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A re-assessment of German import demand

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Abstract

Empirical studies analysing German import demand functions traditionally report implausibly high income and relative low price elasticities. Furthermore, estimation results strongly depend on the observation period. Minor variations in the estimation period typically lead to insignificant price terms often displaying the wrong sign. Based on an extensive econometric analysis, we show that these problems are caused by the use of highly aggregated activity variables (GDP or total demand). The problem is easily solved if single GDP components, namely exports and investment, are used to model domestic economic activity. We find that imports, exports, investment, and a relative import price form highly stable cointegration relationships. The corresponding activity elasticity is clearly below 1 and the price elasticity is highly significant. Changes in the estimation period neither change the impact nor the significance of the determinants of imports.

Keywords: German import demand equation, price elasticity, income elasticity, activity elasticity, aggregation problems, error correction model

JEL Codes: C22, C52, F17

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1 Introduction

Foreign trade topics are traditionally well represented in economic research, since they are not only of academic interest but also highly relevant for economic policy. This holds especially true for research on the determining factors of export and import demand.[1] Tables 1 and 2 summarize the results of a number of studies on import demand equations for Germany. Although these studies differ widely with regard to the data used (explanatory and explained variables), the geographic area (West Germany and unified Germany) and the period under consideration, the estimation approach etc. they consistently report very large income and low price elasticities. The conformity of estimation results has lead to the widely accepted conclusion that German import demand is highly income elastic, but price inelastic.

A closer look, however, reveals some fundamental problems. *First*, the estimated income elasticities are implausibly large. They are well in excess of one, and frequently above two implying that the import to GDP ratio will rise without bound and that in the long run all income would be spent on imports. Some authors argue that the very high income elasticities are only a temporary phenomenon reflecting different facets of globalisation (liberalisation of trade, ongoing international division of labour, growing intra-industry trade). If this argument holds true, then studies including data from the 1990s onwards, when globalisation became more and more important, should find significant higher income elasticities than studies excluding these years. But this is not the case. Other authors like Strauß (2003) or Barrell and Dées (2005) include additional variables in the estimation equations to account for globalisation effects. This approach, however, does not solve the problem either.[2] *Second*, it is well-known from the literature that the price elasticity of German import demand is quite low and frequently insignificant. In fact, German import demand equations are far from being stable. Minor changes in the estimation period often change dramatically the estima-

[1] Cf. the surveys of Magee (1975); Goldstein and Khan (1985); Sawyer and Sprinkle (1999).

[2] Strauß (2003) includes the world trade intensity to account for globalisation effects. The estimated income elasticity is 1.64. Barrell and Dées (2005) include the ratios of inward and outward FDI to GDP as additional openness and globalisation indicators. In their favourite model (PMGE3: Pooled Mean Group Estimate with constraints on income elasticities) the estimated income elasticity is 1.24.

tion results. It is not only that the price elasticity becomes insignificant, it also displays the wrong sign[3]. Although this problem is widely recognized among researchers, no attempt was made so far to solve it.

The aim of this study is to detect the causes of the aforementioned problems and to suggest an alternative approach that provides stable import demand equations with reasonable and statistically significant income and price elasticities. In contrast to recent studies[4] assuming that the problems can be solved, if additional globalisation indicators are included in the traditional import demand model, we argue that the whole set of variables traditionally used to explain German import demand should be thoroughly checked, since unreliable elasticities could stem from aggregation problems inherent in the data. Our approach stays within the framework set out by Orcutt (1950) who presented a set of factors possibly responsible for low price elasticities in international trade. The structure of this paper is as follows: Section 2 reviews the arguments given by Orcutt (1950) and suggests alternative variables that should be considered as additional explanatory variables in our study. Since empirical studies explaining German import demand differ widely with regard to their research design (explanatory and explained variables, observation period, region under consideration, estimation approach etc.), it is difficult to compare their results. Therefore, Section 3 examines a large set of variables covering the same observation period and derives different import demand equations which are evaluated with respect to both data fit and forecasting ability. Since two observation periods (1975-1995 and 1975-2003) are considered, we are able to check whether impact and significance of the determinants changed over time. Section 4 concludes.

[3] For an illustration of the problem see Stephan (2005), Chapter 4.2.

[4] Cf. Strauß (2003); Barrell and Velde (2002); Barrell and Dées (2005).

Authors	Frequency/ Time	Estimation approach	Dependent variable	Activity variables Y_1	Y_2	P_M/P	P^*_M	P	E
Houthakker/ Magee (1969)	Annual 1951-1966	OLS static	Goods	GNP 1.80		P_M/WSPI -0.24			
Khan/Ross (1975)	Semi-annual 1960:1-1972:2	OLS static	Goods + Services	GNP 2.23	Trend of GNP -0.21	P_M/WSPI -0.53			
Goldstein/Khan/ Officer (1980)	Annual 1951-1973	OLS static	Goods + Services	Output gap 1.38	Trend of GDP 1.57	P_M/P_{gdp} -0.46			
Goldstein/Khan/ Officer (1980)	Annual 1951-1973	OLS static	Goods + Services	Output gap 1.39	Trend of GDP 1.67	P_M/P_T -0.47			
Warner/ Kreinin (1983)	Quarterly 1972:1-1980:3	OLS static	Goods pc	GNP pc 2.09			-0.50	WSPI 0.83	0.41
Fischer (1995)	Quarterly 1970:1-1994:3	SEECM	Goods	GDP+M 1.58		P_M/PPI -0.20			
Senhadji (1998)	Annual 1960-1993	ARDL	Goods + Services	GDP-X 2.76		P_M/P_{gdp} -0.20			
Meier (1998)	Quarterly 1976:4-1995:4	SEECM	Goods	GDP+M 1.33		P_M/PPI -0.52			

Time series in logs; P_M/P: relative import price; P^*_M: import price (foreign currency); P: domestic price level; E: exchange rate; OLS: ordinary least squares; ARDL: autoregressive distributed lag specification; SEECM: single equation error correction model; GNP: gross national product; GDP: gross domestic product; pc: per capita; X: exports; M: imports; P_M: import price; WSPI: wholesale price index; P_{gdp}: GDP deflator; P_T: price index of tradable goods; PPI: producer price index

Table 1: West Germany: income and price elasticities of import demand

Authors	Frequency/ Time	Estimation approach	Dependent variable	Activity variables			Deterministic components in EC term		
				Y_1	Y_2	P_M/P	$s9101$	$s9301$	Trend
Clostermann (1996)	Quarterly 1975:1-1995:4	SEECM	Goods	GDP 1.90		P_M/P_{gdpm} -0.18	-0.11	-0.07	
Clostermann (1996)	Quarterly 1975:1-1995:4	SEECM	Goods	GDP 1.92		P_M/PPI -0.22	-0.12	-0.06	
Clostermann (1998)	Quarterly 1974:1-1997:2	SEECM	Goods	GDP 1.91		P_M/P_{gdp} -0.15	-0.12	-0.05	
Bundesbank (1998a)	Quarterly 1975:1-1997:2	SEECM	Goods	GDP 2.07		REEV18 0.25	-0.13	-0.05	
Strauß (2000)	Quarterly 1976:3-1999:4	SEECM	Goods + Services	GDP+M 1.59		REEV38 0.09	-0.10	-0.05	linear[1] 0.007
Seifert (2000)	Quarterly 1979:1-1999:4	SEECM	Goods + Services	I 0.21	X 0.94	REEV18 0.70			
Strauß (2003)	Quarterly 1976:3-1999:4	SEECM	Goods + Services	GDP+M 1.64		REEV38 0.31	-0.23		WTI 0.64
Meurers (2003)	Quarterly 1975:1-1999:4	JOH	Goods	IPRO 1.05		P_M/CPI -0.22			linear 0.005
Stirböck (2006)	Quarterly 1980:1-2004:4	SEECM	Goods	C+GCF 1.59	X 0.55	P_M/PPI -0.04			

Time series in logs; $s9101$: shift dummy (German reunification); $s9301$: shift dummy (European Single Market); JOH: simultaneous estimation of supply and demand using the Johansen approach (only cointegration relationship); I: investment (firms); IPRO: industrial production; C: consumption; GCF: gross capital formation; P_{gdpm}: final demand deflator; REEV18(38): indicator of price competitiveness of German economy compared to 18 (38) countries; CPI: consumer price index; [1] 1993:1 onwards; WTI: world trade intensity

Table 2: Germany: income and price elasticities of import demand

2 Reasons for low price elasticities in international trade

In his pathbreaking article Orcutt (1950) presents a number of factors possibly responsible for low price elasticities in international trade: simultaneous-equation bias[5], model misspecification[6] as well as measurement errors and aggregation problems inherent in the data. In the past fifty years data quality and econometric methods were considerably improved. Nowadays it is common practice to estimate import demand functions in the form of error-correction models based on quarterly data covering a sufficient long time period. This means that modelling both long-run relationship and short-run dynamics is no longer a problem. Furthermore, there is growing empirical evidence that import supply is in fact totally price elastic (Meurers 2003). Therefore, it is reasonable to conclude that low price elasticities in international trade are neither caused by model misspecification nor by simultaneous-equation bias.

