restricted to two. Using the Newey-West covariance estimator, the regressions are adjusted for autocorrelation and heteroscedasticity. In the second step, the short-run adjustment process is estimated, the long-run relationship being a given. The two-step estimation has two advantages over the one-step error correction model. First, it overcomes the possibility of endogeneity in the cointegrating relationship. Second, the estimation of the short-run determinants does not have any impact on the elasticities of the long-run relationship.

The estimation approach for the two-step procedure is:

$$\Delta x_t^r = \alpha \cdot ect_{t-1}^r + \gamma \Delta d_{93} + \sum_{i=1}^{4} \lambda_i \Delta x_{t-i}^r + \sum_{j=0}^{4} \mu_j \Delta y_{t-j}^r + \sum_{k=0}^{4} \nu_k \Delta w_{t-k}^r + u_t, \qquad (2)$$

with the long-run elasticities in the error correction term $ect_t^r = x_t^r - \beta_0 - \beta_1 y_t^r - \beta_2 w_t^r - \beta_3 d_{93}$ stemming from the following equation:

$$x_t^r = \beta_0 + \beta_1 y_t^r + \beta_2 w_t^r + \beta_3 d_{93} + \sum_{m=-2}^{2} \left(\eta_{1m} \Delta y_{t+m}^r + \eta_{2m} \Delta w_{t+m}^r + \eta_{3m} \Delta d_{93+m} \right) + v_t, \quad (3)$$

where v denotes the residual.

To assess whether changes in the external environment in the 1990s have had an impact on the supply behaviour of German exporters or the demand of foreign buyers for German products, a further estimation is carried out using the Saikkonen approach. The case that the influence of the constant and each regressor in the sub-samples 1980–1992 Q4 and 1993 Q1–2004 may have changed will be examined. The estimation is therefore conducted across the entire 1980–2004 period, and a dummy variable (which is zero prior to 1993 Q1 and one from that point in time on) is included for each regressor and the constant. Expressed in this way, the elasticities of the dummy variables illustrate how the influence of the respective regressor has changed in the sub-sample 1993 Q1–2004 compared with the earlier sub-sample 1980–1992 Q4.[32]

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[32]See Judge et al (1988), pp 428–429.

The estimation approach is:

$$x_t^r = \beta_0' + \beta_1' y_t^r + \beta_2' w_t^r + \sum_{m=-2}^{2} \left(\eta_{1m}' \Delta y_{t+m}^r + \eta_{2m}' \Delta w_{t+m}^r \right) \tag{4}$$

$$+ \left[\beta_0^* + \beta_1^* y_t^r + \beta_2^* w_t^r + \sum_{m=-2}^{2} \left(\eta_{1m}^* \Delta y_{t+m}^r + \eta_{2m}^* \Delta w_{t+m}^r \right) \right] \cdot d_{93} + v_t.$$

It holds:

$$\beta_0' + \beta_0^* = \beta_0, \ \beta_1' + \beta_1^* = \beta_1, \ \beta_2' + \beta_2^* = \beta_2$$

with β_0, β_1, β_2 from equation (3) for the *short* sample.

4 Estimation results

First, estimation results for both the *long* and the *short* sample are presented. Then the estimation results of a *change* in the elasticities of the key determinants of exports are analysed.

4.1 Estimation of intra and extra exports for a *long* and a *short* sample

The aim of the regressions is to find an economically plausible estimation model that most closely approximates the actual values. The following Table 2 lists the estimation results of the error correction models. The numbers in square brackets denote the t-values and those in round brackets the marginal significance level. The asterisks * on the estimation coefficients indicate a significance level of 1% (***) /5% (**) /10% (*). Moreover, the adjusted R^2 and the standard error (SE) are given. The Breusch-Godfrey-LM test for autocorrelation up to the fourth order (LM(4)), the normality test using the Jarque-Bera criterion (JB) and the White test for heteroscedasticity (without cross terms) are conducted. Regressions labelled with a hash ♯ were estimated using White's heteroscedasticity-consistent procedure.

