Exchange rate and foreign trade

The Deutsche Mark has appreciated strongly in nominal terms against the currencies of Germany's major trading partners during the past 20 years. Essentially, this was a reflection of the edge that the German currency has acquired in the international stability stakes over many years. Consequently, the purchasing power of the Deutsche Mark has remained remarkably stable over the past few decades not only at home but also abroad. At times, however, the exchange rate has deviated significantly from its prescribed path, owing to inflation differentials, with the result that the – real – exchange rate of the Deutsche Mark (adjusted for inflation differences) has sometimes been subject to fairly pronounced fluctuations in the shorter term. The most recent example of this was the sharp appreciation of the Deutsche Mark against the dollar and some European partner currencies in the spring of 1995. It is true that this distortion in exchange rates has now been fully rectified; for a time, however, it greatly impaired the price competitiveness of German exporters, especially as high wage settlements adversely affected the cost situation of enterprises at the same time. The present article examines the effects of these changes in exchange rates on German foreign trade.

The development of the exchange rate affects a country's economic competitiveness.

The problem

Domestic products become comparatively more expensive and foreign goods become comparatively less expensive if the domestic currency appreciates while costs remain the same. The conclusion generally drawn from this is that a real appreciation will adversely affect exporters' sales chances on foreign markets and will shift competition in the home market in favour of imported goods. This would seem to suggest that the balance of trade, that is to say, the difference between exports and imports, will tend to deteriorate as a result of real appreciation. Given this preconception, the reaction of Germany's foreign trade to the significant distortions in currency patterns in 1995 was remarkably moderate in various respects: German exports proved to be very robust right into the autumn of 1995, despite the exceptionally rapid appreciation; it was not until later that they showed the expected downturn. In the end Germany's trade surplus did not decline in 1995 but increased, instead, by almost DM 19 billion.

"Anomalous" reactions of the trade balance

Reactions of a similarly "anomalous" nature had been observed in earlier years, too: for example, at the end of the seventies and at the beginning of the eighties, the Deutsche Mark depreciated significantly (particularly against the US dollar) following the second oil crisis and the consequent shifts in prices, while the German trade balance deteriorated (see chart). Conversely, Germany's foreign trade position improved in the mid-eighties, despite a significant real appreciation of the Deutsche Mark, and peaked at its historic high of 1989. The dramatic turnaround in the trade balance which immediately followed

Real external value of the Deutsche Mark and trade balance

End-1975 =100, log. scale
Real external value[1]

lin. scale
Trade balance as % of GDP

1 Real external value of the Deutsche Mark against the currencies of 18 industrial countries calculated on the basis of the price index of total expenditure. — **o** From 1991 Germany as a whole.

Deutsche Bundesbank
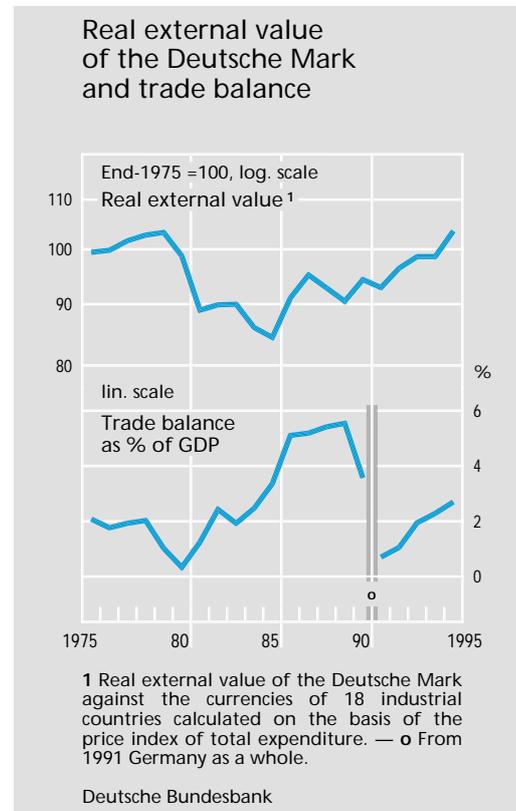
was essentially related to German unification.[1] Even in the light of these facts, however, the generally supposed negative interaction between the trend in the real external value of the Deutsche Mark and Germany's foreign trade position is not immediately evident.

Complex links between various factors

There are many possible reasons for these apparently contradictory observations. Firstly, it has to be remembered that the interactions assumed at the beginning refer to the real flows in foreign trade and not to the value of the nominal flows as is the case in trade balances. Indeed, there is much to suggest

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1 For a detailed account of the external adjustment to German unification see Deutsche Bundesbank, The state of external adjustment after German unification, Monthly Report, May 1996, page 47 ff.

that, particularly in the short term, exchange-rate-related changes in foreign trade prices conceal possible real effects on exports and imports. The consequent changes expected in volumes become apparent only in the longer run. The delays which arise between the booking of orders and their eventual delivery indicate that a certain amount of time is necessary before the effects on the volumes of exports and imports are discernible. Moreover, the reaction of the trade balance following exchange rate movements also depends on the pricing and marketing strategy of exporting firms. At all events, there were some indications in 1995, for example, that German exporters were defending their market shares by appropriate price concessions. Despite temporary losses of earnings, which are inevitably associated with such a strategy, an approach of this kind may be quite rewarding if, for example, the disruptions emanating from the exchange rate side are assumed to be only temporary. Irrespective of this, it is also conceivable that exporters and importers protect themselves against short-term exchange rate fluctuations through hedging operations. In any case, the greater range of derivatives offered by the financial markets provides a better and presumably also cheaper means of doing this today than, say, 20 years ago.

Price and volume reactions

These considerations make it clear that simply comparing (nominal) foreign trade figures can only provide a limited indication of the way and the extent to which exchange rate trends and international trade flows interact. For that reason the manner in which prices and volumes react to exchange rate movements will be analysed separately below in order to show more clearly the complexity of the underlying interrelationships. Other effects which may arise from the volatility of exchange rates and which may influence the choice of production locations have not been taken into account.