However, Orcutt's argument that aggregation problems inherent in the data are possibly responsible for the fact that empirical studies underestimate price elasticities is still valid. If price elasticity of demand is low, relatively greater price changes are required to induce quantity adjustments. Therefore, it is likely that commodities with low elasticities exhibit greater price variations. If the weight of these goods in an aggregative index is sufficiently large, the index will be unduly volatile and the estimated price elasticity will be downward biased. Estimating sectoral import equations or constructing aggregative price indexes for goods with

[5]Applying Ordinary Least Squares (OLS) requires exogenous explanatory variables. Using contemporaneous price terms as explanatory variables in demand equations implies that price development does not depend on quantity development, or in other words import and export supply are infinitely price elastic. Regarding import supply this assumption is met, since the import supply a single country faces equals total exports from the "rest of the world". Regarding the export supply of a single country, however, the validity of this assumption is questionable. Here it is more likely that quantities and prices are simultaneously determined by the interaction of supply and demand and demand shocks will affect prices. In this case, the contemporaneous price term used as an explanatory variable is correlated with the error term and therefore the OLS estimator is biased.

[6]Here model misspecification means that in most studies a short-run elasticity was calculated which was expected to be lower than the long-run elasticity.

similar price elasticities avoids this problem. This approach, however, can not be applied in this study, since we focus on *aggregate* imports. In order to find out how the use of aggregative price indexes influences the estimation results, we use different aggregative price indexes as proxies for the domestic price level and compare the estimated price elasticities.

Aggregation problems can distort both price indexes and aggregated activity variables[7]. Studies on import demand mostly use GDP or total demand (GDP+imports). The use of these highly aggregated activity variables, however, is only appropriate if the assumption is met that changes in single components have the same impact on the aggregate. This is unlikely, since GDP components differ with regard to their import content. Calculating weighted activity variables may alleviate the problem; e.g. each GDP component could be weighted by its respective import content taken from input-output tables. Then, however, we face the problem that input-output tables only provide annual information published with a remarkable time lag. Therefore, it is much better to use single GDP components. Following this approach, we can test which components necessarily belong to the cointegration relationship and, since their coefficients are not restricted, we avoid that incorrect weights are used for calculating the aggregate. In the next section major GDP components are analysed – these are exports of goods, gross fixed capital formation, and private consumption accounting for about 82% of total demand.

3 Empirical analysis of import demand

This section analyses the determining factors of German import demand. The set of explanatory variables includes both aggregated activity variables preferred in the literature and single GDP components. Different relative prices are used to model price competitiveness of imports. We always use the price index that corresponds to the activity variable under consideration to model the domestic price level. Import functions are behavioural equations and should therefore reflect theoretically-founded long-run steady state relationships. From an econometric point of view, this is equivalent to the requirement that the time series

[7] We prefer to use the broader term activity variable instead of income variable.

forming import demand should be cointegrated. Since we are also interested in the question whether these cointegration relationships are stable over time, the econometric analysis is performed for the observation periods 1975:1-1995:4 and 1975:1-2003:4.

3.1 Traditional import demand model

Since more than two-thirds of German imports are closely related to the production process and can therefore be regarded as factors of production in a broader sense, the import demand function is derived from a CES production function[8]

$$Y = \left[\alpha_1 H^{-\rho} + \alpha_2 M^{-\rho}\right]^{-\frac{\varphi}{\rho}}, \tag{1}$$

describing the technical relationship between the quantities of domestic (H) and imported (M) input factors and production output (Y). The resulting log-linear import demand function is

$$m = \beta_0 + \beta_1 y - \beta_2(p_M - p), \tag{2}$$

with m and y denoting import and output quantities, p_M and p are the prices of imports and output.[9] Thus, import demand depends on domestic production and on a relative import price. Furthermore, $\beta_0 = \frac{1}{1+\rho}(\ln\alpha_2 + \ln\varphi)$, $\beta_1 = \frac{\varphi+\rho}{\varphi(1+\rho)}$ and $\beta_2 = \frac{1}{1+\rho}$.

3.2 Data

The dependent variable is German imports of goods (*MG95*). The set of alternative activity variables comprises GDP (*GDP95*), total demand (*GDPM95*), private consumption (*C95*), disposable income (*DISPY95*), exports of goods (*XG95*), and gross fixed capital formation (*IFC95*). The time series are expressed in real terms (at constant prices of 1995). They are taken from the German National Accounts Statistics (NAS). Price competitiveness of imports is measured by a set of different relative import prices: import prices/producer prices ($PREL_{ppi}$), import prices/GDP deflator ($PREL_{pgdp}$), import prices/total demand deflator ($PREL_{pgdpm}$), import prices/consumer prices ($PREL_{pc}$) as well

[8] For a detailed exposition see Stephan (2005), p.98.

[9] Lower-case letters are variables transformed taking the logarithm.

as import prices/prices of exports of goods and gross fixed capital formation ($PREL_{pifcxg}$). Except for the producer prices all time series are taken from the NAS or are calculated on the basis of NAS figures. See the Appendix for data description.

We use seasonally unadjusted quarterly data covering the period 1975:1-2003:4. The data refer to West Germany until 1990:4 and to the unified Germany afterwards. All time series are transformed taking the logarithm.

3.3 Unit root and cointegration tests

All variables under consideration are integrated in levels and stationary in first differences (Tables 4 and 5, Appendix).[10] Thus, a cointegration analysis is appropriate. Since the model corresponding to equation (2) contains $n > 2$ variables, up to $n - 1$ linear independent cointegrating vectors could exist. Therefore, we test for the number of cointegrating vectors using the Johansen cointegration test. The Johansen procedure (Johansen 1995) is based on a multivariate VAR which can be reparameterized as a vector error correction model (VECM). In the first step, a vector autoregression is set up, with the lag order suggested by the Akaike information criterion. The lag order is accepted if serial correlation is absent in the residuals. Otherwise, the lag length is extended until this requirement is met. In the second step, the corresponding VECM is estimated to test for the number of cointegrating vectors using the trace test adjusted for small samples.[11] Since the data are seasonally unadjusted, centered seasonal dummies are used. Regarding the deterministic trend specification, it is assumed that there are linear trends in the levels of the data but no trend in the cointegrating vectors.

We performed a large number of Johansen cointegration tests both for the observation period 1975:1-1995:4 and 1975:1-2003:4 (Tables 6-11, Appendix) to detect

[10]Time series taken from the German National Accounts Statistics were subjected to the Perron test (Perron 1989), since these series may have a structural break due to German reunification; on all other time series the augmented Dickey-Fuller test was applied. Detailed test specifications are displayed in Table 4 and 5, Appendix. EViews 4.0 and PcGive 10.0 were used for the econometric analysis.

[11]See Doornik (1999).

combinations of variables that are *irreducibly* cointegrated (Davidson 1998).[12] Regarding the short sample, the Johansen test indicates cointegration (CI) relationships among imports, the aggregated activity variable (GDP or total demand respectively) and a shift dummy ($s9101$) accounting for the structural break present in the national accounts data in the first quarter 1991 due to German reunification (Table 6, Appendix). Regarding the long sample, these variables are not cointegrated. Even if a relative import price corresponding to the activity variable under consideration is additionally included, no long-run relationship is found (Table 8, Appendix). In addition to aggregated demand variables traditionally used in import equations, we checked whether single GDP components could be used as well. Regarding the short sample, the Johansen test indicates a long-run relationship among imports, private consumption (or disposable income respectively) and the shift dummy ($s9101$) accounting for the structural break in the first quarter 1991 (Table 6, Appendix). Considering the long sample, these variables are not cointegrated. Enhancing the set of variables adding investment (or exports respectively) and a relative import price does not help to establish a cointegration relationship (Table 9, Appendix).

