Macroeconomic effects of changes in real exchange rates

In the past year, the euro appreciated distinctly against key currencies. This aroused fears that the stronger euro might have a highly adverse effect on German business activity. However, the regional pattern of Germany's foreign trade, established invoicing practices and enterprises' hedging activities have so far done much to cushion the effects of appreciation, especially on exports. Nonetheless, volume effects may be expected to occur over the longer term, as exporters and importers will not be able to completely factor lasting exchange rate shifts into their prices. However, there is empirical evidence that the exchange rate elasticity of German foreign trade, particularly exports, has declined over the past few years.

With regard to demand, shifts in relative prices in the markets for exports and imports can affect foreign trade, and thus economic growth, via their impact on competitiveness. Additional effects result from purchasing power-related income gains or losses (known as "terms of trade effects") which generally tend to counteract the competition effects.

Increasing openness and new exchange rate structure

Germany's participation in the international exchange of goods has risen sharply since

Growing openness of German economy

German unification. Real openness of the German economy, measured here as the ratio of total nominal exports and imports of goods and services to gross domestic product (GDP), rose from 47½% in 1995 to 66½% in 2000 to 86½% in 2007, a figure that is very high also by international standards. This reflects, for one thing, the fact that the volume of internationally tradable goods has grown considerably and, for another, that the emerging market economies and the central and east European countries in transition have given a new boost to world trade. As a corollary, changes in product prices on the world markets and of exchange rates have gained considerably in structural importance for the German economy.

New exchange rate structure as a result of Stage Three of EMU

Moreover, the international exchange rate structure changed decisively upon the introduction of the euro on 1 January 1999. There have been no more exchange rate-related shifts in competitiveness between euro-area partners since that time. The exchange rate of the single currency generally reflects the relative performance and stability of the euro area as a whole; from the point of view of a member state, it can thus – depending on the country's economic size – be regarded more or less as exogenous.

Strong influence of US dollar on euro's nominal effective exchange rate

The US dollar, at just under 24% (including third-market effects), accounts for the largest weight in the euro's trade-weighted external value.[1] From the beginning of monetary union until the end of 2007, the euro-US dollar exchange rate, following a marked depreciation lasting until autumn 2000, rose by a total of 25% in the subsequent phase of appreciation. The euro increased by 11¾% against the US dollar in the past year alone. In addition, the euro also appreciated against the pound sterling (9¼%) and the Japanese yen (5%); these currencies' trade weights in the euro's external value are 20¾% and 10½% respectively. By contrast, the euro mostly fell against the currencies of the new EU member states, which have evolved into significant trading partners of the euro area. On a trade-weighted average, the euro's external value gained 8¾% between the launch of monetary union and the end of 2007.

Exchange rate effects and price setting

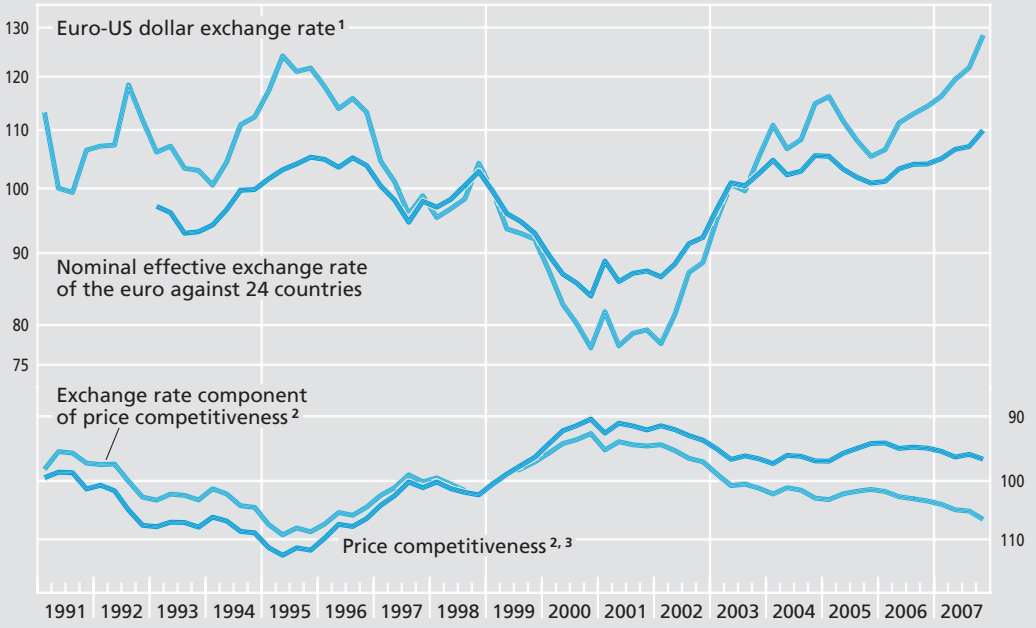
Germany's regional foreign trade pattern