Effects on foreign trade prices

The effects of exchange rate movements on the prices of exported and imported goods depend decisively on the cost and competitive situation in the various markets. The attitudes and reactions observed may differ accordingly. In concrete terms, the possible effects range from the one extreme where the exchange rate changes are immediately passed on in full to the customer through price increases to the other extreme where the supplier of the goods concerned fully absorbs the exchange-related reduction (or increase) in his earnings. In recent literature on foreign trade theory the first situation is referred to as the complete exchange rate pass-through, while the second pricing method mentioned is described as pricing to market.[2]

Differences in pricing strategies

In the case of the complete pass-through, the exchange rate movements are reflected immediately in market prices: provided cost levels remain the same both at home and abroad, an appreciation of the domestic currency (Deutsche Mark) will therefore result in

Exchange rate pass-through…

2 Krugman, P.R. (1986), Pricing to market when the exchange rate changes, NBER Working Paper No. 1926.

... or pricing to market

a corresponding reduction in import prices calculated in Deutsche Mark and an increase in export prices calculated in foreign currency. In the case of pricing to market, by contrast, import and export prices remain unchanged. Exchange rate movements are reflected in corresponding changes in the profit margin in foreign trade: if the domestic currency appreciates, domestic exporters accept lower profits in order to maintain sales prices on export markets; on the import side, however, larger profits associated with the appreciation will accrue to foreign suppliers and/or to domestic importers.

Defending market shares

One major reason which may induce exporting enterprises to refrain from immediately passing on an appreciation of their currency in their prices and, instead, to absorb the effects themselves through reducing their own profit margins is to defend market shares abroad against foreign competition. Such strategies are likely to appear advantageous if the costs of regaining market shares later are thought to be higher than the resultant reductions in profits, which may be only of a temporary nature.[3] In view of the costs of market entry, such as advertising and the creation of a marketing and service infrastructure, which in many cases are high and initially independent of sales successes, these considerations may often be decisive for many producers of industrial goods.

Pricing strategy and exchange rate volatility

Recent contributions to the academic debate on entrepreneurial pricing emphasise the significance of exchange rate expectations in the pricing-to-market strategy of enterprises.[4] Irreversible "menu costs" – these include all

unrecoverable costs of adjusting prices, such as the printing costs of catalogues and other expenditure on information for customers – delay the continual pass-through in sales prices in the event of exchange rate fluctuations. Instead, the selling prices are often not adjusted until the lower earnings expected for the following periods and arising from the decision not to adjust prices exceed the menu costs. These price rigidities are directly related to exchange rate volatility. In the case of sharp and frequent exchange rate fluctuations there is a greater likelihood that an exchange-rate-related price change will subsequently have to be retracted. Consequently, enterprises tend to pursue a wait-and-see strategy if an exchange rate movement is regarded as temporary and leave prices unchanged. In this situation they accept a reduction in their trading margins in the event of an appreciation rather than pass on the effects of exchange rate movements fully in their own sales prices. In the event of a depreciation they refrain from temporarily expanding their market shares and enjoy the temporary competitive advantage in the form of improved profit margins. In both cases suppliers will change prices only if an exchange rate movement is deemed to be permanent.

In the end, however, this boils down to a certain degree of international price differentiation which sooner or later may give rise to

Incentive to engage in arbitrage

3 Krugman, P.R. (1989), Exchange Rate Instability, MIT Press.
4 Delgado, F.A. (1991), Hysteresis, Menu Costs, and Pricing with Random Exchange Rates, Journal of Monetary Economics, Vol. 28, page 461 ff.

arbitrage transactions that then smooth out the differences. An important vehicle of international arbitrage in goods is the reimporting of products sold on foreign markets with smaller profit margins. The price adjustment mechanisms that are set in motion as a result are not activated in many cases until certain threshold values have been reached because the costs of information and transport as well as tariff and non-tariff trade barriers make such arbitrage operations unattractive where price differences are relatively small. Moreover, enterprises can make the arbitrage more difficult through "grey market" business by deliberately making changes to products in the case of what are already fairly heterogeneous industrial products.

Long-term need to cover costs

Over the longer term, however, price equalisation will also be encouraged by the fact that continuing losses from exporting cannot be sustained for ever. In the long run, in any case, no enterprise can produce at costs which it cannot recover in the markets concerned.

Trend in export prices

The empirical evidence is consistent with this picture. Over the long term the trend in export prices actually proves to be essentially determined by costs. At any rate, that is true if one takes the producer prices in the manufacturing sector (domestic sales) as a measure of domestic cost trends. Apart from short-term deviations, these have moved largely parallel to export prices during the past two decades (see the adjacent chart). A similar result is obtained if the price index of total expenditure is used as an overall indicator of the domestic costs of macroeconomic value added. In both

Export prices and domestic prices

1975 =100; log. scale

1 Producer prices in the manufacturing sector. — o From 1991 Germany as a whole.

Deutsche Bundesbank

cases, however, it can be seen that over the shorter term export price trends may deviate from the prices in the home market or the domestic costs, a situation which is possibly explained by the pricing–to–market strategy mentioned. Apart from that, the – at times – considerable increase in domestic costs may have been a major factor in the deviations observed, especially during the nineties. Evidently only part of this increase could be passed on by enterprises in their sales prices in international markets, and for that reason, the increase impaired the profitability of German exporters – and, conversely, enhanced the competitive position of foreign suppliers.

A certain indication that German enterprises do not let short-term exchange rate fluctuations affect their sales prices in export mar-

Earnings ratio in the producing sector

kets in full can be obtained by comparing the trend in the real external value of the Deutsche Mark with the earnings ratio of the producing sector, which, with an export ratio of almost 30 %, demonstrates an above-average dependency on foreign trade (see chart). The two series run more or less inversely to each other, which is in line with the pricing-to-market strategy described. The relationship normally observed seems to have been substantially removed by other influencing factors only at the time of the second oil crisis. During these years the earnings ratio in the producing sector declined considerably owing to the sudden rise in energy and raw material prices and a sharp rise in domestic costs, despite the significant depreciation of the Deutsche Mark.
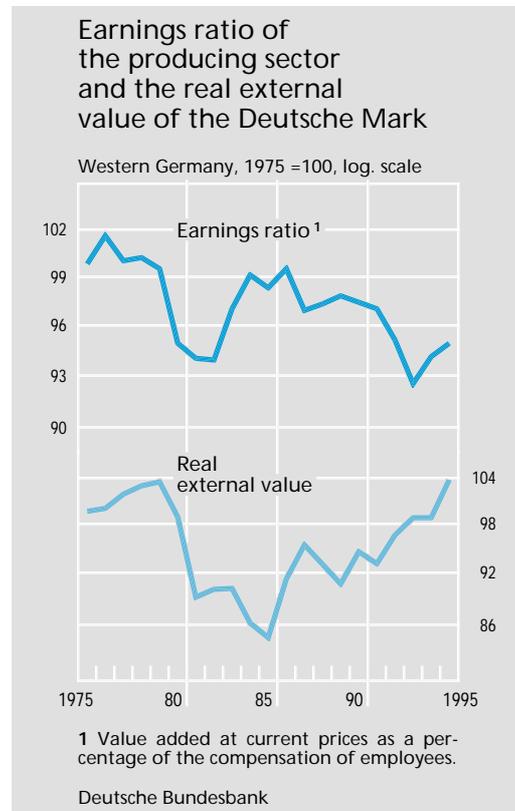
Trend in import prices