Only imports, investment, exports and a relative import price form stable cointegration relationships in *both* observation periods (Tables 10 and 11, Appendix). In the following, they are analysed in detail. All long-run relationships are highly significant. There is no need for a shift dummy ($s9101$) in the long-run relationship. It was tested within the Johansen framework, but it was always insignificant and therefore dropped. It is remarkable that using different domestic price indexes for calculating relative import prices hardly change the estimation results. However, relative import prices based on broader domestic price indexes perform slightly better. The finding that investment and exports are part of the CI relationship whereas private consumption is not, indicates that German imports are mainly driven by the production side in the long run.[13] This conclusion is

[12] A set of I(1) variables is irreducibly cointegrated if they are cointegrated, but dropping any of these variables leaves a set that is not cointegrated.

[13] Note, that our aim is to detect combinations of variables that are *irreducibly* cointegrated. Our finding that private consumption does *not* belong to the CI relationship is indirectly confirmed by Stirböck (2006) stating that model 3 postulating a CI relationship among imports, private consumption, investment (gross capital formation), exports and a relative import price should be interpreted with caution, since "the results from specification (3) are not reliable –

underpinned by the fact that two-thirds of German imports are intermediate and investment goods.

If a single cointegrating vector is determined and all variables except imports are weakly exogenous, we can estimate a conditional single equation error correction model that can be interpreted as a structural import demand function. In a conditional (or structural) error correction model contemporaneous differences of the weakly exogenous regressors are additionally included. The Johansen test procedure indicates exactly one cointegrating vector in all cases (Tables 10 and 11, Appendix). It also shows that exports and investment are always weakly exogenous, whereas the relative import price is often not – especially in the shorter observation period. In these cases, the contemporaneous difference of the relative import price is not considered in the estimation equation. In the following structural import equations for both time periods are presented.

3.4 Import equations, Sample: 1975:1-1995:4

All import demand equations are estimated according to the Stock approach (Stock 1987), i.e. long-run relationship and short-run dynamics are simultaneously determined and the error correction term is nonlinearly estimated. Thus, the corresponding t-values can be evaluated without any further transformation. Since all time series are in logs, the estimated coefficients can be interpreted as elasticities. The alternative import equations are derived applying the "general to specific" approach: the estimation procedure starts with four lags for all variables and insignificant ones are excluded one by one. The short-hand notation for the variables was introduced in subsection 3.2. sd_1, sd_2 and sd_3 are centered seasonal dummies. The impulse dummies $i9101$ and $i9301$ account for changes in the National Accounts Statistics in the first quarter 1991 due to German unification and for the effects of the completion of the European Single Market in the first quarter 1993. An additional impulse dummy ($i8904$) is needed to correct for an outlier in the forth quarter 1989. T-values of the estimated coefficients are indicated in parentheses. For the residual and specification tests p-values are given in brackets.

this particularly applies to the long-run consumption variable, which was still insignificant in the general starting equation." Stirböck (2006), footnote 23, p.12.

Model 1a

$$\Delta \ln MG95_t =$$

$$\underset{(-6,4)}{-0,52}\,[\ln MG95_{t-1} \underset{(-24,9)}{-0,70} \ln XG95_{t-1} \underset{(-9,5)}{-0,48} \ln IFC95_{t-1} \underset{(4,5)}{+0,26} \ln PREL_{pgdp_{t-1}}]$$

$$\underset{(7,5)}{+0,51}\, \Delta \ln XG95_t \underset{(-2,2)}{-0,14} \Delta \ln XG95_{t-1} \underset{(4,3)}{+0,21} \Delta \ln IFC95_{t-3}$$

$$\underset{(2,8)}{+0,15}\, \Delta \ln IFC95_{t-4} \underset{(2,4)}{+0,26} \Delta \ln PREL_{pgdp_{t-2}} \underset{(-3,2)}{-0,33} \Delta \ln PREL_{pgdp_{t-3}}$$

$$\underset{(2,5)}{+0,19}\, \Delta \ln DISPY95_{t-1} \underset{(-3,5)}{-0,09}\, csd_{1t} \underset{(-1,4)}{-0,02}\, csd_{2t} \underset{(-4,9)}{-0,09}\, csd_{3t}$$

$$\underset{(0,5)}{+0,11} \underset{(-3,3)}{-0,07} i9301_t \underset{(4,4)}{+0,09}\, i9101_t \underset{(2,0)}{+0,04}\, i8904_t + \hat{u}_{1t}$$

$\bar{R}^2$=0,86, SEE=0,0181, LM(1)=[0,20], LM(4)=[0,36], LM(8)=[0,10], ARCH(1) =[0,69], White test=[0,33], RESET test=[0,42], NORM=[0,42], Cusum/Cusum^2: stable

Model 2a

$$\Delta \ln MG95_t =$$

$$\underset{(-6,3)}{-0,53}\,[\ln MG95_{t-1} \underset{(-25,0)}{-0,69} \ln XG95_{t-1} \underset{(-9,5)}{-0,48} \ln IFC95_{t-1} \underset{(4,6)}{+0,32} \ln PREL_{pgdpm_{t-1}}]$$

$$\underset{(7,4)}{+0,5}\, \Delta \ln XG95_t \underset{(-2,3)}{-0,15} \Delta \ln XG95_{t-1} \underset{(4,4)}{+0,22} \Delta \ln IFC95_{t-3}$$

$$\underset{(2,8)}{+0,16}\, \Delta \ln IFC95_{t-4} \underset{(2,4)}{+0,31} \Delta \ln PREL_{pgdpm_{t-2}} \underset{(-3,0)}{-0,39} \Delta \ln PREL_{pgdpm_{t-3}}$$

$$\underset{(2,3)}{+0,18}\, \Delta \ln DISPY95_{t-1} \underset{(-3,4)}{-0,09}\, csd_{1t} \underset{(-1,4)}{-0,02}\, csd_{2t} \underset{(-4,9)}{-0,09}\, csd_{3t}$$

$$\underset{(1,1)}{+0,27} \underset{(-3,3)}{-0,07} i9301_t \underset{(4,4)}{+0,09}\, i9101_t \underset{(2,0)}{+0,04}\, i8904_t + \hat{u}_{2t}$$

$\bar{R}^2$=0,86, SEE=0,0182, LM(1)=[0,22], LM(4)=[0,41], LM(8)=[0,11], ARCH(1) =[0,53], White test=[0,33], RESET test=[0,47], NORM=[0,45], Cusum/Cusum^2: stable

Model 3a

$$\Delta \ln MG95_t =$$

$$\underset{(-6,2)}{-0,59} [\ln MG95_{t-1} \underset{(-27,3)}{-0,71} \ln XG95_{t-1} \underset{(-10,6)}{-0,51} \ln IFC95_{t-1} \underset{(4,5)}{+0,40} \ln PREL_{ppi_{t-1}}]$$

$$\underset{(6,9)}{+0,48} \Delta \ln XG95_t \underset{(-2,6)}{-0,18} \Delta \ln XG95_{t-1} \underset{(1,6)}{+0,14} \Delta \ln IFC95_t$$

$$\underset{(3,5)}{+0,19} \Delta \ln IFC95_{t-3} \underset{(1,8)}{+0,12} \Delta \ln IFC95_{t-4} \underset{(1,5)}{+0,22} \Delta \ln PREL_{ppi_{t-1}}$$

$$\underset{(2,2)}{+0,32} \Delta \ln PREL_{ppi_{t-2}} \underset{(-2,2)}{-0,29} \Delta \ln PREL_{ppi_{t-3}} \underset{(2,3)}{+0,18} \Delta \ln DISPY95_{t-1}$$

$$\underset{(-0,9)}{-0,03}\, csd_{1t} \underset{(-1,2)}{-0,02}\, csd_{2t} \underset{(-2,4)}{-0,05}\, csd_{3t} \underset{(1,3)}{+0,40} \underset{(-3,4)}{-0,07} i9301_t \underset{(2,1)}{+0,06}\, i9101_t + \hat{u}_{3t}$$

$\bar{R}^2$=0,85, SEE=0,0186, LM(1)=[0,13], LM(4)=[0,29], LM(8)=[0,16], ARCH(1) =[0,93], White test=[0,28], RESET test=[0,61], NORM=[0,40], Cusum/Cusum^2: stable