In addition, two coefficient tests are carried out. A Wald test is run to examine whether the long-run impact of foreign demand is significantly different from one. A second test for omitted variables (OV) is carried out to find out whether the short-term regressors up to the fourth lag, which are individually insignificant and were therefore eliminated from the error correction model, have a joint significant impact on the change in exports.

Table 2: Estimation results for German exports to the euro-area and the non-euro-area

Region	Euro-area				Non-euro-area			
Sample	1980 Q3–2004 Q3		1993 Q1–2004 Q3		1980 Q2–2004 Q3		1993 Q1–2004 Q3	
Equation	(1)	(2), (3)	(1)♯	(2)♯, (3)	(1)	(2), (3)	(1)	(2), (3)
β_1	0.88 *** [22.79]	**0.91** *** [35.07]	0.98 *** [14.67]	**0.91** *** [12.37]	0.81 *** [22.22]	**0.79** *** [32.62]	0.99 *** [17.72]	**1.05** *** [30.54]
β_2	0.92*** [3.23]	**0.58*** [3.06]	0.32 [1.02]	**0.50** [1.17]	0.63*** [3.72]	**0.71*** [8.61]	0.30* [1.91]	**0.01** [0.07]
β_3	−0.09** [−2.69]	**−0.13*** [−5.36]	—	—	—	—	—	—
β_0	4.11*** [2.92]	**2.45** [2.59]	0.78 [0.47]	**1.95** [0.85]	3.28*** [4.06]	**3.72*** [9.83]	0.88 [0.93]	**−0.77** [−1.09]
α	−0.37*** [−3.54]	**−0.38*** [−3.80]	−0.44*** [−3.54]	**−0.48*** [−3.64]	−0.23*** [−3.72]	**−0.21*** [−3.54]	−0.37*** [−3.72]	**−0.34*** [−3.56]
Δd_{93}	−0.06** [−2.40]	**−0.07*** [−3.20]	—	—	—	—	—	—
Δx^r_{t-1}	−0.30*** [−3.09]	**−0.28*** [−3.02]	—	—	—	**−0.18** [−2.09]	−0.24* [−2.12]	**−0.23** [−2.02]
Δx^r_{t-4}	—	—	—	—	0.18* [1.95]	**0.18** [2.20]	—	—
Δy^r_t	0.93*** [5.38]	**0.93*** [6.01]	0.85*** [4.00]	**0.79*** [4.57]	0.48** [2.40]	**0.55*** [3.49]	0.53* [1.96]	**0.51** [2.29]
Δy^r_{t-1}	0.46** [2.57]	**0.42** [2.62]	—	—	—	—	—	—
Δw^r_t	0.48* [1.99]	**0.49* [2.07]	—	**0.53* [1.86]	—	—	—	—
Δw^r_{t-1}	—	—	—	—	0.24* [2.02]	**0.27** [2.33]	—	—
Δw^r_{t-3}	—	—	—	—	—	—	—	**0.23* [1.89]
Adj. R^2	0.48	**0.49**	0.54	**0.56**	0.26	**0.30**	0.36	**0.37**
SE	0.02	**0.02**	0.02	**0.02**	0.03	**0.03**	0.02	**0.02**
LM(4)	(0.87)	**(0.84)**	(0.70)	**(0.48)**	(0.12)	**(0.84)**	(0.49)	**(0.65)**
JB	(0.24)	**(0.14)**	(0.35)	**(0.54)**	(0.10)	**(0.03)**	(0.57)	**(0.94)**
White	(0.15)	**(0.25)**	(0.05)	**(0.06)**	(0.21)	**(0.14)**	(0.29)	**(0.54)**
Wald(β_1)	(0.00)	**(0.00)**	(0.86)	**(0.22)**	(0.00)	**(0.00)**	(0.90)	**(0.12)**
OV	(0.99)	**(0.97)**	(0.28)	**(0.28)**	(0.33)	**(0.22)**	(0.90)	**(0.88)**

The residuals are normally distributed at a 1% significance level according to the Jarque-Bera criterion, homoscedastic according to the White test and not autocorrelated up to the fourth order according to the Breusch-Godfrey LM test. The signs of the estimation coefficients are plausible. The joint influence of the eliminated short-run determinants up to the fourth lag is insignificant in all regressions.