The trend in German import prices is much less clear. Owing to the lack of a comparable producer price index for the manufacturing sectors of Germany's 18 major trading partners, the weighted unit labour costs in the manufacturing sectors of these countries, after conversion into Deutsche Mark, were used as a basis (see chart). Furthermore, the price index of total expenditure was used in the econometric estimates for this purpose. The relationship between these cost indicators and the trend in German import prices is much less close here when viewed over the longer term than it was in the case of export prices. One reason for this can be found in the large proportion of raw materials and energy figuring in German imports. Firstly, the prices in these markets bear no relationship to the trend in costs in the industrial nations on which the cost indicators used are

Earnings ratio of
the producing sector
and the real external
value of the Deutsche Mark

Western Germany, 1975 =100, log. scale

1 Value added at current prices as a percentage of the compensation of employees.

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based. Secondly, the fluctuations in the Deutsche Mark/US dollar rate fully affect the prices in the world commodity and energy markets which, typically, are quoted in dollars. Accordingly, the deviations are observed precisely from the end of the seventies to about the middle of the eighties when the rise in oil prices and the firming of the dollar both had mutually reinforcing effects on German prices for energy imports – just as the subsequent relaxation in the crude oil and energy markets together with the pronounced weakness in the dollar in 1985-6 again enabled German import prices to fall significantly. If imports of raw materials and energy are excluded, the long-term relationship between the trend in German import prices and the trend in wage costs – calculated in Deutsche Mark – in the industrial

countries which are important for German foreign trade proves to be much closer as a result than the total figures analysed above would perhaps suggest at first sight. In the short term, however, quite substantial deviations are evident here, too, and these suggest a pricing-to-market strategy on the import side as well.

Preliminary result

Overall, this indicates at first that in the longer run an almost complete exchange rate pass-through exists; exporters and importers pass on exchange rate movements almost fully in their sales prices in the long term. In the short term, however, there are fairly clear indications of the existence of temporary pricing to market and of corresponding fluctuations in earnings ratios.

Estimated price adjustment

The results of an econometric analysis of this question (see annex) also indicate that, especially in the short term, there is a certain relevance in pricing to market both on the export and the import sides. In line with the considerations above, however, the importance of this strategy both quantitatively and in respect of the length of time during which such price reactions can be observed is limited. According to these estimates, a real appreciation of the Deutsche Mark of 5% would result – on an average of the past two decades and provided all other conditions remained unchanged – in a 0.5% fall in export prices, expressed in Deutsche Mark, during the same period. This means that on average exporters passed on 90% of the exchange rate changes in their sales prices calculated in foreign currency. It may well be, however, that the results are somewhat dif-

Import prices and trend in foreign costs

1975=100, log. scale

Import prices

Unit labour costs abroad [1]

Import prices excluding sources of energy

1975 80 85 90 1995

o From 1991 Germany as a whole. — **1** Unit labour costs of the manufacturing sector abroad (calculated in Deutsche Mark).

Deutsche Bundesbank
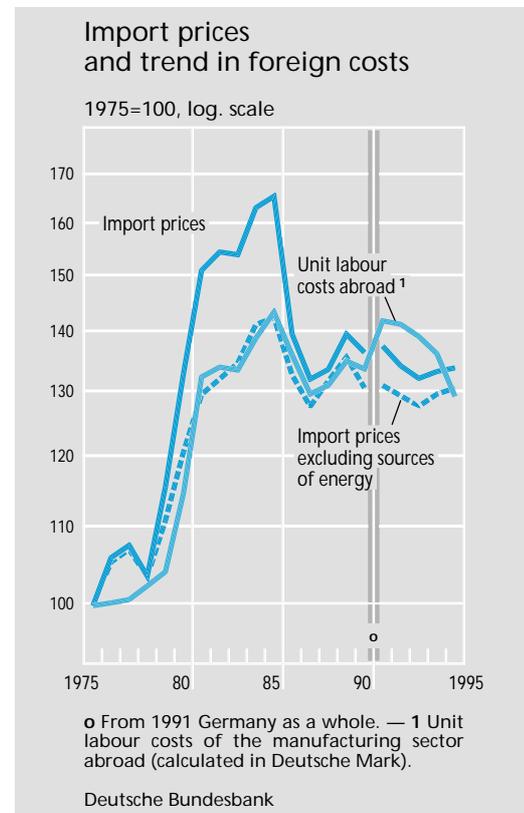
ferent in individual industrial sectors and at different times during the 20-year period observed. This is suggested, for example, by surveys of exporting enterprises which were conducted by the HWWA Institute some time ago and which showed appreciably greater compensating reactions on the part of exporters.[5] The surprisingly low significance of pricing to market could also be explained by statistical factors if it were established that, in the event of an appreciation of the Deutsche Mark, enterprises did not take the price concessions they grant in the short term fully into account in their reports on the development of export prices to the Federal Statistical

5 Scharrer, H.-E., Langer, C. (1988), *Wechselkursverschiebungen und Unternehmensreaktionen* (Exchange rate shifts and corporate reactions), Wirtschaftsdienst, Vol. 68, No. 9, September, page 470 ff.

47

Office. It is true that the export prices recorded here are effective prices and not list prices but such "sources of error" cannot be ruled out.

Nevertheless, it probably has to be assumed that such pricing strategies were only of limited importance for exporters during the two decades under review. Another explanation is probably to be seen in the fact that for many years the steeper increase in prices abroad or the stability edge of the Deutsche Mark provided German exporters with temporary competitive advantages; these were used initially to expand their market position, especially as the more or less compensating appreciation of the Deutsche Mark often occurred with a time lag. Owing to this strategy, which is geared on the whole to expanding market shares, enterprises may have seen absolutely no cause for taking measures of a price policy nature under these circumstances. To the extent that this interpretation is correct, it is quite conceivable that pricing to market as a means of defending market shares did not assume any great significance until after the excessive wage cost increases in the early nineties and in 1995, as is suggested by the estimated results of the econometric analyses for the entire period of the past 20 years. Seen in this light, the pricing strategy of enterprises in the event of temporary competitive disadvantages may differ considerably from their behaviour in situations in which they can profit for a time from competitive advantages over their competitors.