Model 4a

$$\Delta \ln MG95_t =$$

$$\underset{(-6,0)}{-0,51} [\ln MG95_{t-1} \underset{(-23,3)}{-0,68} \ln XG95_{t-1} \underset{(-10,1)}{-0,50} \ln IFC95_{t-1} \underset{(4,5)}{+0,34} \ln PREL_{pifcxg_{t-1}}]$$

$$\underset{(7,3)}{+0,51} \Delta \ln XG95_t \underset{(-2,0)}{-0,13} \Delta \ln XG95_{t-1} \underset{(4,4)}{+0,22} \Delta \ln IFC95_{t-3}$$

$$\underset{(2,8)}{+0,16} \Delta \ln IFC95_{t-4} \underset{(2,0)}{+0,24} \Delta \ln PREL_{pifcxg_{t-2}} \underset{(-2,5)}{-0,32} \Delta \ln PREL_{pifcxg_{t-3}}$$

$$\underset{(2,4)}{+0,18} \Delta \ln DISPY95_{t-1} \underset{(-2,9)}{-0,07}\, csd_{1t} \underset{(-1,0)}{-0,02}\, csd_{2t} \underset{(-3,9)}{-0,06}\, csd_{3t}$$

$$\underset{(1,1)}{+0,30} \underset{(-3,2)}{-0,07} i9301_t \underset{(4,2)}{+0,09}\, i9101_t \underset{(2,0)}{+0,04}\, i8904_t + \hat{u}_{4t}$$

$\bar{R}^2$=0,85, SEE=0,0186, LM(1)=[0,17], LM(4)=[0,47], LM(8)=[0,27], ARCH(1) =[0,51], White test=[0,28], RESET test=[0,44], NORM=[0,54], Cusum/Cusum^2: stable

Model 5a

$$\Delta \ln MG95_t =$$

$$\underset{(-6,2)}{-0,59} [\ln MG95_{t-1} \underset{(-27,9)}{-0,70} \ln XG95_{t-1} \underset{(-11,0)}{-0,52} \ln IFC95_{t-1} \underset{(4,1)}{+0,25} \ln PREL_{pc_{t-1}}]$$

$$\underset{(7,4)}{+0,49} \Delta \ln XG95_t \underset{(-2,9)}{-0,20} \Delta \ln XG95_{t-1} \underset{(2,0)}{+0,16} \Delta \ln IFC95_t$$

$$\underset{(3,6)}{+0,19} \Delta \ln IFC95_{t-3} \underset{(2,0)}{+0,12} \Delta \ln IFC95_{t-4} \underset{(2,0)}{+0,24} \Delta \ln PREL_{pc_{t-1}}$$

$$\underset{(-3,1)}{-0,34} \Delta \ln PREL_{pc_{t-3}} \underset{(2,5)}{+0,18} \Delta \ln DISPY95_{t-1} \underset{(-0,6)}{-0,02} csd_{1t} \underset{(-1,3)}{-0,02} csd_{2t}$$

$$\underset{(-2,5)}{-0,05} csd_{3t} \underset{(-0,0)}{-0,01} \underset{(-3,4)}{-0,07} i9301_t \underset{(2,1)}{+0,05} i9101_t \underset{(2,0)}{+0,04} i8904_t + \hat{u}_{5t}$$

$\bar{R}^2$=0,86, SEE=0,0180, LM(1)=[0,33], LM(4)=[0,26], LM(8)=[0,21], ARCH(1) =[0,70], White test=[0,65], RESET test=[0,90], NORM=[0,40], Cusum/Cusum^2: stable

In all five equations the cointegration relationship is among imports of goods, export of goods, gross fixed capital formation and a relative import price. The estimated adjustment coefficients are highly significant indicating a CI relationship at the 1 % significance level.[14] Thus, the results of the Johansen tests are confirmed. The long-run relationships are very similar with regard to the size of the estimated price and activity elasticities: The estimated coefficient of exports is about 0.7, that of investment is about 0.5. Thus, the elasticity of German imports with regard to domestic economic activity of is about 0.6.[15] The finding that a 1% increase in domestic economic activity leads to a less than proportional increase in imports is quite reasonable. It indicates that German production capacities are large enough so that imports can be replaced to a certain extent by

[14] Since no linear trend is included in the ECM, but at least one of the three stochastic regressors incorporates a linear trend, we have to apply the critical value corresponding to the specification with two stochastic regressors, constant and trend which is -4.51 (cf. Hassler 2004, p.108). Critical values are taken from Hassler (2004), Table 4.

[15] The elasticity is calculated as follows: If domestic economic activity is approximated using exports and investment, the share of exports (investment) is 65% (35%). That implies a weight of 0.65 for exports and 0.35 for investment. The above-mentioned elasticity is the average value of the weighted activity elasticities of the five import functions.

domestic products in the long run. This result, however, is in stark contrast to the mainstream literature reporting income elasticities well in excess of one, and frequently above two implying that in the long run all income would be spent on imports – a scenario which even the authors themselves judge as highly unrealistic.[16] The estimated long-run price elasticities are significant and have the right sign. The point estimators range between -0.25 and -0.40, i.e. they are (in absolute values) larger than most of the corresponding point estimators reported in Table 2.[17] In the majority of cases, however, this difference is not statistically significant at the 5% level.

The short-run adjustment is carried out by contemporaneous and lagged changes of exports and investment as well as by lagged changes of relative import prices, i.e. that import demand is not only determined by the production side in the long run but also in the short run. But not exclusively – the inclusion of lagged differences of disposable income reflects the impact of consumer demand in the short run. The reported diagnostic tests show that the five models fit the data very well. There is no evidence for model misspecification or parameter instability. The residuals are not autocorrelated and they are approximately normally distributed. Thus, regarding the diagnostic tests, the five import demand equations perform equally well. In the next subsection we enlarge the estimation sample in order to check whether impact and significance of the determinants change over time.

3.5 Import equations, Sample: 1975:1-2003:4

The estimated import demand equations based on the data set covering the period 1975:1-2003:4 closely resemble the equations presented in the precedent subsection. Again, the cointegration relationship is among imports of goods, export of goods, gross fixed capital formation and a relative import price. The adjustment coefficients are highly significant indicating a CI relationship at the 1% significance level.

[16] E.g. Barrell and Dées (2005).

[17] These studies can be compared to our study since they also estimate SEECM based on data for unified Germany. The results presented by Meurers (2003) are excluded from the comparison since he used a different estimation approach.

Model 1b

$$\Delta \ln MG95_t =$$

$$\underset{(-6{,}58)}{-0,51} [\ln MG95_{t-1} \underset{(-37{,}1)}{-0,77} \ln XG95_{t-1} \underset{(-8{,}5)}{-0,43} \ln IFC95_{t-1} \underset{(4{,}7)}{+0,28} \ln PREL_{pgdp_{t-1}}]$$

$$\underset{(2{,}2)}{+0,15} \Delta \ln MG95_{t-4} \underset{(7{,}8)}{+0,48} \Delta \ln XG95_t \underset{(-2{,}6)}{-0,16} \Delta \ln XG95_{t-1} \underset{(2{,}5)}{+0,15} \Delta \ln IFC95_t$$

$$\underset{(3{,}6)}{+0,16} \Delta \ln IFC95_{t-3} \underset{(2{,}2)}{+0,23} \Delta \ln PREL_{pgdp_{t-1}} \underset{(-2{,}0)}{-0,20} \Delta \ln PREL_{pgdp_{t-3}}$$

$$\underset{(2{,}0)}{+0,13} \Delta \ln DISPY95_{t-1} \underset{(-2{,}1)}{-0,05} csd_{1t} \underset{(-2{,}2)}{-0,04} csd_{2t} \underset{(-3{,}9)}{-0,06} csd_{3t}$$

$$\underset{(0{,}5)}{+0,12} \underset{(-3{,}2)}{-0,07} i9301_t \underset{(1{,}7)}{+0,04} i9101_t + \hat{u}_{1t}$$

$\bar{R}^2$=0,83, SEE=0,0197, LM(1)=[0,25], LM(4)=[0,44], LM(8)=[0,65], ARCH(1) =[0,61], White test=[0,12], RESET test=[0,77], NORM=[0,71], Cusum/Cusum^2: stable