For both estimation periods, first the effects of export market trends on intra exports and extra exports are interpreted, and then the impact of price competitiveness is analysed (see Table 2 for the results).

4.1.1   Impact of export market trends

The results from equations (1) and (3) for estimating the long-run impact of *export market trends* on regionally disaggregated exports are nearly identical for both the *long* and the *short* sample. For the *long* estimation period, the elasticity value is 0.9 for intra exports and 0.8 for extra exports.[33]

By contrast, the regressions across the *short* sample show an elasticity of around one. Moreover, the hypothesis that the elasticity is one cannot be rejected at a significance level of 1%. A look at the period from 1993 on shows that this elasticity means Germany was able to hold its position on the market. This is also borne out by calculations of Germany's share of real world exports based on IMF data.[34]

Furthermore, the short-run impact of current export market growth is significant for both the *long* and the *short* analysis period. This makes the development in German export markets the dominant regressor over the short term, too.[35]

4.1.2   Impact of price competitiveness

By contrast, the long-run influence of *price competitiveness* on regionally disaggregated exports is dependent on the estimation period. For the *longer* period, the regressions indicate that price

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[33]These results are in line with the estimations of overall exports with the world trade volume as variable of foreign economic activity, as conducted by Clostermann (1996), p 28, Deutsche Bundesbank (1997), p 58, (1998a), p 57 and (1998b), p 49 (see the case of the real external value on the basis of the deflators of total sales).

[34]See Deutsche Bundesbank (2003), p 21, and Sachverständigenrat (2004), p 355, para 460.

[35]However, this cyclical factor has a somewhat stronger impact on intra exports than on extra exports.

competitiveness has a substantial long-run influence: The elasticities assume values of 0.9/0.6 for intra exports and of 0.6/0.7 for extra exports and are highly significant.[36] The estimation results for equations (1) and (3) are again very similar. Apparently, for this estimation period the long-run impact of price competitiveness is nearly as strong as the influence of export market growth.[37]

For the *short* sample, the competitiveness effect is distinctly lower (the elasticities are 0.3/0.5 for intra exports and 0.3/0.0 for extra exports). Moreover, the long-run impact of price competitiveness on both intra and extra exports is statistically insignificant at a significance level of 5%.[38] Both estimation approaches show that the long-run impact of export market trends is now perceptibly stronger than the impact of price competitiveness.[39] This is consistent with observations from a continuous analysis of foreign trade, namely that, in the past few years, the influence of trading partners' economic activity on German exports has far outweighed the effects of price competitiveness. Here, too, the intra-export estimation results of equations (1) and (3) are quite similar. For extra exports, the differences between the two estimation approaches regarding the value and significance level of elasticities might be due to the problem of endogeneity in the cointegrating relationship, which is overcome by equation (3), but not taken account of by equation (1).

The estimation results for the short-run effect of competitiveness are in line with those for its long-run influence. For the *long* sample, changes in price competitiveness have a lesser impact on exports than short-run cyclical effects. Moreover, in most regressions the impact is only weakly

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[36]The elasticity of 1.0 in absolute value for intra exports obtained by Stephan (2003), p 14, who uses the real effective exchange rate on the basis of consumer prices as relative price variable, is only slightly higher. Hooper et al (1998), who estimate exports to the non-EU countries taken together – which are comparable with extra euro-area estimations – also obtain slightly sharper elasticities when applying the real effective exchange on the basis of unit labour costs (0.9–1.1 in absolute terms). In contrast, the elasticities of the ratio of German export prices to the foreign deflator of total sales as relative price variable are considerably smaller (0.2–0.3 in absolute terms).