From the perspective of the German economy, an important feature is that a large percentage of its exports of goods (around 42¾% in 2007) are destined for other euro-area countries. This export segment is exchange rate-dependent only to the extent that competitors from non-euro-area countries benefit from the euro's appreciation against the US dollar and other non-euro-area currencies. Given this regional focus, movements of the euro's nominal effective exchange rate therefore have only a muted effect on Germany's foreign trade. Regarding the US dollar, it should be noted that the share of Germany's exports destined for the United States, at 7½% in 2007, is not very large. However, the exchange rate effect is

1 This is based on the euro's nominal effective exchange rate against a group of 24 countries. For more on the weights, see European Central Bank, The effective exchange rates of the euro following the recent euro area and EU enlargements, Monthly Bulletin, March 2007, p 78.

Exchange rates and the German economy's price competitiveness

1999 Q1 = 100, quarterly, log scale



1 Before 1999: D-Mark-US dollar exchange rate. — **2** Against 19 industrial countries. Inverted scale: rise in the curve (decline in values) indicates increase in competitiveness. — **3** Based on the deflators of total sales.

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amplified by the fact that certain Asian emerging market economies which, in the past few years, have evolved into major export markets (accounting for 3½% of German exports at the last count), oriented their currencies very closely to the US dollar, at least in the past.[2] Measured by a group of 19 major trading partners of Germany,[3] the US dollar, including third-market effects, has a weight of around 15% from the point of view of the German economy.

Short-term effects dependent on the invoicing currency …

The impacts of exchange rate movements on real exports depend in great measure on the time horizon under observation. Over the short term, the choice of invoicing currency and the degree of cross-currency hedging play an important role. Where it has been agreed that the delivery contracts for German exports will be invoiced in euro, it is the foreign buyer who bears the exchange rate risk of an appreciating euro. By contrast, exporters whose sales are invoiced in US dollars – unless they have hedged their anticipated foreign currency-denominated revenue flows – must expect that a bilateral appreciation of the euro will cause their export revenues to fall when they settle transactions concluded previously. According to surveys conducted by the Ifo Institute on behalf of the Bundesbank, 80% of Germany's exports are currently invoiced in euro and only 13% in US dol-

2 China and Malaysia are counted here among this group. However, these countries have latterly permitted somewhat stronger movements in their bilateral exchange rates to the US dollar.
3 This list includes, specifically, the euro-area partners of 2006 as well as Canada, Denmark, Japan, Norway, Sweden, Switzerland, the United Kingdom and the United States.

Regional and product structure of German foreign trade *

Data for 2006

Product category	Euro area	European countries in transition	Other European countries	North America	Japan	Other Asian countries	OPEC	All seven regions
	Percentage share in total exports of each product category							
Food	60.2	13.1	17.4	3.2	0.6	0.9	1.5	96.9
Textiles	48.9	23.5	15.5	3.3	0.7	2.4	0.6	94.9
Paper products	48.2	16.2	18.2	5.0	0.5	3.4	1.6	93.1
Petroleum products	53.0	11.5	20.2	8.8	0.1	0.6	0.2	94.4
Chemicals	46.2	12.6	13.8	9.7	2.2	6.0	1.5	92.0
Plastic products	44.8	17.8	16.3	7.1	0.9	3.8	1.5	92.2
Metals	43.6	16.9	16.4	7.2	0.9	5.7	3.1	93.8
Machinery	30.0	17.1	13.0	10.7	1.5	12.2	3.6	88.1
Computers	45.8	15.6	23.4	4.0	0.6	2.9	2.8	95.1
Electrical equipment	33.1	16.6	14.1	11.3	2.0	10.6	2.7	90.4
Motor vehicles	39.0	12.7	17.3	15.0	2.3	4.2	2.0	92.5
All products	41.8	14.6	15.7	9.5	1.6	6.6	2.2	92.0
	Percentage share in total imports of each product category							
Food	56.5	8.1	9.0	2.7	0.1	4.2	0.5	81.1
Textiles	23.7	15.7	4.7	1.2	0.4	26.2	0.4	72.3
Paper products	50.9	9.1	29.9	4.4	0.3	1.5	0.0	96.1
Petroleum products	20.6	33.1	25.5	0.7	0.1	0.1	15.7	95.8
Chemicals	56.0	4.5	20.0	11.7	2.0	3.0	0.2	97.4
Plastic products	46.2	25.6	7.8	3.3	3.9	6.7	0.0	93.5
Metals	46.0	20.8	14.6	2.7	0.8	5.9	0.4	91.2
Machinery	39.0	16.3	20.1	7.7	5.9	6.6	0.1	95.7
Computers	21.6	4.9	4.5	8.4	11.4	48.0	0.0	98.8
Electrical equipment	24.1	15.1	11.3	12.5	7.1	25.4	0.3	95.8
Motor vehicles	48.4	18.0	10.5	7.6	6.8	3.5	0.0	94.8
All products	38.4	15.6	15.0	7.2	3.3	11.7	1.4	92.6