Another factor that is important for accurately interpreting the result of the analyses mentioned, however, is that pricing to market is evidently closely related to the volatility of exchange rates, a point that was suggested in the aforementioned preliminary considerations as a possible way of explaining the phenomenon. The various estimates made here actually provide certain clues as to why exporting enterprises which see themselves confronted in their markets with fairly volatile exchange rate movements gear their pricing policy more to their somewhat longer-term exchange rate expectations and prefer to absorb the exchange rate fluctuations which they deem to be temporary through their profit margins unless they can meet the short-term currency risks anyway by hedging. In the past few years, in particular, enterprises have probably been making greater use of this technique, especially as banks are offering favourably priced and appropriately tailored hedging opportunities in the course of the expansion of currency-related derivatives.

At all events, the estimates indicate that exporters operating outside the EU area show a greater tendency to use pricing to market than enterprises which sell their products within the EU. According to these estimates, exporters in the short term pass on only 31% of exchange rate movements in their selling prices in business operations outside the union, compared with 45% in the case of intra-European trade. A possible reason for this may be the relatively sharp fluctuations of the Deutsche Mark against the major world currencies, whereas its volatility against the other EU currencies is significantly less pronounced; exchange rate expectations

within Europe were actually marked for a time by a pronounced "fixed-rate illusion", which appeared to make appropriate hedging operations superfluous.

High degree of integration within the EU

On the other hand, the estimates may also be taken as an indication of the high degree of integration in the European goods markets. If a supplier in the single European market quotes different prices, it is much more likely that he will have to expect that the price differences will be exploited by arbitrageurs through reimports. By contrast, a German enterprise exporting overseas is probably not so exposed to this danger of having to "compete with its own products". Owing to the higher transport costs, the product and security standards (which are sometimes different) and not least any customs tariffs which may arise, considerable exchange rate movements are necessary before "grey" imports are worthwhile.

Effects on real trade flows

Volume reactions delayed

Suppliers' price policies are directly related to the volume reactions by customers. As long as they try to keep their sales prices constant, volume reactions to exchange rate movements are not to be expected, provided all other conditions remain the same. However, there may also be other reasons for delays in the reactions of potential customers. The most important factor to be borne in mind here is the possibility of adjustment costs. These consist, firstly, in the fact that trade relations often develop over lengthy periods of time and entail fairly long supply contracts

with certain commitments to purchase. Under such conditions price changes do not affect demand until certain threshold values are exceeded and/or until the need for new negotiations arises because existing contracts are about to expire. Secondly, customers need time to acquire the necessary information on the prices of competitors.

Considering these influences together, it is likely that the volume reactions will follow exchange rate changes with a time lag. The econometric analyses that have been undertaken confirm this supposition. Initially, both German imports and exports have shown that they are completely insensitive to exchange-rate-induced changes in competitor prices. Initial demand reactions do not become evident until the quarter following the one in which the exchange rate change took place. Over the long term economic agents react to exchange-rate-induced price changes by switching from the products which have become more expensive to those of competitors which have become comparatively cheaper. In this respect foreign demand for German products as a whole has proved to be clearly more price sensitive than German demand for imports. For example, the long-term elasticity of foreign demand for German exported goods reacts to changes in the real external value of the Deutsche Mark, according to the estimates, by a factor of -0.8; that means that a 5% appreciation of the Deutsche Mark results in the long term in a 4% reduction in real export demand. By contrast, the corresponding elasticity of German import demand amounts to something in the order of 0.2, with the result that a 5% ap-

Price elasticity of export and import demand

preciation of the Deutsche Mark leads in the long term to a 1% rise in real import demand.

Germany's dependence on raw materials could be a possible explanation for this observation. Imported raw materials are normally more difficult to replace by other products than, for example, industrial products, especially as Germany finds itself exposed to increasing world market competition, particularly in this field.

Exchange rate effects and other influencing factors

A simple comparison of the trend in real exports and imports with movements in the real external value of the Deutsche Mark, however, does not seem to be entirely consistent with the estimates mentioned here for the exchange rate elasticity of Germany's foreign trade. For example, the slump in German exports later in 1995 was considerably greater than might have been expected from the elasticities calculated. The most important reason for this was that the trend in foreign trade in 1995 – as in previous years – was influenced by additional factors, notably the general weakness in economic growth in Germany and in major partner countries. In the econometric approaches mentioned (and described in detail in the annex) this fact has been taken into account by including not only the exchange rate which is of primary importance here but also the general world trade growth or the corresponding macroeconomic income trends as determinants of foreign trade.

According to the estimates, the influences stemming from exchange rates play only a subordinate role in explaining export and import flows. This is particularly true in the case of imports. Domestic growth in income is the decisive driving force here (see chart). On an average of the past 20 years income elasticity of imports has been just below 2; this means that a 1% rise in gross domestic product has been accompanied by an almost 2% rise in imports. This is a reflection of the considerable extent to which the German economy has been integrated internationally and the increasing international diversification of production. The import content of German production has ultimately risen as a result of this. The supply of consumer goods in Germany is also being gradually supplemented to an above-average degree by foreign goods. Both reflect the growing division of labour in the world economy.

High income elasticity of German imports…

The situation on the export side is similar; here, too, the growth in Germany's foreign markets or the total volume of world trade is the relevant explanatory variable for the overall trend. A 1% rise in the volume of world trade has been accompanied by an almost identical growth in German exports on an average of the past 20 years.[6] This means that German exporters have not been able to maintain their share of the world market; however, the losses in market shares recorded here have been essentially due, as in the case of the other industrial countries, to the increasing integration of the developing

…and of exports

6 The greater rate of growth in world trade, which on average has been rising about twice as fast as world gross domestic product, is ultimately reflected in the quantitative difference between the import elasticity mentioned in relation to Germany's real income and the export elasticity in relation to the world trade volume.

countries into the world economy. The unification of the two parts of Germany and the continuing process of transformation in central and eastern Europe, particularly during the past few years, have also been contributory factors.