Model 2b

$$\Delta \ln MG95_t =$$

$$\underset{(-6{,}58)}{-0,43} [\ln MG95_{t-1} \underset{(-30{,}4)}{-0,76} \ln XG95_{t-1} \underset{(-6{,}4)}{-0,38} \ln IFC95_{t-1} \underset{(5{,}0)}{+0,43} \ln PREL_{pgdpm_{t-1}}]$$

$$\underset{(1{,}4)}{+0,09} \Delta \ln MG95_{t-4} \underset{(7{,}6)}{+0,48} \Delta \ln XG95_t \underset{(-2{,}0)}{-0,12} \Delta \ln XG95_{t-1}$$

$$\underset{(3{,}6)}{+0,16} \Delta \ln IFC95_{t-3} \underset{(2{,}5)}{+0,32} \Delta \ln PREL_{pgdpm_{t-2}} \underset{(-2{,}2)}{-0,27} \Delta \ln PREL_{pgdpm_{t-3}}$$

$$\underset{(-3{,}6)}{-0,08} csd_{1t} \underset{(-1{,}1)}{-0,02} csd_{2t} \underset{(-4{,}5)}{-0,08} csd_{3t} \underset{(2{,}0)}{+0,52} \underset{(-3{,}3)}{-0,07} i9301_t \underset{(3{,}9)}{+0,08} i9101_t + \hat{u}_{2t}$$

$\bar{R}^2$=0,82, SEE=0,0200, LM(1)=[0,18], LM(4)=[0,38], LM(8)=[0,28], ARCH(1) =[0,86], White test=[0,13], RESET test=[0,61], NORM=[0,86], Cusum/Cusum^2: stable

Model 3b

$$\Delta \ln MG95_t =$$

$$\underset{(-5{,}17)}{-0,35} [\ln MG95_{t-1} \underset{(-25{,}3)}{-0,78} \ln XG95_{t-1} \underset{(-5{,}2)}{-0,38} \ln IFC95_{t-1} \underset{(4{,}3)}{+0,65} \ln PREL_{ppi_{t-1}}]$$

$$\underset{(-1{,}1)}{-0,08} \Delta \ln MG95_{t-1} \underset{(7{,}6)}{+0,48} \Delta \ln XG95_t \underset{(4{,}0)}{+0,17} \Delta \ln IFC95_{t-3}$$

$$\underset{(3{,}1)}{+0,43} \Delta \ln PREL_{ppi_{t-2}} \underset{(-1{,}6)}{-0,22} \Delta \ln PREL_{ppi_{t-3}} \underset{(-4{,}6)}{-0,09} csd_{1t} \underset{(-1{,}7)}{-0,02} csd_{2t} \underset{(-5{,}4)}{-0,07} csd_{3t}$$

$$\underset{(2{,}6)}{+0,76} \underset{(-3{,}2)}{-0,07} i9301_t \underset{(3{,}9)}{+0,08} i9101_t + \hat{u}_{3t}$$

$\bar{R}^2$=0,82, SEE=0,0202, LM(1)=[0,26], LM(4)=[0,31], LM(8)=[0,20], ARCH(1) =[0,66], White test=[0,43], RESET test=[0,42], NORM=[0,44], Cusum/Cusum^2: stable

Model 4b

$$\Delta \ln MG95_t =$$

$$\underset{(-5{,}99)}{-0,42} [\ln MG95_{t-1} \underset{(-28{,}1)}{-0,77} \ln XG95_{t-1} \underset{(-7{,}8)}{-0,45} \ln IFC95_{t-1} \underset{(4{,}4)}{+0,38} \ln PREL_{pifcxg_{t-1}}]$$

$$\underset{(2{,}1)}{+0,15} \Delta \ln MG95_{t-2} \underset{(2{,}2)}{+0,16} \Delta \ln MG95_{t-3} \underset{(3{,}6)}{+0,26} \Delta \ln MG95_{t-4}$$

$$\underset{(8{,}0)}{+0,51} \Delta \ln XG95_t \underset{(-1{,}7)}{-0,11} \Delta \ln XG95_{t-1} \underset{(-2{,}6)}{-0,17} \Delta \ln XG95_{t-4}$$

$$\underset{(-2{,}4)}{-0,16} \Delta \ln IFC95_{t-1} \underset{(-2{,}6)}{-0,14} \Delta \ln IFC95_{t-2} \underset{(1{,}9)}{+0,15} \Delta \ln DISPY95_{t-1}$$

$$\underset{(-3{,}0)}{-0,06} csd_{1t} \underset{(-1{,}8)}{-0,04} csd_{2t} \underset{(-2{,}5)}{-0,06} csd_{3t} \underset{(1{,}2)}{+0,27} \underset{(-2{,}8)}{-0,07} i9301_t \underset{(3{,}4)}{+0,08} i9101_t + \hat{u}_{4t}$$

$\bar{R}^2$=0,81, SEE=0,0210, LM(1)=[0,25], LM(4)=[0,33], LM(8)=[0,52], ARCH(1) =[0,78], White test=[0,24], RESET test=[0,67], NORM=[0,77], Cusum/Cusum^2: stable

Model 5b

$$\Delta \ln MG95_t =$$

$$\underset{(-6,75)}{-0,47} [\ln MG95_{t-1} \underset{(-33,6)}{-0,75} \ln XG95_{t-1} \underset{(-7,9)}{-0,39} \ln IFC95_{t-1} \underset{(5,8)}{+0,41} \ln PREL_{pc_{t-1}}]$$

$$\underset{(1,3)}{+0,08} \Delta \ln MG95_{t-3} \underset{(1,3)}{+0,08} \Delta \ln MG95_{t-4}$$

$$\underset{(7,5)}{+0,45} \Delta \ln XG95_t \underset{(-2,2)}{-0,13} \Delta \ln XG95_{t-1} \underset{(3,7)}{+0,17} \Delta \ln IFC95_{t-3}$$

$$\underset{(1,8)}{+0,09} \Delta \ln IFC95_{t-4} \underset{(2,9)}{+0,32} \Delta \ln PREL_{pc_{t-2}} \underset{(-2,7)}{-0,29} \Delta \ln PREL_{pc_{t-3}}$$

$$\underset{(-3,0)}{-0,07} csd_{1t} \underset{(-1,7)}{-0,03} csd_{2t} \underset{(-4,6)}{-0,07} csd_{3t} \underset{(2,2)}{+0,52} \underset{(-3,3)}{-0,07} i9301_t \underset{(4,1)}{+0,09} i9101_t + \hat{u}_{5t}$$

$\bar{R}^2$=0,84, SEE=0,0193, LM(1)=[0,16], LM(4)=[0,60], LM(8)=[0,38], ARCH(1) =[0,72], White test=[0,14], RESET test=[0,77], NORM=[0,95], Cusum/Cusum^2: stable

The long-run relationships are again very similar with regard to the size of the estimated activity elasticities: the estimated coefficient of exports is about 0.8, that of investment is about 0.4. Thus, the elasticity of German imports with regard to the domestic activity variables is about 0.7. The point estimators of the long-run price elasticities range between -0.28 and -0.65. They are (in absolute values) clearly larger than most of the point estimators presented in Table 2. This time the difference is statistically significant at the 5% level in 30% of cases.

Model version *a* and *b* mainly differs with regard to the short-run dynamics. In models $1b-5b$ the short-run adjustment is again carried out by contemporaneous and lagged differences of exports and investment as well as by lagged differences of relative import prices. Additionally, lagged changes of imports have to be considered to account for autocorrelation in the residuals. In some equations disposable income is no longer part of the short-run dynamics. Whenever it turned out to be insignificant it was excluded from the equation.

Regarding the diagnostic tests, all five import equations fit the data very well. The usual misspecification tests (White's Heteroscedasticity Test and Ramsey's

RESET Test) do not signal any problem. No autocorrelation is detected in the residuals, which are approximately normally distributed, and the CUSUM tests indicate parameter stability in all cases. Regarding the diagnostic tests, the five import demand functions perform equally well. Since we are generally interested in a specification which is well-suited for short-term forecasts, the five equations are now subjected to an out-of-sample forecasting exercise to evaluate their forecast performance.

3.6 Forecast evaluation

For each import demand equation we perform a sequence of h-step ahead forecasts for $h = 1, 2, 4$, and 6 quarters.[18] The forecast period is 1996:1-2003:4. Thus, for each model four series with 32 forecasts are carried out.[19] For the dynamic out-of-sample forecast we estimate rolling regressions. The forecast of imports at time t is based on actual values of the dependent variables available at time $t-h$ and on actual values of the explanatory variables available at time t.[20] At each new forecasting date the sample is extended by one further observation and the parameters are re-estimated.