* Definition of product categories (SITC two-digit codes) and regions: food (01-09, 11, 41-43), textiles (65, 84), paper products (25, 64), petroleum products (33), chemicals (51-59), plastic products (62), metals (67-69), machinery (72-74), computers (75), electrical equipment (71, 76-77, 87-88), motor vehicles (78); euro area: Austria, Belgium, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain; European countries in transition: Armenia, Azerbaijan, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Republic of Belarus, Rumania, Russian Federation, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan; other European countries: Cyprus, Denmark, Malta, Norway, Sweden, Switzerland, United Kingdom; North America: Canada, United States; other Asian countries: Brunei Darussalam, China, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; OPEC: Algeria, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela.

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lars.[4] Two-thirds of German exports to non-euro-area countries are invoiced in euro and one-fifth in US dollars.

... and cross-currency hedging

German companies invoicing in foreign currencies, moreover, are making widespread use of the possibility of hedging their export revenues against exchange rate risk. According to the Ifo survey results, three-quarters of all foreign currency receivables from export business were hedged against exchange rate-related losses. Enterprises can use hedging products that have standardised maturities and currency amounts and are traded on official exchanges. Alternatively, especially for large projects, customised hedges with maturities lasting over several years are available. In practice, foreign currency receivables are often only partly hedged, either for cost reasons or speculative purposes.

Given the major weight of the euro as an invoicing currency for German export business and the large share of hedged foreign currency receivables, a depreciation of the US dollar against the euro therefore squeezes German enterprises' export revenues only to a relatively small extent in the short term. Over the longer term, when the issue is not only fulfilling existing delivery contracts but also concluding new ones, the significance of the invoicing currency is tempered somewhat because the prices are generally recalculated or renegotiated based on the new exchange rates. In addition, special hedges for new export deals are only possible based on the exchange rate that is then current. If expected export revenue flows are systematically hedged, the costs of hedging the underlying transaction are likely to increase distinctly as the time horizon lengthens.

Cost relief owing to appreciation

However, the current appreciation of the euro generally affects not only firms' export sales but also their costs by reducing the price of the imported intermediate inputs that go into the manufacture of exported goods. These imported inputs latterly made up 45% of exports, as against 31% in 1995.[5] It should be noted in this context that the euro's exchange rate against the US dollar is more relevant for imports than for exports. Thus the share of Germany's imports from the USA and the countries which oriented their currencies very closely to the US dollar in total German imports, at 13½%, is larger than their share in German exports (11%). In addition, the prices of most commodities (including crude oil) in the world markets are quoted in US dollars. The appreciation-related cost relief, which has been particularly noticeable in Germany's energy bills, was a key factor in ensuring that, all in all, German exporters have coped relatively well with the strengthening euro in the past few years.

Temporary versus permanent exchange rate changes

Whether or not firms will tolerate reduced export revenues owing to currency appreciation depends, among other things, on whether they see the shifts in exchange rates as being temporary or permanent. If they regard the euro's appreciation as merely transient, ex-

4 See: Ifo Institute, Fakturierte Währungen im deutschen Außenhandel und Absicherung von Fremdwährungsforderungen im 3. Quartal 2006, Ergebnisse der Umfrage 2006-07 (research project commissioned by the Deutsche Bundesbank), Munich, 2007 (in German only).
5 See A Loschky and L Ritter, Konjunkturmotor Export, in: Federal Statistical Office, Wirtschaft und Statistik, 5/2007, p 485 f (in German only).

porters can hold prices in their sales markets constant as long as their variable unit costs are covered. Or they may opt to temporarily "cross-subsidise" their exports to those countries from their profits in domestic business or revenue from intra-euro-area trade. Major shifts in exchange rates that are regarded as permanent, by contrast, cause exporters to rethink their strategic behaviour. Owing to the relatively volatile nature of exchange rate movements, however, it is hard for market participants to decide early on whether the change is temporary or permanent. This continues to hold even though the volatility of both the euro's nominal effective exchange rate and the euro-US dollar exchange rate has, on the whole, shown a visible downward tendency over the past few years.