[37]It is striking, however, that the regressions of intra exports for the *long* analysis period (from 1980) are not robust: shortening the estimation period at the current end clearly reduces the long-run influence of price competitiveness. This is further evidence that, in the 1990s, euro-area export market growth was the dominant influence on German intra exports. By contrast, no such effect for extra exports can be detected.

[38]Intra-export regressions were also performed with an indicator of price competitiveness which is composed of the ratio between German export prices and euro-area partner countries' producer prices – converted into domestic currency at the nominal effective exchange rate. The estimations also result in the long-run influence of the competitive position on the *short* sample being much lower than that on the *long* analysis period and being, in addition, insignificant.

[39]For the *short* sample, regressions are also performed using export values deflated with regionally disaggregated unit values. They, too, show that, in the long run, the influence of competitiveness is much smaller than the impact of export market developments. For the *long* estimation period, not enough data points are available for this specification.

significant. For the *short* estimation period, hardly any short-run effect of relative prices can be detected empirically.[40]

4.2   Estimation of *changes* in the behaviour of intra and extra exports

In Table 3 below, the elasticities of export market trends and price competitiveness for the sub-sample 1980–1992 and the changes in the elasticities in the sub-sample 1993–2004 compared with the previous sub-sample 1980–1992 are presented. In addition, Wald tests are carried out on the elasticity of foreign demand for both the first sub-sample (Wald(β'_1)) and the second sub-sample (Wald($\beta'_1 + \beta^*_1$)) to assess whether the long-run impact of foreign demand is significantly different from one.[41]

As in the previous chapter, first the impact of export market trends on both intra and extra exports and then the effects of price competitiveness are examined.

Table 3: Estimation results for changes in the key determinants of German exports

Region	Euro-area	Non-euro-area	United States
Sample	1980 Q4–2004 Q1	1980 Q4–2004 Q1	1980 Q1–2004 Q1
Equation	(4)	(4)	(4)
y^r_t	0.88 *** [50.70]	0.57 *** [13.36]	0.75*** [9.21]
$\mathbf{d_{93}y^r_t}$	**0.03** [0.41]	**0.49***** [8.88]	**0.23**** [2.40]
w^r_t	0.81*** [3.94]	0.57*** [8.23]	0.90*** [7.55]
$\mathbf{d_{93}w^r_t}$	**−0.32** [−0.68]	**−0.57***** [−4.00]	**−0.19** [−1.31]
Constant	3.62*** [3.85]	4.02 *** [14.73]	2.86*** [5.32]
$\mathbf{d_{93}}$	**−1.67** [−0.68]	**−4.79***** [−6.31]	**−2.01** [−2.44]
Wald(β'_1)	(0.00)	(0.00)	(0.00)
Wald($\beta'_1 + \beta^*_1$)	(0.20)	(0.11)	(0.71)

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[40]Menu costs or hedging against exchange rate fluctuations could be the reason why the short-run effect of the competitive position is, on the whole, weak or insignificant.

[41]Slight differences between equation (3) and equation (4) regarding the marginal significance level of the Wald test on the elasticity of foreign demand for the period 1993–2004 may arise.

4.2.1 Changes in the impact of export market trends

For the sub-sample 1980–1992, the long-run impact of export market trends on intra exports takes a value of 0.9, whereas for extra exports this elasticity is somewhat lower (0.6). However, both elasticities are significantly less than one. The fact that Germany's exports grew somewhat more slowly during this period than the regional export markets may be interpreted as a loss of market share.[42]

The test for *changes* in the long-run export behaviour indicates that, for the sub-sample 1993–2004, the long-run impact of foreign demand on extra exports rose statistically significantly by 0.5. By contrast, this elasticity remained unchanged for intra exports.

The sharp increase in the long-run impact of foreign demand on extra exports could be explained by changes in the external environment since the 1990s, which affected non-euro-area countries in particular, eg the elimination of the "Iron Curtain" in Eastern europe or the emerging markets' efforts to catch up to the developed world. For instance, German exports, which contain a large share of capital goods, might have benefited in particular from the rising import demand resulting from central and eastern European transition countries' and Asian emerging market economies' efforts to catch up. Furthermore, German enterprises might have gained a better foothold in countries outside the euro area through large infusions of foreign direct investment (FDI).