As a measure of accuracy, h-step root mean squared errors (RMSE) are computed for each model. Thus, we can check whether the models' forecast performance varies subject to the forecast horizon. The overall RMSE gives the total forecast error for each equation. The results are displayed in Table 3. In the lower part of the table the models are ranked according to their forecast accuracy: the model with the smallest forecast error has rank 1, the model with the largest forecast error has rank 5.

Considering the one-step-ahead forecasts, all models possess equal predictive abil-

[18] I thank F. Zinsmeister and S. Yahnych for providing me with Eviews programs that greatly facilitate the forecasting exercise.

[19] In order to ensure that the number of forecasts is equal if the step length varies, the estimation period for the models has to be adjusted subject to h. If we forecast the amount of imports in the first quarter 1996 and $h = 1$, the estimation period is 1975:1-1995:4. If $h = 2$, the estimation period is 1975:1-1995:3 and so on.

[20] Since we are interested in evaluating the errors resulting from our model specification, we take the exogenous variables as given.

ity.[21] Differences between the models become clearer, if the forecasting horizon is extended. In terms of both h-step RMSEs and overall RMSE model $5b$ performs best and model $4b$ performs worst. The other models are in between, whereas models $1b$ and $2b$ perform clearly better than model $4b$. It is remarkable that models using relative import prices based on broader domestic price indexes (consumer price index, GDP deflator, total demand deflator) outperform those models using relative import prices based on producer price index or the price index of exports and investment which – from a theoretical point of view – correspond well to the activity variables. This finding is important for applied economic research, since the broader domestic price indexes are easily available from the National Accounts Statistics.

Root Mean Squared Errors						
Model	rel. import price	$h = 1$	$h = 2$	$h = 4$	$h = 6$	overall RMSE
1b	$PREL_{pgdp}$	0,0232	0,0270	0,0304	0,0332	0,1138
2b	$PREL_{pgdpm}$	0,0228	0,0266	0,0301	0,0329	0,1124
3b	$PREL_{ppi}$	0,0223	0,0271	0,0337	0,0375	0,1207
4b	$PREL_{pifcxg}$	0,0244	0,0294	0,0377	0,0432	0,1347
5b	$PREL_{pc}$	0,0221	0,0251	0,0273	0,0294	0,1039
Rank						
1b	$PREL_{pgdp}$	4	3	3	3	3
2b	$PREL_{pgdpm}$	3	2	2	2	2
3b	$PREL_{ppi}$	2	4	4	4	4
4b	$PREL_{pifcxg}$	5	5	5	5	5
5b	$PREL_{pc}$	1	1	1	1	1

Table 3: Forecast evaluation of import functions

[21] One-step ahead forecasts were evaluated using the Diebold-Mariano-Test (Diebold and Mariano 1995) indicating that differences in the models' the predictive ability are not statistically significant.

4 Conclusions

In this article we have shown that the implausibly high income elasticities usually reported in empirical studies dealing with German import demand are caused by the use of highly aggregated activity variables. In an extensive econometric analysis covering two different observation periods we tested a large set of potential determinants to detect combinations of variables that are *irreducibly* cointegrated. The Johansen test clearly indicates that such a relationship does not exist among imports, the traditional activity variables (GDP or total demand) and a relative import price. Either imports, the aggregated activity variable and a shift dummy (accounting for the structural break in the National Accounts Statistics due to German unification) are already cointegrated or they are not, but then additionally including a relative import price does not help to establish a cointegration relationship. The systematic analysis of single GDP components reveals that *only* imports, exports, investment and a relative import price form stable cointegration relationships in both observation periods. The result that exports and investment are part of the CI relationship whereas consumption is *not* indicates that German imports are mainly driven by the production side. The finding that in our specifications the activity elasticity is clearly below 1 is quite reasonable indicating that German production capacities are large enough so that imports can be replaced to a certain extent by domestic products in the long run. Furthermore, there is no need for an additional variable that accounts for the effects of globalisation, since the rapid increase in the international division of labour is automatically reflected in the export development.[22] The analysis of different relative price indexes reveals that relative import prices based on broader domestic price indexes like consumer prices, GDP deflator or total demand deflator perform better than more specific price indexes. Furthermore, there is no evidence that the relative low price elasticities are caused by aggregation problems inherent in the aggregated price indexes. In fact, the stability of the estimated import demand equation and the size of the estimated activity and price elasticities crucially depend on the choice of the domestic activity variable.

[22] See Seifert (2000).

5 Appendix

Augmented Dickey-Fuller Tests						
	Level			First differences		
Variables	**Lags**	**Deterministics**	**Test statistics**	**Lags**	**Deterministics**	**Test statistics**
$\ln PREL_{pgdp}$	1, 2, 5, 9, 11	c, t, csd	-1,51	5, 9, 11	c, csd	-5,25***
$\ln PREL_{pgdpm}$	1, 2, 5, 11	c, t, csd	-1,66	5, 9, 11	c, csd	-5,32***
$\ln PREL_{ppi}$	1, 2, 5, 11	c, t	-2,06	2-4, 9, 11, 12	c	-7,20***
$\ln PREL_{pc}$	1, 4, 5, 9, 11	c, t	-1,21	3-5, 9, 11	c	-6,31***
$\ln PREL_{ifcxg}$	1, 2, 5, 9, 11	c, t	-1,52	2, 4, 9, 11,12	c	-6,80***
Two-step Perron Tests						
	Level			First differences		
Variables	**Lags**	**Deterministics**	**Test statistics**	**Lags**	**Deterministics**	**Test statistics**
$\ln MG95$	1-4, 6	c, t, csd, s9101*t, s9101	-1,98	2-6	c, csd, d(s9101)	-10,81***
$\ln GDP95$	1, 6	c, t, csd, s9101*t, s9101	-2,35	1, 3, 4	c, csd, d(s9101)	-9,99***
$\ln GDPM95$	1, 4, 6, 8	c, t, csd, s9101*t, s9101	-2,26	1, 3, 4	c, csd, d(s9101)	-8,75***
$\ln DISPY95$	1, 4, 5, 8	c, t, csd, s9101*t, s9101	-2,45	1, 3-6, 8	c, csd, d(s9101)	-12,50***
$\ln C95$	1, 4, 5	c, t, csd, s9101*t, s9101	-2,56	2-5	c, csd, d(s9101)	-16,64***
$\ln IFC95$	1, 4, 8	c, t, csd, s9101*t, s9101	-2,98	1, 3, 4	c, csd, d(s9101)	-8,99***
$\ln XG95$	1, 5, 8	c, t, csd, s9101*t, s9101	-2,43	2-4, 7	c, csd, d(s9101)	-10,84***

c: constant, t: trend, csd: centered seasonal dummies, s9101: shift dummy (zero until 1990:4, one from 1991:1 onwards), s9101*t: kinked trend, ***: denote significance at 1% level

Table 4: Unit root tests, (1975:1-1995:4)

Augmented Dickey-Fuller Tests						
	Level			**First differences**		
Variables	**Lags**	**Deterministics**	**Test statistics**	**Lags**	**Deterministics**	**Test statistics**
$\ln PREL_{pgdp}$	1, 2, 5, 9	c, t, csd	-2,07	2-4, 9	c, csd	-7,29***
$\ln PREL_{pgdpm}$	1, 2, 5, 7	c, t, csd	-2,29	3, 5, 9	c, csd	-6,95***
$\ln PREL_{ppi}$	1, 2, 5, 10, 11	c, t	-2,45	2, 5, 9, 11, 12	c	-8,05***
$\ln PREL_{pc}$	1, 2, 4, 5, 9, 11	c, t	-2,06	2-6, 9	c	-7,74***
$\ln PREL_{ifcxg}$	1, 2, 5, 9	c, t, csd	-1,80	2-4, 9, 11,12	c, csd	-8,15***
Two-step Perron Tests						
	Level			**First differences**		
Variables	**Lags**	**Deterministics**	**Test statistics**	**Lags**	**Deterministics**	**Test statistics**
$\ln MG95$	1-3, 6	c, t, csd, s9101*t, s9101	-3,30	3-6	c, csd, d(s9101)	-13,01***
$\ln GDP95$	1, 4, 6, 8	c, t, csd, s9101*t, s9101	-3,43	3, 4	c, csd, d(s9101)	-15,97***
$\ln GDPM95$	1, 6, 8	c, t, csd, s9101*t, s9101	-2,88	1, 4	c, csd, d(s9101)	-10,12***
$\ln DISPY95$	1, 4, 5, 8	c, t, csd, s9101*t, s9101	-3,14	1, 3-6, 8	c, csd, d(s9101)	-13,73***
$\ln C95$	1, 4-6, 8	c, t, csd, s9101*t, s9101	-3,56	3-5	c, csd, d(s9101)	-18,02***
$\ln IFC95$	1, 4-6, 8	c, t, csd, s9101*t, s9101	-3,27	1, 3, 4	c, csd, d(s9101)	-10,09***
$\ln XG95$	1, 4, 6, 8	c, t, csd, s9101*t, s9101	-3,29	4	c, csd, d(s9101)	-12,91***
c: constant, t: trend, csd: centered seasonal dummies, s9101: shift dummy (zero until 1990:4, one from 1991:1 onwards), s9101*t: kinked trend, ***: denote significance at 1% level						