Summary: exchange rate and trade balance

Typical pattern of reactions

As indicated at the beginning, the overall effects of exchange rate changes on foreign trade are reflected in the trade balance. Its trend is therefore ultimately a reflection of the interplay between price and volume effects, which influence the value of trade flows with varying time lags. Typically, the price reactions occur first. This is particularly true of the effect of an exchange rate movement on import prices, which, for example, in the event of an appreciation, decline relatively quickly and steeply, whereas pricing to market on the export side mitigates the effects of the appreciation of the domestic currency on the sales prices calculated in foreign currency. Conversely, export prices in Deutsche Mark fall somewhat during this phase. According to the estimates presented here, however, the effect is not very pronounced, with the result that in the case of a real appreciation of the Deutsche Mark a distinct improvement in the terms of trade must be expected, on balance, from the price side and therefore initially a tendency for the trade balance to improve.

The corresponding changes in volumes occur somewhat later. In the event of an appreciation of the domestic currency these come in

Economic trend and real foreign trade flows

1975 = 100, log. scale

o From 1991 Germany as a whole.

Deutsche Bundesbank
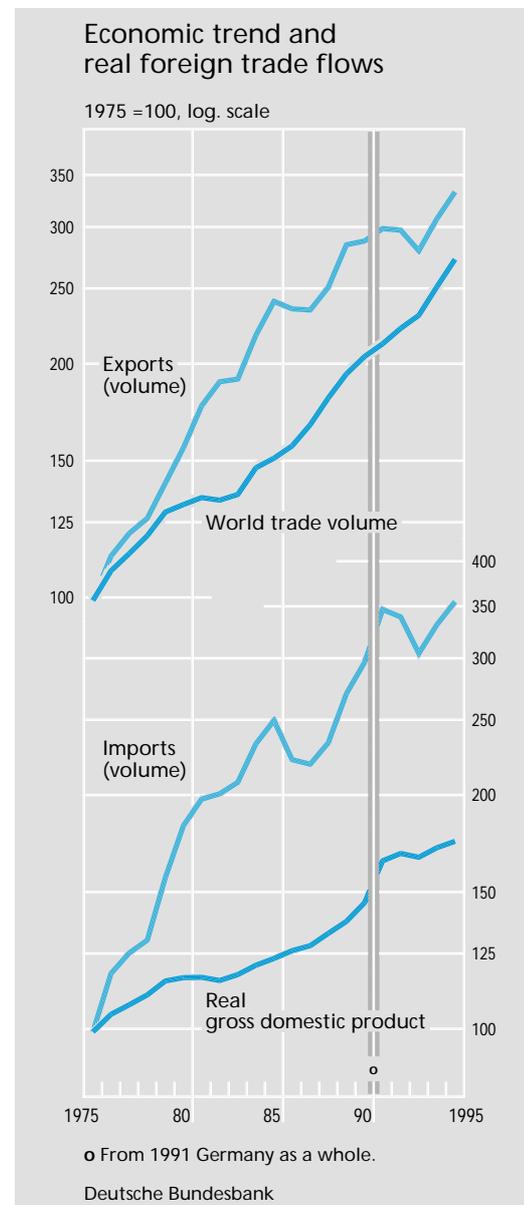
the form of a curb in real exports and a relatively small increase in imports. The effect on the trade balance is clearly negative from that point of view; that is to say, the trade balance tends to deteriorate.

The overall effect of the movements in prices and volumes described is initially uncertain unless the various effects of prices and volumes can be quantified more accurately. In

Reaction of the trade balance to exchange rate movements

In the economic literature the impact of exchange rate movements on the trade balance is usually discussed within the framework of a partial elasticity approach.[1] According to this approach, the trade balance reacts "normally" in the sense that it deteriorates (improves) in the event of an appreciation (depreciation) of the domestic currency if the sum of export and import demand elasticities – in absolute terms – is greater than one ("Marshall/Lerner condition"). From a purely formal point of view this precondition, according to the estimates of the relevant elasticities outlined in the annex, is fulfilled in the long term. Strictly speaking, however, the Marshall/Lerner condition is not applicable here as it only applies when there is a 100% exchange rate pass-through – which is what has been traditionally assumed in the literature on foreign trade.

If, instead, the approaches used here are taken as a basis for the price and demand behaviour, which may be represented in a somewhat simplified form as follows:

$$PX = P^{\alpha_1} \cdot \left(\frac{P^*}{W}\right)^{\alpha_2}, PM = \left(\frac{P^*}{W}\right)^{\beta_1} \cdot P^{\beta_2}, X = \left(\frac{PX \cdot W}{P^*}\right)^{-\eta}, M = \left(\frac{PM}{P}\right)^{-\varepsilon}$$

PX = Export price
PM = Import price
P = Domestic price level
P* = Foreign price level

W = Weighted nominal external value
X = Export volume
M = Import volume,

one obtains as a condition for a normal reaction of the trade balance:

$$-\eta \cdot \alpha_2 + \eta + \alpha_2 + \varepsilon \cdot \beta_1 - \beta_1 > 0,$$

where η equals the price elasticity of export demand and ε the price elasticity of import demand; the exponents α_1 and α_2, and β_1 and β_2, stand for the pass-through and pricing-to-market coefficients in the export price and import price equations. If $\alpha_2 = 0$ and $\beta_1 = 1$, one immediately obtains the "traditional" Marshall/Lerner condition: $\eta + \varepsilon > 1$. In that sense the modified condition concerns a kind of "generalised" Marshall/Lerner condition which takes account of the aspect of a possible pricing-to-market strategy. In the event of a pattern of coefficients resembling the estimated results for the short-term equation in the annex ($\alpha_2 = 0.10$, $\beta_1 = 0.47$, $\eta = 0$ and $\varepsilon = 0$), this condition is not fulfilled, that is to say, the foreign trade balance deteriorates in the short term. According to the estimates for the long-term relationship ($\alpha_2 = 0.11$, $\beta_1 = 1.00$, $\eta = 0.87$ und $\varepsilon = 0.18$), by contrast, the condition of a normal reaction of the trade balance does exist.[2]

In addition to this rather theoretical solution one can determine the impact of the exchange rate on the trade balance by using simulation calculations. Here one combines the various estimated price and volume functions for exports and imports in a total system and assesses the exchange rate impact in its entirety.