4.2.2 Changes in the impact of price competitiveness

For the sub-sample 1980–1992 the long-run impact of price competitiveness on intra exports assumes a value of 0.8, whereas for extra exports this elasticity is a little lower (0.6). Obviously, across this estimation period for both intra and extra exports the long-run impact of price competitiveness is roughly as strong as the impact of export market trends. This result is similar to that for the *long* estimation period. This statement also holds for the estimation of exports to the United States, where for the first sub-sample the elasticities of foreign demand and competitiveness amount to 0.8 and 0.9.[43]

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[42]This result is consistent with the pattern of Germany's share of real world exports. See Deutsche Bundesbank (2003), p 21, and Sachverständigenrat (2004), p 355, para 460.

[43]See the appendix for the estimation results of exports to the USA across the *long* and the *short* sample.

The test for *changes* in the long-run export behaviour from 1993 on indicates a statistically significant decrease in the long-run impact of price competitiveness on extra exports. Also for intra exports, the influence of competitiveness declined (by 0.3), although this fall was slightly smaller and statistically insignificant. For exports to the United States, too, a decrease in the impact of competitiveness – of 0.2, and thus likewise statistically insignificant – was found.

Thus, for all three regions under review, price competitiveness appears to have been exerting a weaker influence on exports since 1993. There are various possible supply-side and demand-side reasons for this. Supply of or demand for export goods could have shifted in favour of less price-elastic products, for instance. The fact that the share of capital goods in German exports is large may contribute to a dampening of price competition effects. Furthermore, on account of the elimination of fluctuations in the nominal effective exchange rate through the establishment of EMU and the convergence of inflation rates in EMU member states, changes in price competitiveness vis-à-vis suppliers from the (future) euro area, especially since the mid-1990s, have remained quite slight. A further reason might be that the measured changes in price competitiveness are not reflected in suppliers' prices since the pricing behaviour of German exporters might have changed. It is possible that enterprises cushion a larger share of the (relative) fluctuations in prices and exchange rates by adjusting their margins. Increasing intra-firm trade may have led to a reduction in exchange rate pass-through. The advance of globalisation, the establishment of monetary union and EU enlargements may have contributed to pricing-to-market becoming increasingly important for German exporters.[44]

However, the decline in the relative price sensitivity of extra exports, which is the strongest within the three regions and, moreover, highly significant, might also be due, at least in part, to the construction of the indicator of relative price competitiveness vis-à-vis third-country suppliers, which does not include all non-euro-area countries. For instance, Germany's exports to the United States react sharply to changes in bilateral price competitiveness for both the first sub-sample (the elasticity takes the value of 0.9) and the second sub-sample (elasticity of 0.7). Moreover, since, notably, some Asian emerging markets peg their currencies *de facto* to the US

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[44]Estimations based on the aggregated export price index have shown that, in the past few years, the long-run effects of pricing-to-market have been continuously on the rise, with exchange rate pass-through declining at the same time. These findings are in line with results from estimating the export pricing behaviour of German enterprises for eleven categories of goods. The regressions provide evidence that, in the 1990s, exchange rate pass-through effects declined significantly for five product groups, which in 2004 accounted for 25% of German overall export volume. At the same time, pricing-to-market behaviour increased significantly for four categories of goods, which made up 47% of German export volume. See Stahn (2006).

dollar, the US dollar's weight within this indicator, which is fixed at the 1995–1997 period, is probably too small.[45]

To summarise, the test for long-run *changes* in the impact of key determinants of German exports reveals a decrease in the influence of price competitiveness for all three regions under review. Although this decline is statistically significant only for extra exports, these results – taking into account the small size of the sub-samples and the possibility of parameter instability at the time of German unification – might be taken as initial and tentative evidence that, since the 1990s, a decline in the relative price sensitivity not merely of extra exports, but also of both intra exports and exports to the United States has occurred.