Restructuring of production chains and increase in foreign direct investment

To some degree, exporters can offset exchange rate-related losses in price competitiveness by adjusting their intermediate inputs. Firms can, for instance, transfer their business at fairly short notice to suppliers from countries whose currencies have depreciated against the euro or otherwise provide cost advantages. Medium to long-term strategies are aimed more at restructuring production and revising the firm's internal policies for choosing production sites. In this way the share of imported intermediate inputs from low-cost countries can be increased at the expense of domestically generated value added – made more expensive by currency appreciation – or else manufacturing can be shifted partly to other, lower-cost countries in order to be able to sell the final products at competitive euro prices without any (major) losses in revenues. An important element of this strategy is "natural hedging", which has been practised, for instance, by the German automotive industry and its suppliers particularly in the past 15 years by establishing manufacturing capacity in the United States. This means not only that products are delivered to the local buyers without any exchange rate risk but that, if the euro appreciates, exchange rate-related losses from German exports to the USA are offset within the firm through exports to Europe. Such a hedge can also be achieved by buying equity stakes or existing manufacturing sites.

Influence of exchange rate on price setting

For the aforementioned reasons, exchange rate movements have a noticeable impact on prices in the respective foreign sales markets only after a time-lag. To a lesser extent, this also holds for imports. Instead of passing the appreciation through to local prices directly and completely, foreign trade enterprises pursue a pricing-to-market policy at times. The tougher the competition in the respective sales market, the less the firm's own revenues and costs play a key role in short-term price-setting and the more its competitors' prices play a role. Such behaviour is more or less pronounced across the various product types depending on the market and competitive situation.[6] Empirical studies have shown that, in the case of food, motor vehicles and computers, ie products that are traded on highly competitive markets, up to between one-quarter and one-third of the shifts in exchange rate parities are factored into export prices (in domestic currency) over the long

6 Significant factors here include the degree of concentration, market segmentation or homogeneity of the traded products.

term.[7] On the whole, export prices calculated in euro, as a weighted average of the sectors studied, are adjusted to include only around one-eighth of each respective change in exchange rates.

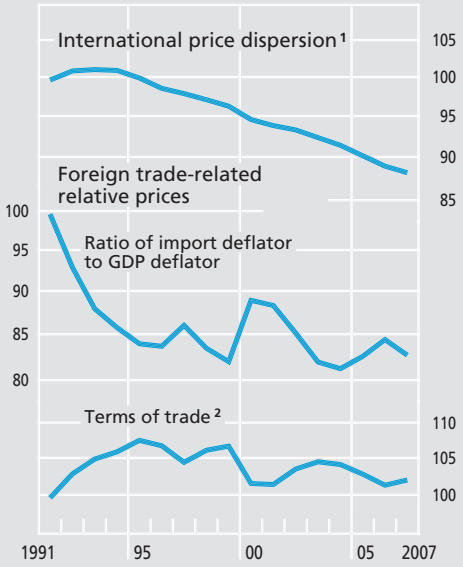
Import prices show marked exchange rate pass-through

When importers set their prices in euro, exchange rates are important insofar as their own costs depend on the exchange rate at which they can obtain their imported goods. The less price-elastic domestic demand for the imported product is, the more strongly domestic importers react to exchange rate fluctuations. Econometric analyses for Germany show that between one-tenth and four-fifths of exchange rate movements, depending on the product category, are reflected in import prices over the long term.[8] Import prices for computers, paper products, metals, machinery, electrical equipment and petroleum products show an exchange rate pass-through of one-third or more. In the case of product categories with a large share of commodities, the exchange rate pass-through is particularly high as commodities are priced in US dollars in the global markets and the demand for these goods is largely price-inelastic in the short and medium term. Accordingly, a virtually complete pass-through can be demonstrated for imported petroleum products.

On the whole, it transpires that German importers adjust their euro-denominated prices far more strongly to exchange rate movements than do exporters. This is partly because commodities and semi-finished goods are more important for imports than for exports. Had the euro not appreciated against the US dollar, the costs of purchasing crude oil and petroleum products as well as other commodities would, at any rate, have risen even more strongly than was actually the case.

International relative prices

1991 = 100, log scale



1 Ratio of domestic deflator of total sales to the trade-weighted deflators of total sales of 19 industrial countries in local currency. — **2** Based on the national accounts deflators.

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7 See K Stahn (2007), Has the export pricing behaviour of German enterprises changed? Empirical evidence from German sectoral export prices, Journal of Economics and Statistics, Vol 227/3, p 295 ff. This study analyses the exchange rate's impact by means of the exchange rate component of the indicator of the price competitiveness of the German economy against 19 major trading partners, with the exception of export prices for computers. Therefore, the small exchange rate effect observed for some product categories might be attributable to the fact that the group of 19 industrial countries no longer completely reflects the regional composition of foreign competitors. In addition, the estimation approach does not capture the influence of exchange rates on domestic manufacturing costs.

8 The estimations of import prices produce relatively robust results for the exchange rate pass-through. Since the domestic competitors' prices themselves are dependent on import prices, however, the pricing-to-market effect could not be analysed for each product category.