The simulation results (see the adjacent table) show that a 5% real appreciation of the Deutsche Mark initially results in an improvement of about 1.8% in the terms of trade, a result which is due jointly to a 2.3% reduction in the prices of imported goods and – owing to a short-term pricing-to-market strategy on the part of exporters – a 0.5% reduction in export prices quoted in Deutsche Mark. The improvement in the terms of trade – with a value of 4.4% – subsequently reaches almost the level of the 5% appreciation initially assumed. The remaining difference of 0.6% is due to the pricing-to-market policy which exporters continue to pursue even in the longer term, although to a certain extent this difference may also reflect statistical shortcomings. The reaction of prices is accompanied by changes in volume, but these do not become significant until some time has elapsed. Over the long term they add up to a total of – 4.8%; the reduction in the volume of exports accounts for 3.9% of this and the increase in the demand for imported goods accounts for 0.9%. Overall, a 0.4% deterioration in the trade balance remains after the adjustment process is complete.

1 For more information see, for example, Jarchow, H.-J., Rühmann, P. (1991), *Monetäre Aussenwirtschaft* (Monetary external economics), Vol. 1, Third edition, Göttingen, page 43 ff. — **2** Essentially, the reaction of the trade balance is therefore consistent with the so-called J-curve effect. See, for example, Willms, M. (1995), *Internationale Währungspolitik* (International monetary policy), Munich, page 45 ff.

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*Normal
reaction of
Germany's
trade balance*

order to obtain more detailed information on this, however, it is necessary to assess the magnitude of the individual effects and to link these in a simulation analysis. For example, the econometric estimates explained in more detail in the annex can be used as a basis for this. These provide the results given in the adjacent overview. Generally speaking, it can be seen that Germany's foreign trade balance reacts normally in the long term to exchange rate movements; that is to say, a real appreciation of the currency is accompanied over the longer term by a deterioration in the foreign trade balance, and vice versa. When comparing the reaction patterns derived from this with the actual trend in Germany's trade balance during the past 20 years, however, it has to be remembered that in addition to the exchange rate effects which were the main object of analysis here other important factors, such as economic growth and the trend in world trade, have also a determining effect on foreign trade. Generally speaking, the effects arising from

Simulation: permanent 5% appreciation of the Deutsche Mark

Change in %

Short-term reaction	
Exports, real	+ 0.0
Imports, real	+ 0.0
Trade balance, [1] real	+ 0.0
Export prices	− 0.5
Import prices	− 2.3
Terms of trade	+ 1.8
Exports, nominal	− 0.5
Imports, nominal	− 2.3
Trade balance, [1] nominal	+ 1.8
Long-term reaction	
Exports, real	− 3.9
Imports, real	+ 0.9
Trade balance, [1] real	− 4.8
Export prices	− 0.6
Import prices	− 5.0
Terms of trade	+ 4.4
Exports, nominal	− 4.5
Imports, nominal	− 4.1
Trade balance, [1] nominal	− 0.4

1 Defined here as a ratio of exports to imports.

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this even dominate the development tendencies observed. That explains why the impact of exchange rates on Germany's trade balance is not immediately obvious.

Annex

Econometric analysis of the impact of exchange rate movements on foreign trade prices and volumes

*Preliminary
theoretical
considerations*

Conditional equations for the export and import prices and the corresponding demand functions form the basis of the econometric analyses. In line with other empirical studies[7] it is assumed that enterprises determine their sales price on the basis of mark-up pricing.

The export price (in domestic currency) is therefore obtained by adding a mark-up to the unit costs of the exporting enterprise:[8]

Export prices

$$(1)\ PX = (1 + \pi) \cdot C$$

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7 Menon, J. (1996), The Degree and Determinants of Exchange Rate Pass-Through: Market Structure, Non-Tariff Barriers and Multinational Corporations, The Economic Journal, Vol. 106, page 438.
8 The theoretical basis for this is the "Extended Dixit/ Stiglitz model". Dornbusch, R. (1987), Exchange Rates and Prices, The American Economic Review, Vol. 77, No. 1, page 99 ff.

PX = Export price (in domestic currency)

π = Mark-up

C = Domestic cost level.

The mark-up rate π, however, is not constant but depends on the competitive situation in the market concerned. An indication of the price competitiveness of an exporter in foreign markets is the ratio between the foreign competitor price for the given good and the exporting enterprise's own selling price (converted into foreign currency). The higher the foreign competitor price is vis-à-vis the exporter's selling price, the higher is the mark-up rate π which the exporter can add:

(2) $(1 + \pi) = \left(\dfrac{P^*}{W \cdot PX}\right)^{\beta}$, where $\beta \geq 0$

P* = Competitor price abroad (in foreign currency)

W = External value of the domestic currency.

Equation (2) entered in (1) gives in logarithmic form:

(3) $px = \gamma \cdot (p^* - w) + (1 - \gamma) \cdot c$, where $\gamma = \dfrac{\beta}{1 + \beta} \geq 0$.

The coefficient γ measures the extent to which exporters use the price of competing suppliers abroad as a guide when fixing their own prices. When $\gamma = 1$, exporters are effecting a 100% pricing to market. If, on the other hand, they gear their pricing to their own cost situation alone ($\gamma = 0$), a 100% exchange rate pass-through occurs, that is to say, the export price in foreign currency (W · PX) is moving in line with the exchange rate fluctuations. Between these two extremes ($0 < \gamma < 1$) exchange rate movements result in a simultaneous change in profit margins and selling prices. A value of $\gamma = 0.3$ for the pricing-to-market coefficient implies, for example, that, following a 10% appreciation, the exporter reduces

his unit earnings by 3% and raises his selling prices abroad by 7%.

Import prices

As in the case of export price equations, import prices can be formulated (in logarithmic form) as a function of the foreign cost level (converted into domestic currency) and of the domestic competitor price level:

(4) $pm = \delta \cdot p + (1 - \delta) \cdot (c^* - w)$, $0 \leq \delta \leq 1$

pm = Import price (in domestic currency)

p = Domestic competitor price

c* = Foreign cost level

w = Weighted nominal external value of the Deutsche Mark.

However, the estimated results on the basis of this approach have not shown any stable cointegration relationship. Irrespective of the underlying price series, the coefficent δ was never significantly different from zero. Apparently the pricing policy of foreign suppliers or of German importers is essentially geared to costs in the long term. Given the relatively high proportion of energy raw materials in German imports, this is not implausible. Consequently, a somewhat modified approach has been used for import prices; the prices of energy as autonomous determinants of domestic import prices have been taken into consideration in addition to the foreign cost level. The estimating approach chosen is as follows (in logarithmic form):

(4') $pm = \alpha \cdot (c^* - w) + \beta \cdot (roh - w_\$)$

$w_\$$ = Nominal external value of the Deutsche Mark against the US dollar

roh = Price of energy calculated in dollars.