5 Simulations

In this section, simulations are performed to follow the adjustment process for exports after shocks. First a permanent 10% increase in demand on the relevant regional export market is analysed. The second shock is a permanent 10% deterioration in the German economy's price competitiveness against competitors in the region under review caused by shifts in the relative price or exchange rate framework. The simulations are based on the error correction model (1).

Table 4: Reaction of exports to permanent shocks

| Reaction in % at/after	$t = 0$	1 quarter	1 year	2 years	3 years	long-term
10% export market growth						
Intra exports: long sample	9.3	11.0	9.4	9.0	8.8	8.8
short sample	**8.5**	**9.1**	**9.7**	**9.8**	**9.8**	**9.8**
Extra exports: long sample	4.7	5.4	7.7	8.3	8.2	8.1
short sample	**5.2**	**5.7**	**8.4**	**9.5**	**9.8**	**9.9**
10% deterioration in competitiveness						
Intra exports: long sample	–4.9	–5.1	–7.8	–8.8	–9.1	–9.2
short sample	**0.0**	**–1.5**	**–3.0**	**–3.3**	**–3.3**	**–3.2**
Extra exports: long sample	0.0	–3.9	–5.3	–6.5	–6.6	–6.3
short sample	**0.0**	**–1.2**	**–2.4**	**–2.9**	**–3.1**	**–3.0**

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[45]Furthermore, the high aggregation of "third countries" conceals diverging trends in individual countries outside the euro area. This fact might have contributed at least partly to the minor impact of competitiveness on extra exports across the *short* sample if these divergences have increased since the 1990s.

Table 4 gives the percentage change in exports relative to the *baseline*, ie the development in the absence of the shock, for both the *long* and the *short* sample period. Shocks occur at the beginning of the period t = 0. Figures 1 and 2 of sections 5.1 and 5.2 give a graphic representation of the corresponding adjustment processes.

5.1   Reaction to increased export market growth

Figure 1 shows that, given a positive demand shock (in $t = 0$), both intra exports and extra exports – irrespective of the estimation period chosen – increase immediately. For the *long* sample, intra exports rise somewhat more sharply than extra exports over the long run. In the short run, by contrast, intra exports rise distinctly more sharply than extra exports. Moreover, in the second quarter after the shock, intra exports considerably exceed their long-term rate of change as they react to export market growth with an additional one-period time-lag. On the other hand, the adjustment process for extra exports is largely monotonic. For both intra exports and extra exports, the adjustment to their demand shock-induced long-term change has largely run its course after three years.

Figure 1: Reaction of exports to a permanent 10% increase in foreign demand


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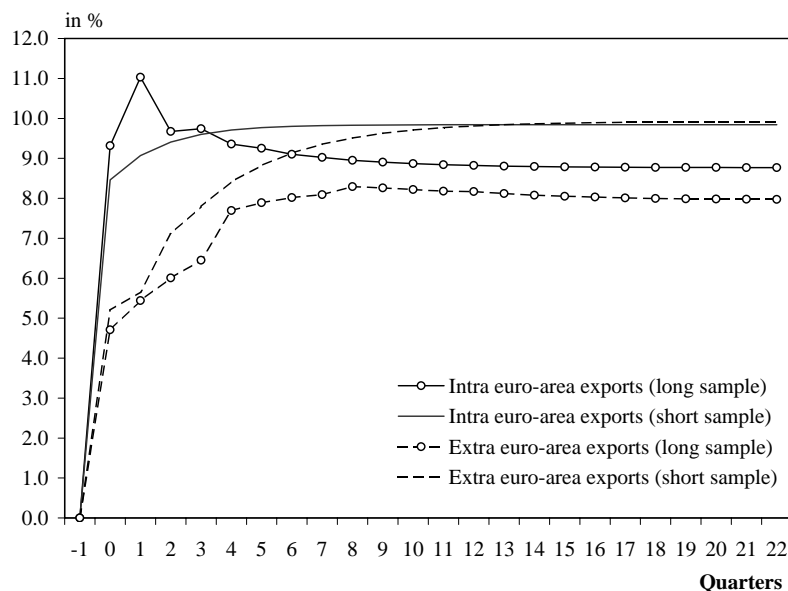
For the *short*-sample simulations, intra exports and extra exports react nearly equally strongly to the export market shock over the long run and somewhat more strongly than for the *long* estimation period. Moreover, both responses adjust monotonically. A large percentage of the reaction of intra exports already transpires immediately after the shock occurs. All in all, intra exports already complete the adjustment process to their long-term change after $1\ 1/2$ years and hence earlier than extra exports (roughly three years).