Significance of demand and income effects

Competition effect: concept and measurement

Where exchange rate movements change the relationship between domestic and foreign prices (converted to domestic currency), they trigger, via substitution processes, shifts in the structure of domestic expenditure and in foreign trade which, in turn, influence domestic economic growth (competition effect). If the domestic economy's competitiveness deteriorates through, for instance, a rise in domestic prices relative to foreign prices, domestic exporters tend to lose market share in their foreign sales markets while the position of foreign sellers in the domestic market improves. The size of this competition effect depends on how strongly domestic export and import volumes react to shifts between domestic and foreign prices. Empirical studies show that, in terms of amount, the elasticity of German exports to changes in this price ratio averages 0.25 over the long term.[9] This means that, if domestic prices rise by 1% relative to foreign prices, real exports go down by 0.25%. This relatively small influence is due partly to the fact that the share of relatively price-inelastic goods in the range of German exports is quite high. Exports to non-euro-area countries, in particular, respond relatively weakly to price competitiveness.

Econometric studies also find evidence that the responsiveness of German exports, especially to non-euro-area countries, to relative prices has decreased since German unification in comparison with the 1980s.[10] This could be due to the fact that domestic exporters' pricing-to-market behaviour has grown in importance since the 1990s, thereby reducing appreciation-related losses in the German economy's measured price competitiveness (for more on the econometric analyses see the annex on page 43 ff). However, it should be pointed out that the underlying indicator used here does not contain the currencies of all non-euro-area countries. Thus the Asian emerging markets, which to date have oriented their currencies closely to the US dollar, are not recorded, which means that the US dollar may be underweighted.[11]

For German imports of goods, the elasticity to the relevant price ratio can be quantified at 0.21. This likewise relatively small effect is attributable to the fact that the largely price-inelastic categories of commodities and semi-finished goods make up a significant share of German imports. To the extent that rising import prices are related to the increase in the prices of energy and commodities, domestic

9 For exports, the price ratio is adequately represented by the indicator of the German economy's price competitiveness against 19 major trading partners based on the deflators of total sales. Price competitiveness thus shows the price ratio between a domestic basket of goods and a foreign basket of goods. These can be compared by converting the foreign currency-denominated foreign prices into domestic currency units using the appropriate exchange rates. For the concept, see Deutsche Bundesbank, New and recalculated indicators of the German economy's price competitiveness, Monthly Report, May 2007, pp 31-35. For imports, the ratio of the import deflator to the GDP deflator is used. The elasticities of the foreign trade-relevant price ratios were derived from estimations of exports and imports of goods and services as defined in the national accounts over the period 1992-2006.

10 See K Stahn (2006), Has the impact of key determinants of German exports changed?, in: Convergence or divergence in Europe. Growth and business cycles in France, Germany and Italy, O de Bandt and H Herrmann (eds), Berlin, pp 361-384.

11 Additionally, there may be an aggregation problem if bilateral exports, which are determined by the relevant price ratios, have diverged.

buyers can substitute foreign goods by domestic products only to a limited degree.

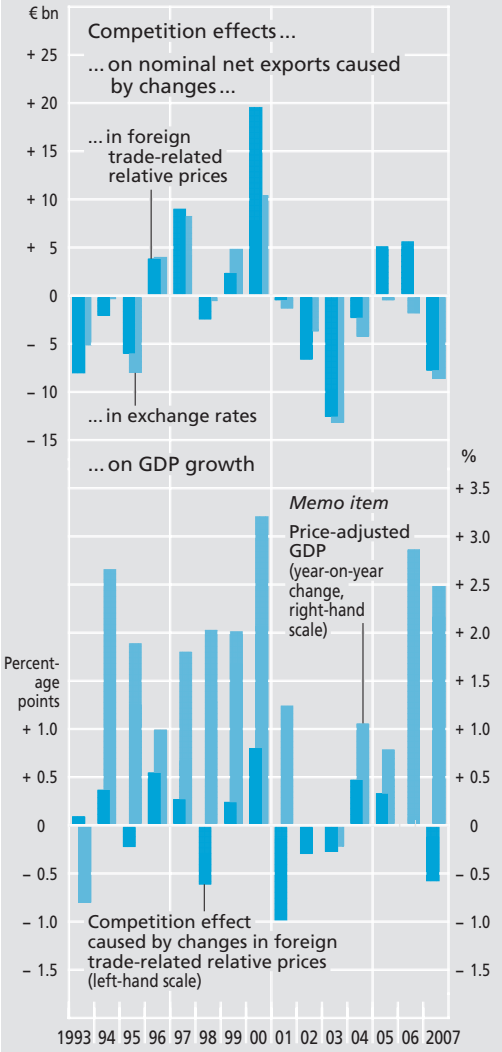
Terms of trade effect: definition ...