The long-term coefficient of the foreign cost level (α) is restricted here to one.[9] That is to say, import prices (at given energy prices) are assumed to be proportional to the cost level abroad over the long term.[10]

Export and import demand

The export and import demand functions can be derived from utility and/or production-theoretical considerations. Demand in each case ultimately depends on an activity variable and the relative prices.[11] Accordingly, the (logarithmic) estimating function for (real) exports is:

$$(5)\ x = \eta_0 + \eta_1 \cdot y^* - \eta_2 \cdot (px - (p^* - w))$$

x = Exports (real)
y^* = Foreign activity variable (real)
p^* = Foreign price level.

The same applies to (real) imports:

$$(6)\ m = \varepsilon_0 + \varepsilon_1 \cdot y - \varepsilon_2 \cdot (pm - p)$$

m = Imports (real)
y = Foreign activity variable (real)
p = Domestic price level.

Estimating method

The price and volume equations have been estimated on the basis of a single-step error correction model developed by Stock.[12] We also calculate the t-statistics for the long-term coefficients here using the equation modified by Bewley,[13] because, owing to the non-stationarity of the regressors, the usual significance tests cannot be applied to the traditional t-values of the Stock method.[14]

Data

The observation period on which the estimates are based stretches from the first quarter of 1975 up to and including the fourth quarter of 1995. All time series used are seasonally adjusted.[15] In the case of the domestic time series quarterly data for western Germany were used up to the fourth quarter of 1990; from the first quarter of 1991 the corresponding figures for Germany as a whole were used.

The export and import prices were measured by means of the German export prices and import prices; the domestic and foreign cost and price levels were shown by the price index of total expenditure.[16] As an alternative, other indicators, such as the unit labour costs and producer prices of the manufacturing sector (domestic sales), were used. Although the results generally proved to be largely independent of the choice of the price or cost index,

9 The restrictions made *a priori* in equations (3) and (4) in conjunction with the export and import demand equations (5) and (6) ensure that a proportional trend in the domestic and foreign price or cost level (i.e. the real external value remains constant) has no long-term impact on the foreign trade balance.
10 This assumption is confirmed by unrestricted estimates. Statistical tests show here that the "freely" estimated coefficient of the foreign cost level is not significantly different from one.
11 For a detailed discussion, see Sanderman, G. (1975), *Die Zahlungsbilanz der Bundesrepublik Deutschland* (The balance of payments of the Federal Republic of Germany).
12 Stock, J.H. (1987), Asymptotic Properties of Least Square Estimators of Cointegrating Vectors, Econometrica, Vol. 55, page 1035 ff.
13 Scharnagl, M. (1996), Monetary aggregates with special reference to structural changes in the financial markets, Discussion paper 2/96, Economic Research Group of the Deutsche Bundesbank, page 21.
14 West, K.D. (1988), Asymptotic Normality, When Regressors Have A Unit Root, Econometrica, Vol. 56, page 1397 ff.
15 The seasonal adjustment here was made by using the "Ratio to Moving Average – Multiplicative" procedure from Eviews' program package (version 2.0) which was also used for estimating.
16 The foreign price index of total expenditure is established as a geometric mean for the group of 18 industrial countries, the weights used being the same as those for calculating the weighted external value. For more information on the calculation method, see Deutsche Bundesbank, Revision of the method of calculating the external value of the Deutsche Mark and foreign currencies, Monthly Report, April 1989, page 43 ff.

Export price

I/1975–IV/1995

Item	Export price, total		Export price, EU		Export price, non-EU	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Long-term regression [1]						
Constant	4.64	(182.29)	4.68	(396.48)	4.63	(128.63)
Domestic price index of total expenditure	0.89	(23.27)	0.91	(53.27)	0.89	(16.19)
Foreign price index of total expenditure/ external value	0.11	(3.02)	0.09	(5.27)	0.11	(2.00)
Trend	– 0.00	(9.41)	– 0.00	(15.58)	– 0.00	(6.80)
Dummy 1	– 0.07	(6.93)	– 0.08	(12.62)	– 0.06	(4.89)
Short-term regression						
d(Export price(– 1))	0.31	(3.95)	0.41	(5.62)	0.27	(3.08)
d(Dummy 1)	– 0.03	(2.47)	– 0.03	(1.95)	– 0.03	(1.86)
d(Domestic price index of total expenditure)	0.35	(3.91)	0.45	(4.90)	0.31	(2.84)
d(Foreign price index of total expenditure/ external value)	0.10	(4.14)	0.04	(2.85)	0.09	(2.65)
Error correction term	– 0.22	(3.52)	– 0.31	(5.16)	– 0.24	(3.86)
Test statistics						
Adj. R^2	0.70		0.70		0.59	
DW	1.96		2.16		1.95	

1 Long-term coefficients of the two price variables are restricted to one.

Deutsche Bundesbank

the price index of total expenditure in the estimates for export prices emerged as the superior cost indicator.[17]

The relevant HWWA price index (based on the US dollar) was used for the prices of energy.

To estimate import and export demand, imports and exports of goods as defined for special trade (c.i.f./f.o.b.) were used as explanatory variables; these were adjusted by means of the import and export prices.

Germany's real gross domestic product was used as an activity variable for estimating import demand, and the world trade volume for export demand.

All variables are integrated of the order of 1 (error probability < 5%), i.e. they are stationary. This means that the basic precondition for using the method applied here has been fulfilled.

The unification-related statistical break in the series for real exports and imports as well as real gross domestic product was taken into account in the estimate equations for the export and import demand by means of a shift dummy, whose value from the first quarter of 1975 up to and including the fourth quarter of 1990 amounted to zero and thereafter to one. An additional shift dummy takes account of the statistical break which occurred as a result of the reorganisation of foreign trade

Statistical breaks in the time series

17 See Clostermann, J. (1996), *Der Einfluss des Wechselkurses auf die Handelsbilanz* (The impact of the exchange rate on Germany's balance of trade), Discussion paper 7/96, Economic Research Group of the Deutsche Bundesbank.

statistics at the beginning of 1993. The value of this "single European market dummy" up to and including the fourth quarter of 1992 is zero and thereafter one.