Table 5: Unit root tests, (1975:1-2003:4)

Model	1	2	3	4	5	6
Error correction term						
$\ln MG95$	x	x	x	x	x	x
$\ln GDP95$	x					
$\ln GDPM95$		x				
$\ln C95$			x			
$\ln DISPY95$				x		
$\ln IFC95$					x	
$\ln XG95$						x
$s9101$	x	x	x	x	x	x
Lags	1-7	1-4	1-4	1-5	1-5	1-4
Number of CI vectors[a,b,c]	1***	1***	1***	1***	0	0

[a] Results of trace test (small sample adjusted); [b] Johansen test: constant included in both cointegrating vector and VAR; [c] Deterministic terms in VAR: csd, i9101, i9301. *** (**): denote significance at 1% (5%) level

Table 6: Results of Johansen cointegration test I, (1975:1-1995:4)

Model	1a	2a	3a	4a	5a	6a
Error correction term						
$\ln MG95$	x	x	x	x	x	x
$\ln GDP95$	x					
$\ln GDPM95$		x				
$\ln C95$			x			
$\ln DISPY95$				x		
$\ln IFC95$					x	
$\ln XG95$						x
$s9101$	x	x	x	x	x	x
Lags	1-8	1-8	1-5	1-5	1-5	1-4
Number of CI vectors[a,b,c]	0	0	0	0	0	0

[a] Results of trace test (small sample adjusted); [b] Johansen test: constant included in both cointegrating vector and VAR; [c] Deterministic terms in VAR: csd, i9101, i9301.

Table 7: Results of Johansen cointegration tests I, (1975:1-2003:4)

Model	7	8	9	10
Error correction term				
$\ln MG95$	x	x	x	x
$\ln GDP95$	x			
$\ln GDPM95$		x		
$\ln C95$			x	
$\ln DISPY95$				x
$\ln PREL_{pgdp}$	x			
$\ln PREL_{pgdpm}$		x		
$\ln PREL_{pc}$			x	x
$s9101$	x	x	x	x
Lags	1-5	1-5	1-4	1-5
Number of CI vectors^{a,b,c}	0	0	0	0

^{a} Results of trace test (small sample adjusted); ^{b} Johansen test: constant included in both cointegrating vector and VAR; ^{c} Deterministic terms in VAR: csd, i9101, i9301.

Table 8: Results of Johansen cointegration test IIa, (1975:1-2003:4)

Model	11	12	13	14
Error correction term				
$\ln MG95$	x	x	x	x
$\ln C95$	x	x		
$\ln DISPY95$			x	x
$\ln IFC95$	x		x	
$\ln XG95$		x		x
$\ln PREL_{pgdpm}$	x	x	x	x
$s9101$	$-^{d}$	$-^{d}$	$-^{d}$	$-^{d}$
Lags	1-5	1-5	1-5	1-5
Number of CI vectors^{a,b,c,d}	0	0	0	0

^{a} Results of trace test (small sample adjusted); ^{b} Johansen test: constant included in both cointegrating vector and VAR; ^{c} Deterministic terms in VAR: csd, i9101, i9301; ^{d} Step dummy was always insignificant and was therefore dropped.

Table 9: Results of Johansen cointegration test IIb, (1975:1-2003:4)

Model	15	16	17	18	19
Error correction term					
ln $MG95$	1,00	1,00	1,00	1,00	1,00
ln $IFC95$	-0,55	-0,54	-0,56	-0,53	-0,57
(t-Werte)	(-13,10)	(-13,02)	(-13,19)	(-12,48)	(-14,35)
ln $XG95$	-0,72	-0,71	-0,71	-0,72	-0,70
(t-Werte)	(-32,93)	(-33,07)	(-28,62)	(-33,66)	(-31,14)
ln $PREL_{pgdp}$	0,15				
(t-Werte)	(3,52)				
ln $PREL_{pgdpm}$		0,19			
(t-Werte)		(3,62)			
ln $PREL_{ppi}$			0,26		
(t-Werte)			(3,47)		
ln $PREL_{pc}$				0,20	
(t-Werte)				(3,72)	
ln $PREL_{pifcxg}$					0,19
(t-Werte)					(3,31)
Adjustment coefficients					
$\alpha_{Importe}$	-0,55	-0,56	-0,48	-0,54	-0,51
(t-Werte)	(-3,43)	(-3,43)	(-3,19)	(-3,41)	(-3,13)
α_{IFC}	0,30	0,31	0,28	0,31	0,30
(t-Werte)	(1,85)	(1,89)	(1,80)	(1,84)	(1,86)
α_{XG}	0,25	0,24	0,32	0,22	0,33
(t-Werte)	(1,20)	(1,13)	(1,64)	(1,05)	(1,57)
α_{PREL}	0,29	0,26	0,24	0,32	0,31
(t-Werte)	(2,14)	(2,33)	(2,40)	(2,53)	(2,70)
$\alpha_{IFC} = \alpha_{XG} = \alpha_{PREL} = 0$	[0,03]	[0,02]	[0,02]	[0,02]	[0,01]
Number of CI vectors^{a,b,c,d}	1***	1***	1***	1***	1***

[a] Results of trace test (small sample adjusted); [b] Johansen test: constant included in both cointegrating vector and VAR; [c] Deterministic terms in VAR: csd, i8801, i9101, i9301; [d] Lag length: 4; ***: denote significance at 1% level.

Table 10: Results of the Johansen cointegration test III, (1975:1-1995:4)

Model	15a	16a	17a	18a	19a
Error correction term					
$\ln MG95$	1,00	1,00	1,00	1,00	1,00
$\ln IFC95$	-0,40	-0,39	-0,44	-0,41	-0,45
(t-Werte)	(-7,65)	(-7,37)	(-7,91)	(-9,02)	(-7,81)
$\ln XG95$	-0,79	-0,79	-0,80	-0,78	-0,80
(t-Werte)	(-37,09)	(-36,27)	(-30,94)	(-42,01)	(-32,59)
$\ln PREL_{pgdp}$	0,29				
(t-Werte)	(4,99)				
$\ln PREL_{pgdpm}$		0,36			
(t-Werte)		(4,90)			
$\ln PREL_{ppi}$			0,43		
(t-Werte)			(4,14)		
$\ln PREL_{pc}$				0,34	
(t-Werte)				(5,74)	
$\ln PREL_{pifcxg}$					0,28
(t-Werte)					(3,23)
Adjustment coefficients					
$\alpha_{Importe}$	-0,54	-0,54	-0,44	-0,60	-0,44
(t-Werte)	(-4,82)	(-4,81)	(-4,22)	(-5,28)	(-3,78)
α_{IFC}	0,02	0,02	0,02	0,06	0,03
(t-Werte)	(0,19)	(0,14)	(0,22)	(0,49)	(0,23)
α_{XG}	-0,01	-0,02	0,10	-0,05	0,08
(t-Werte)	(-0,06)	(-0,16)	(0,81)	(-0,33)	(0,54)
α_{PREL}	0,10	0,10	0,11	0,14	0,18
(t-Werte)	(1,07)	(1,30)	(1,75)	(1,56)	(2,35)
$\alpha_{IFC} = \alpha_{XG} = \alpha_{PREL} = 0$	[0,70]	[0,55]	[0,46]	[0,30]	[0,25]
Number of CI vectors^{a,b,c,d}	1***	1***	1***	1***	1**

^{a} Results of trace test (small sample adjusted); ^{b} Johansen test: constant included in both cointegrating vector and VAR; ^{c} Deterministic terms in VAR: csd, i8801, i9101, i9301; ^{d} Lag length: 4; *** (**): denotes significance at 1% (5%) level.