Competition effects are supplemented by changes in the purchasing power of incomes which accrue to domestic sectors through changes in the ratio of a country's export and import prices, also known as the terms of trade. The (commodity) terms of trade state the number of units of an imported good that can be exchanged for a unit of an export commodity. It can thus also be interpreted as a measure of welfare which shows the intensity of the benefits of the free international trade of goods. For a given volume of exports, changes in the terms of trade lead to purchasing power effects in that movements in export and import prices either enlarge or narrow domestic sectors' real income. [12]

... and calculation

The real income or the real value of GDP are purchasing power-based volumes that show the quantity of consumer and capital goods that corresponds to a certain level of value added. By contrast, price-adjusted GDP captures real value added (at previous-year prices). Consequently, the terms of trade effect represents the foreign trade-induced gain or loss in purchasing power to the domestic economy resulting from shifts in the ratio of export prices to import prices; it is calculated as the difference in the rates of change between the real value of GDP and price-adjusted GDP. A positive (negative) terms of trade effect measures the added gain (or loss) of purchasing power to domestic sectors – measured as units of price-adjusted GDP – along with the value equivalent of the volume of output.

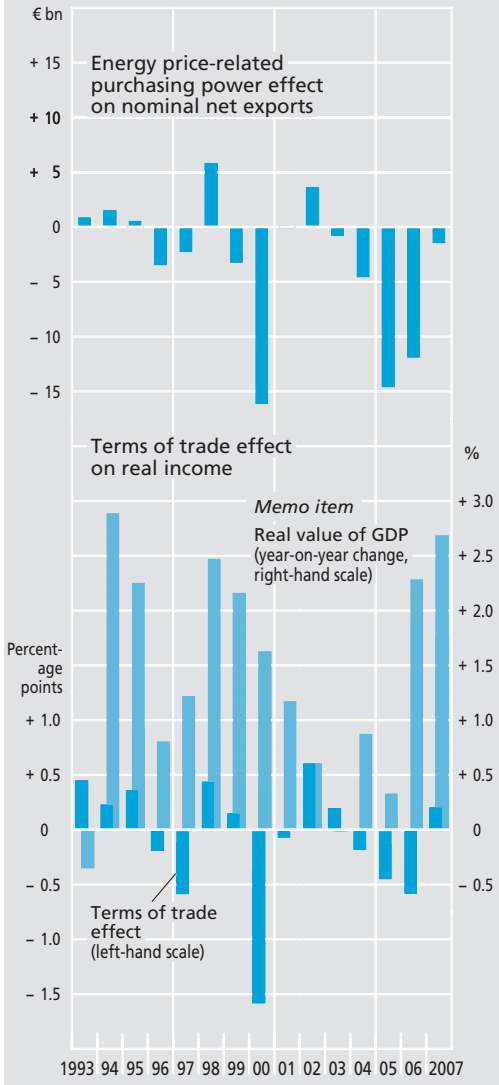
Competition effects on German foreign trade



In order to reflect changes in purchasing power in the real value of GDP, exports and imports – unlike real GDP – are price-adjusted using a uniform price index instead of the special export or import deflator. To this end, the Federal Statistical Office uses the price index of final domestic demand, which re-

12 Here, the terms of trade are calculated based on the export and import deflators taken from the national accounts.

Terms of trade effects



flects the structure of the purchases of goods and services for which the national income is used, thereby revealing the entire gain or loss in purchasing power. The use of this measurement concept leads to purchasing power effects if export and import prices move differently than the price index of domestic demand. In Germany, this is particularly evident in the case of sharp fluctuations in the prices of commodities, since this category of goods is much more important for imports than for domestically produced goods.

Purchasing power effects on domestic demand

It may be expected, moreover, that changes in purchasing power-related income induced by the terms of trade may also impact on the sectoral income distribution and – given specific spending propensities – on real domestic demand. The distribution of income between private consumption and corporate investment may be changing. The better, for instance, companies are able to pass through increased costs caused by terms of trade to domestic buyers – ie the more they are able to maintain their profit margins – the stronger the impact of purchasing power losses caused by a deterioration of the terms of trade will be on the real disposable incomes of domestic households.

Wealth effects

An appreciation or a depreciation of the domestic currency can also lead to valuation-induced wealth effects. Decisive factors include the country's net position and the currency structure of foreign assets and liabilities. According to provisional calculations, Germany's net foreign assets fell in the first three quarters of the past year (more recent data are not available) owing to currency appreciation effects by €47 billion vis-à-vis the end of 2006. Enterprises and individuals saw their wealth decline by €38½ billion. This represented around 2% of total disposable income of all domestic sectors.