By contrast, only one dummy for the unification-related break in the price variables was used for the price equations. In this case the "unification dummy" is not devised as a pure (0.1) variable but as a "moving" variable in order to reflect the successive price adjustments in eastern Germany. The value of the dummy amounts to zero from the first quarter of 1975 up to and including the fourth quarter of 1990. After that period it is increased logarithmically to the value one up to the third quarter of 1994 as it was assumed that the price adjustment in eastern Germany had been largely complete by the middle of 1994.

Inevitably, highly aggregated price and cost indices have to be used for estimating the price equations. In this connection there is a frequent occurrence of index aggregation problems which arise from structural shifts in the various baskets of goods used as a base.[18] To take this into account a trend variable was also included in the price equations for the econometric estimates.[19]

Estimate results for export prices…

The estimate results for German export prices are given in the above table. The coefficient of the error correction term is negative and significant at the 10% level, with the result that in the long term the coefficients of the cointegration relationship become relevant. Accordingly, German exporters for the most part pursue a policy of exchange rate pass-through in the long term. Over the long term about 90% of an appreciation of the Deutsche Mark is passed on in sales prices abroad, while about 10% is absorbed through lower profit margins.

Import price

(I/1975–IV/1995)

Item	Import price, total	
	Coefficient	t-value
Long-term regression		
Constant	4.23	(140.21)
P*	1.00	(restricted)
Energy price	0.09	(5.22)
Trend	– 0.00	(9.67)
Dummy 1	0.05	(1.69)
Short-term regression		
d(Import price(– 1))	0.46	(5.44)
d(Import price(– 3))	0.12	(2.00)
d(Dummy 1)	– 0.06	(1.54)
d(Energy price)	0.09	(6.66)
d(P*)	0.47	(6.24)
d(P*(– 1))	– 0.17	(2.06)
d(P*(– 4))	– 0.25	(3.88)
d(P)	0.60	(2.12)
d(P(– 1))	– 0.61	(2.19)
Error correction term	– 0.18	(3.40)
Test statistics		
Adj. R²	0.83	
DW	1.78	

P* = Foreign price index of total expenditure/external value. – P = Domestic price index of total expenditure.

Deutsche Bundesbank

By contrast, pricing to market is of relatively greater importance in the short term. In the short term only 35% of the cost changes are reflected in export prices.

To test for any possible regional differences in pricing, export prices were estimated separately for German exports of goods to other EU countries[20] and to countries outside the EU. The long-

18 Athukorala, P., Menon, J. (1995), Exchange Rates and Strategic Pricing: The Case of Swedish Machinery Exports, Oxford Bulletin of Economics and Statistics, Vol. 57, No. 4, page 536.
19 Ketelsen, U., Kortelainen, M. (1996), The Pass-Through of Exchange Rate Changes to Import Prices, Bank of Finland Discussion Paper 26/96, page 17.
20 In line with the export price statistics, the EU here comprises the following group of countries: Belgium/Luxembourg, Spain, France, the United Kingdom, the Netherlands, Italy, Denmark, Greece, Portugal and Ireland; the non-EU countries are all remaining countries.

Export and import demand

I/1975–IV/1995

Item	Export demand		Item	Import demand	
	Coefficient	t-value		Coefficient	t-value
Long-term regression				**Long-term regression**	
Constant	13.73	(31.42)	Constant	2.68	(6.58)
Dummy 1 (unification)	– 0.08	(4.52)	Dummy 1 (unification)	– 0.11	(7.01)
Dummy 2 (single European market)	– 0.08	(4.04)	Dummy 2 (single European market)	– 0.07	(5.48)
Export price/foreign price index of total expenditure/external value	– 0.87	(10.48)	Import price/domestic price index of total expenditure	– 0.18	(4.52)
World trade volume	0.80	(25.23)	Gross domestic product (real)	1.90	(43.11)
Short-term regression				**Short-term regression**	
d(Exports, real(– 1))	– 0.20	(2.48)	d(Imports, real(– 2))	0.21	(2.84)
d(Dummy 2)	– 0.06	(2.23)	d(Imports, real(– 4))	0.13	(1.89)
d(World trade volume)	0.68	(4.26)	d(Dummy 1)	– 0.05	(1.81)
Error correction term	– 0.59	(6.38)	d(Dummy 2)	– 0.09	(4.23)
			d(Gross domestic product (real))	1.51	(7.49)
			Error correction term	– 0.76	(6.49)
Test statistics				**Test statistics**	
Adj. R^2	0.55		Adj. R^2	0.63	
DW	1.99		DW	2.17	

Deutsche Bundesbank

term estimate results for the two regional export price equations do not show noteworthy differences, either in relation to each other or in relation to the results of the entire estimate (see the table on page 56). Regionally specific differences can be observed only in the short term. In the case of exports to non-EU countries these estimates show that on average a 10% appreciation of the currency is accompanied by a 1% reduction in profit margins, whereas in the case of exports to other EU countries a similar appreciation is offset by a reduction in profit margins of only 0.5%. There are certain other clues which indicate that German exporters have different pricing policies for coping with changes in the cost situation within the EU and outside the EU; however, these differences are not statistically significant. According to the present results, a 10% rise in costs results in a 4.5% rise in prices in the case of exports to other EU countries in the first quarter, whereas the rise in German selling prices outside the EU is only about 3%. Moreover, exporters adjust their pricing policy in trade within the EU faster to the long-term and primarily cost-determined "equilibrium" prices. Imbalances between current and long-term selling prices are reduced here by about 30% per quarter; in the case of exports to countries outside the EU, adjustment amounts to only about 25%. However, these differences are not statistically significant either; to that extent no important conclusions should be drawn from them.

In the case of German import prices, trends in energy prices and costs abroad are the dominant explanatory variables both in the long term and the short term (see the table on page 57). The domestic price index of total expenditure was also

…and import prices

included in the short-term regression as an indicator of the competitor price level in order to ascertain short-term pricing to market. It appears from this that importers, like exporters, neutralise exchange rate movements initially by varying profit margins to a large extent but later pass these on in their selling prices.

Export and import demand

The estimate results for export and import demand are shown in the table on page 58. In both equations the error correction term is significantly negative (error probability < 1%) and therefore produces a stable equilibrium over the long term. At the same time, the speed with which adjustment is made to the long-term balance is very high, at a rate of approximately 0.6 and 0.8, respectively. The activity variable is the dominant explanatory variable in both cases, in the long and in the short term. No significant response, either of exports or imports, to price and exchange rate changes can be discerned in the short term. By contrast, the long-term price elasticity of export demand is just under – 0.9 whereas that of import demand has a value of "only" – 0.2%.