5.2   Reaction to deteriorating price competitiveness

In response to a deterioration in price competitiveness, intra exports decrease more strongly in the long run for the *long* estimation period than extra exports. Moreover, intra exports are already adversely impacted immediately after the shock occurs (in $t = 0$). By contrast, extra exports react to a deterioration in the competitive position only after a one-period time-lag. In addition, the adjustment process for both intra and extra exports is monotonic. Intra exports' adjustment to their price shock-induced long-term change is largely completed after three years, and half a year later for extra exports.

Figure 2: Reaction of exports to a permanent 10% deterioration in price competitiveness
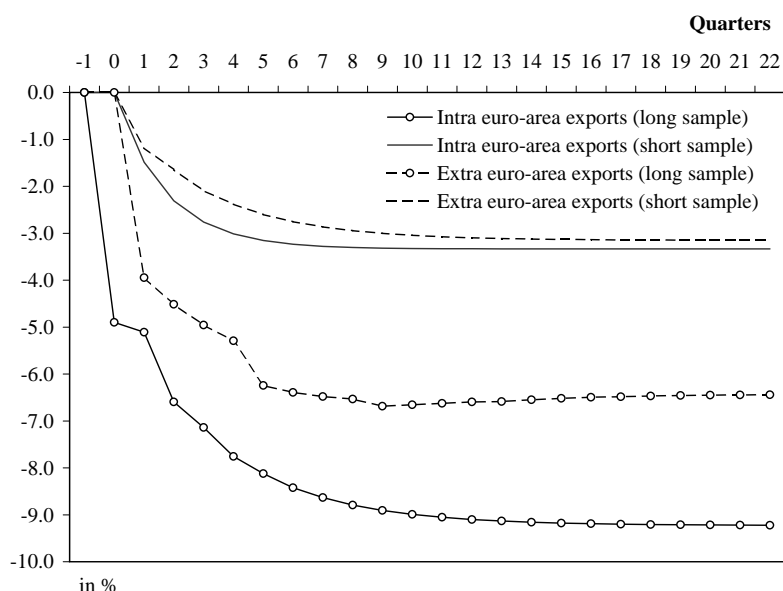
In the simulations across the *short* analysis period, intra exports and extra exports decrease nearly equally, but less strongly, than for the *long* sample (see also section 4.1). For both intra exports and extra exports alike, the adjustment process is monotonic. As already determined for the export market shock, after as early as roughly 1 1/2 years the intra exports have nearly completely adjusted to the new long-run change whereas extra exports need around one year longer.

6   Conclusion

Estimations of German exports to euro-area partners (intra exports) and to non-euro-area countries (extra exports) for a *short* sample (from 1993) indicate that both intra and extra euro area exports have grown in line with Germany's export markets. In contrast, the impact of price competitiveness is considerably smaller. This result is consistent with observations from a continuous analysis of foreign trade, namely that, in the past few years, the influence of trading partners' economic activity on German exports has far outweighed the effects of price competitiveness.

Further estimation of *changes* in the impact of German exports' key determinants in the 1993–2004 sample compared to the previous period of 1980–1992 provides evidence that the long-run relative price sensitivity of German exports has declined for both intra and extra exports. Export supply or export demand shifts in favour of less price-elastic products, the possibility that the pricing behaviour of German exporters may have changed – eg through increasing intra-firm trade or the advancing globalisation and the establishment or enlargement of unified currency or economic areas – as well as the quite slight changes in price competitiveness vis-à-vis suppliers from the (future) euro-area – since the mid-1990s – all may have contributed to this. However, the estimation results for extra exports may also be due at least in part to the fact that the corresponding indicator of price competitiveness does not capture all non-euro area countries.