Empirical findings

Purchasing power-related real income effects are caused particularly by changes in the prices of commodities, especially crude oil and natural gas. This is largely because import

prices react relatively strongly to changes in international commodity prices.[13] The energy price-induced purchasing power effect can be calculated by valuing the previous period's nominal net energy imports with the change in the prices of energy imports. Since the mid-1990s the purchasing power loss associated with rising energy prices has averaged around ¼% of GDP or disposable income of all domestic sectors per year. The strongest purchasing power losses were felt in the years 2000 and 2005-06, when energy import prices rose by 79¼%, 38¼% and 21½% respectively. By contrast, the euro's rise against the US dollar in 2007 contributed to an improvement in the terms of trade by approximately ¾% even though the world market prices for commodities once again jumped sharply.

Overall effects

When assessing the effects of terms of trade and of competition on the real value of GDP, it must be taken into account that the component effects often run in opposite directions. In the 1993-2007 observation period, the overall effects were located in the range of -1 to +½ percentage point. Given an annual average increase in the real value of GDP of 1¼%, the competition and terms of trade effects exerted quite a strong macroeconomic impact in some years. In 2007, growth of the real value of GDP declined by ½ percentage point on balance because the competition effect was much stronger than the terms of trade effect. On average of this period, the total impact on real income of the price changes relevant to foreign trade, however, was virtually neutral. This is also consistent with the finding that the German economy's export activity fundamentally depends much more on the growth of export markets and the attractiveness of exporters' product profile than merely on exchange rate changes.

13 Empirical studies show that the pass-through of crude oil prices to import prices for petroleum products is nearly complete. One-third of the changes in the world market prices for iron and steel are passed through to import prices of metal products. For other product categories, the pass-through rate of selected commodity prices is up to one-seventh.

Annex

Pricing behaviour in German foreign trade

Price formation in foreign trade is shaped by cost factors and competitive relationships. The following empirical study examines the extent to which export and import prices depend on domestic production costs, the prices of imported intermediate goods and commodities and the respective prices of competitors, and how the importance of the individual factors has changed over time. The estimation equation is:

$$p_i^x \text{ or } p_i^m = \beta_{i0} + \beta_{i1} p_i^h + \beta_{i2} p_j^r + \beta_{i3} p^f - \beta_{i4} w.$$

where p_i^x and p_i^m are the export/import price of the product category i in domestic currency units, β_{i0} is a constant and p_j^r is the global market price for commodity j in domestic currency units.[14] For

14 The price of commodities as denominated in US dollars is used only for the import prices of petroleum products and metals. Depending on the product category, global market prices for food, beverages and tobacco, spun yarn, cellulose, crude oil, iron and steel and non-ferrous metals are included.

export prices, the elasticities β_{i1} and β_{i2} represent the cost pass-through, with p_i^h representing the firm's own production costs.[15] β_{i3} and β_{i4} are the pricing-to-market effect via the foreign prices p^f which, for the sake of comparability, are translated into the domestic currency using exchange rate w.[16] In the case of import prices, β_{i1} reflects the pricing-to-market effect via domestic competitors' prices. The other elasticities show the cost or (in the case of β_{i4}) exchange rate pass-through.[17]

The estimations are performed in levels as cointegration relationships were found between the variables.[18] Furthermore – following Saikkonen's (1991) proposed method of solving the endogeneity problem – the first differences of the regressors are taken into account with up to one lag or lead period.[19] The estimations are adjusted for autocorrelation and heteroscedasticity using the Newey-West covariance estimator.

To ascertain whether the importance of individual factors has changed since German unification in the 1990s, an additional dummy variable is introduced for each determinant which splits the observation period into a pre-unification and a post-unification phase.[20] Their estimated elasticities show how the influence of the respective regressor has changed since German unification compared with the preceding period. This approach has the advantage of being able to test the changes in pricing behaviour for statistical significance. Moreover, shifts in cost pass-through and pricing-to-market are tested simultaneously.

To identify the overall effect on exporters' and importers' price-setting, the share of products in the total volume of exports and imports showing an increase in pricing-to-market is compared with the share of products showing a decrease. The cost or exchange rate pass-through is measured analogously. Export prices show a weakening of cost pass-through and a strengthening of pricing-to-market. Import prices, too, indicate stronger pricing-to-market. However, the statistical significance does not give a clear indication as to whether pass-through via the commodities' prices or the exchange rate movements has weakened altogether.[21]

The results indicate that the price pick-up of German export goods compared with competitors'