Table 11: Results of Johansen cointegration test III, (1975:1-2003:4)

Data Sources

Variable	Source
Gross domestic product (at const. prices of 1995) Total demand (at const. prices of 1995) Import of goods (at const. prices of 1995) Export of goods (at const. prices of 1995) Private consumption (at const. prices of 1995) Gross fixed capital formation (at const. prices of 1995) Disposable income (at const. prices of 1995) GDP deflator Total demand deflator Deflator of export of goods Deflator of import of goods Deflator of private consumption Deflator of gross fixed capital formation	German Institute for Economic Research (DIW Berlin): Quarterly National Accounts
Producer price index	OECD: Main Economic Indicators

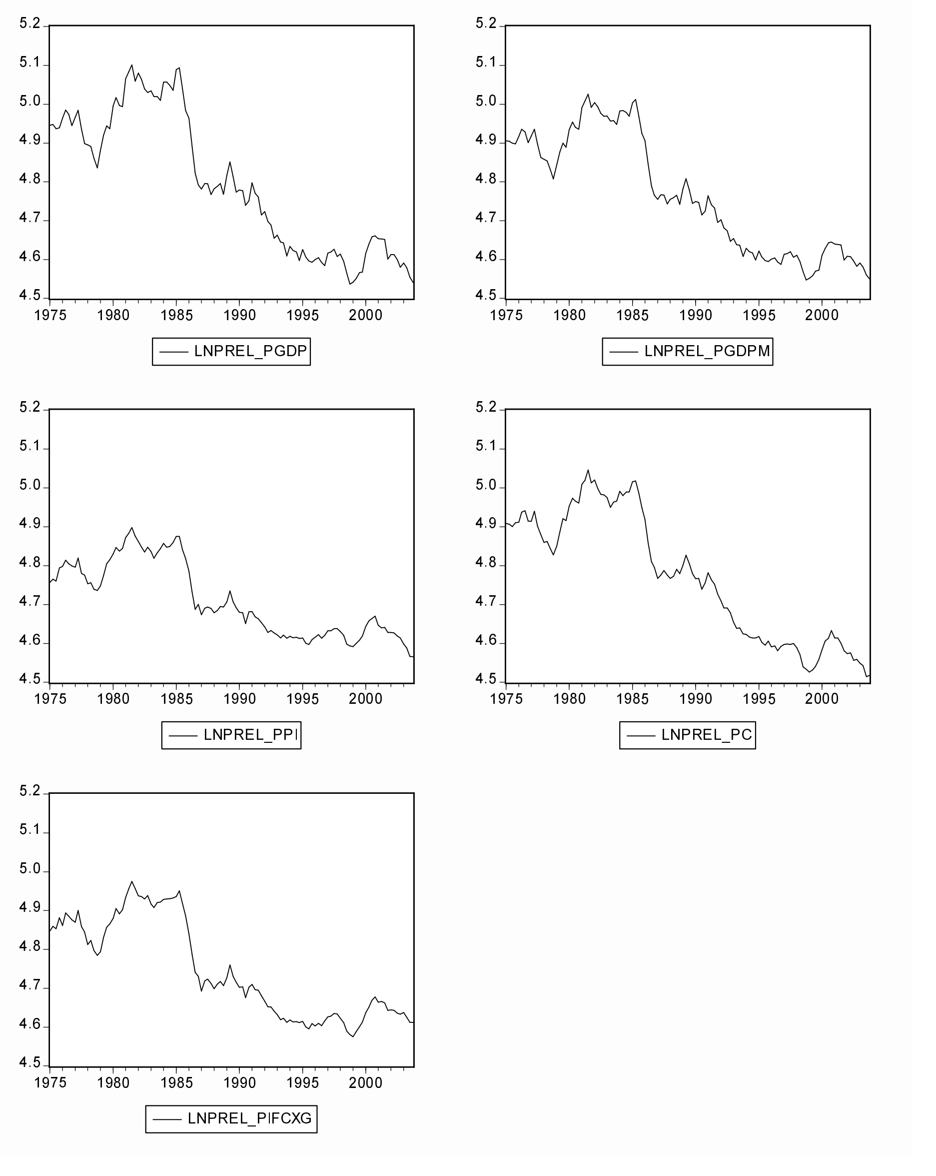

Figure 1: Relative import prices (in logs), (1975:1-2003:4)

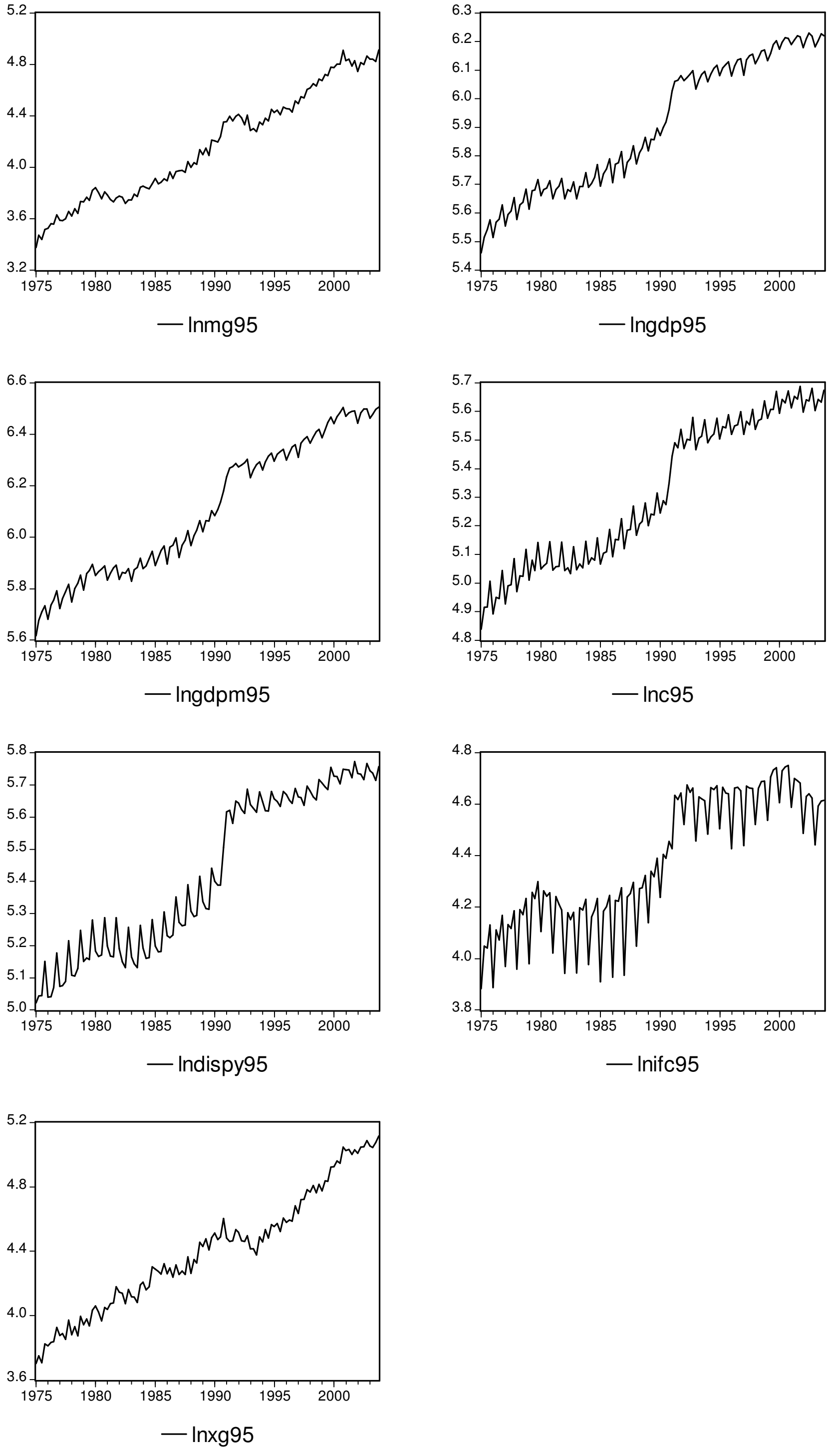

Figure 2: Time series taken from German NAS (in logs), (1975:1-2003:4)

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