7   Appendix

Tests for cointegration

To apply the Johansen procedure for cointegration tests, VECMs with four regionally disaggregated system variables (real exports to region r, real demand in region r addressed to Germany, the numerator – the German deflator of total sales – and the denominator – the deflator of total sales in region r, converted into domestic currency units by the nominal external value against the corresponding circle of trading partners – of the indicator of Germany's price competitiveness against trading partners in region r) are set up. In each model the cointegrating relationship includes a constant. Furthermore, for intra exports the shift dummy is restricted to the cointegrating relationship, and the corresponding impulse dummy is factored in the model. Table 5 below maps the trace test statistic under the null hypothesis that the system's rank is zero and the corresponding critical values for a significance level of 5%.[46] It is shown that the null hypothesis is rejected in each model.

Table 5: Tests for cointegration

System	Estimation period	Number of lags (first differences)	Trace test statistic rank = 0	Critical values (5%) rank = 0
Intra	1980 Q1–2004 Q3	0	210.62	59.50
euro-area	**1993 Q1–2004 Q3**	**0**	**61.25**	**48.52**
Extra	1980 Q1–2004 Q3	0	84.32	50.81
euro-area	**1993 Q1–2004 Q3**	**0**	**59.48**	**48.52**
United	1980 Q1–2004 Q3	0	144.67	50.81
States	**1993 Q1–2004 Q3**	**0**	**60.36**	**48.52**

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[46]The critical values were generated using Johansen's DisCo routines.

Bilateral estimation results

Table 6: Estimation results for German exports to the United States

Region	United States			
Sample	1980 Q1–2004 Q3		1993 Q1–2004 Q3	
Equation	(1)	(2), (3)	(1)	(2), (3)
β_1	0.80 *** [25.57]	$\mathbf{0.80}$*** [43.69]	1.00 *** [27.98]	$\mathbf{0.98}$*** [20.50]
β_2	1.02*** [9.85]	$\mathbf{0.94}$*** [15.30]	0.59*** [7.66]	$\mathbf{0.71}$*** [8.11]
β_3	—	—	—	—
β_0	3.17*** [6.71]	$\mathbf{2.82}$*** [10.04]	0.26 [0.52]	$\mathbf{0.85}$ [1.37]
α	-0.31*** [−5.38]	$\mathbf{-0.32}$*** [−5.79]	-0.59*** [−5.11]	$\mathbf{-0.53}$*** [−4.81]
Δd_{93}	—	—	—	—
Δx^r_{t-1}	-0.34*** [−4.14]	$\mathbf{-0.32}$*** [−3.97]	-0.25** [−2.48]	—
Δx^r_{t-2}	—	—	—	$\mathbf{0.29}$*** [3.17]
Δy^r_t	0.73*** [3.55]	$\mathbf{0.63}$*** [3.28]	0.70** [2.72]	$\mathbf{0.90}$*** [5.66]
Δy^r_{t-1}	0.64** [2.88]	$\mathbf{0.53}$** [2.53]	—	—
Δw^T_t	0.20^* [1.92]	$\mathbf{0.19}^*$ [1.82]	0.20^* [1.87]	—
Δw^T_{t-3}	—	—	0.38** [3.56]	$\mathbf{0.23}$** [2.34]
Adj. R^2	0.48	**0.48**	0.63	**0.61**
SE	0.05	**0.05**	0.03	**0.03**
LM(4)	(0.28)	(**0.49**)	(0.82)	(**0.94**)
JB	(0.16)	(**0.60**)	(0.47)	(**0.59**)
White	(0.53)	(**0.50**)	(0.58)	(**0.52**)
Wald (β_1)	(0.00)	(**0.00**)	(1.00)	(**0.72**)
OV	(0.71)	(**0.73**)	(0.24)	(**0.14**)

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