15 Since changes in the prices of commodities affect both foreign producers and domestic exporters, β_{i2} could also reflect pricing-to-market effects. The small elasticities – apart from the estimations for petroleum products – indicate, however, that this determinant should be attributed to the cost pass-through.
16 For each export product category, production costs are approximated on the basis of sectoral domestic producer prices, foreign competitors' prices on the basis of the trade-weighted aggregated deflators of total sales of 19 industrial countries and exchange rates on the basis of the weighted bilateral exchange rate of these countries against the euro. The sectoral prices of US producers and the euro/US dollar exchange rate are applied to computers.
17 Depending on the import product category, domestic competitors' prices are measured using domestic unit labour costs or the domestic GDP deflator. This effect cannot be estimated robustly for all product categories, however. The trade-weighted foreign unit labour costs or deflators of total sales of 19 industrial countries provide an approximation of the production costs of importers and are translated into domestic currency using the weighted bilateral exchange rate against the euro or the euro/US dollar exchange rate. In the case of computers, the same foreign variables that are used for exports are applied.
18 The regressions are based on logarithmic, quarterly data containing seasonal effects. Corresponding dummy variables are therefore factored in.
19 See P Saikkonen (1991), Asymptotically efficient estimation in cointegrated regressions, Econometric Theory, vol. 7, pp 1-21.
20 Export prices are analysed for the sub-periods 1976-1989 and 1991-2004. 1990 was heavily distorted by German unification and was therefore factored out of the estimation. The import price estimations cover the period 1976-2006. Depending on the product category, the dummy variable is set at 1990 or 1991 (in one case, 1986).
21 This finding is in line with other econometric studies which likewise find no clear-cut empirical evidence for changes in pricing strategy, although there are indications of a weakening of exchange rate pass-through to import and consumer prices.

Product categories with shifts in pricing behaviour *

	Cost pass-through				Pricing-to-market			
Exporters	Domestic prices		Commodity prices		Foreign prices		Exchange rates	
Direction of shift	Stronger	Weaker	Stronger	Weaker	Stronger	Weaker	Stronger	Weaker
2006	Share of total export volume							
Total	18%	70%	16%	7%	66%	21%	70%	15%
of which								
Significant sectors	15% Electrical equipment	25% Textiles, petroleum products, plastic products, machinery, computers	16% Textiles, petroleum products, plastic products, metals	0%	19% Textiles, petroleum products, machinery	10% Food, plastic products, computers	34% Electrical equipment, motor vehicles	6% Textiles, plastic products
Insignificant sectors	3% Paper products	45% Food, chemicals, metals, motor vehicles	0%	7% Food, paper products	47% Chemicals, electrical equipment, motor vehicles	11% Paper products, metals	36% Food, petroleum products, chemicals, machinery, computers	9% Metals
	Pricing-to-market		Cost pass-through					
Importers	Domestic prices		Commodity prices		Foreign prices		Exchange rates	
Direction of shift	Stronger	Weaker	Stronger	Weaker	Stronger	Weaker	Stronger	Weaker
2006	Share of total import volume							
Total	32%	7%	19%	18%	4%	66%	43%	31%
of which								
Significant sectors	22% Machinery, electrical equipment	3% Plastic products	7% Paper products, petroleum products, plastic products	9% Food, textiles	4% Computers	56% Food, textiles, paper products, chemicals, plastic products, metals, machinery, electrical equipment	19% Textiles, electrical equipment	24% Petroleum products, chemicals, plastic products, machinery
Insignificant sectors	10% Motor vehicles	4% Computers	12% Chemicals	9% Metals	0%	10% Motor vehicles	24% Metals, computers, motor vehicles	7% Food, paper products

* The statistical significance is based on an error probability of 5%. Each product category has a 2-digit code pursuant to the German Product Classification for Production Statistics: food (15), textiles (17, 18), paper products (21, 22), petroleum products (23), chemicals (24), plastic products (25), metals (27, 28), machinery (29), computers (30), electrical equipment (31-33), motor vehicles (34).

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products in foreign markets resulting from an appreciation of the domestic currency has been smaller since German unification than it was in the 1980s. This implies that exchange rate movements are being absorbed more through changes in the profit margin, thus at least temporarily lowering the return on capital. Enterprises are evidently now keener to avoid losses in sales volume following currency appreciation than they were in the 1980s. On the other hand, there is no clear evidence that, overall, import prices have become less responsive to exchange rate changes since the 1990s despite the fact that the share of – fairly price-inelastic – commodities and semi-finished goods in German imports has almost halved on average. Assuming comparable exchange rate movements before and after German unification, the cost advantage for German enterprises stemming from currency appreciation has therefore probably remained at largely the same level.

The weakening of cost pass-through or strengthening of pricing-to-market with regard to export prices may not, however, be solely attributable to changes in firms' behaviour in connection with tougher international competition in the wake of ongoing globalisation, the establishment of the euro area or EU enlargement. A wide range of factors may have played a role which imply a similar weakening of exchange rate pass-through in the case of import prices, too. For instance, supply-side factors such as advances in productivity and the deregulation of product and labour markets may have played a part. The clearer prioritising of price stability by central banks worldwide, which pushed down inflation expectations, may likewise have been conducive to reducing cost or exchange rate pass-through. It is also possible that the product profile of the goods traded on import and export markets has shifted from products with high cost pass-through to goods with low pass-through. Improvements in the quality of imported products, for instance, would have had a similar effect since demand for higher-quality goods is usually more price-elastic.