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Unit Value Bias Reconsidered

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Abstract. *The present paper explores, both theoretically and empirically, the bias of unit value indices as opposed to genuine price indices in foreign trade. An analysis of German data reveals conceptual and methodological differences, and their impact on economic indicators, namely imported inflation, terms of trade and gross domestic product, is quantified. By introducing a formal theory, the sources of the discrepancy can be attributed to a Laspeyres effect and a structural component, both strongly negative. Only the latter reflects the unit value bias. Thus, much attention should be paid to gaining a better understanding of the index concepts.*

JEL classification: C43, E01, E31, F14.

Keywords: Laspeyres price index, Paasche unit value index, unit value bias, imported inflation, commodity terms of trade, real gross domestic product.

[*]This paper represents the authors' personal opinion and does not necessarily reflect the view of the Deutsche Bundesbank or its staff. Detailed results and descriptions of methodology are available on request from the authors. Address for correspondence: Jens Mehrhoff, Statistics Department, Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main, Germany, Tel: +49 69 9566-3417, Fax: +49 69 9566-2941, E-mail: jens.mehrhoff@bundesbank.de, Homepage: www.bundesbank.de. Paper prepared for the 2010 Annual Congress of the Verein für Socialpolitik in Kiel, 7-10 September 2010.

1 Introduction

In the course of the revision of the *Export and Import Price Index Manual* (IMF, 2008) a discussion arose as to whether or not customs-based unit values could be considered surrogates for survey-based prices in foreign trade statistics. The common view in the literature is that they should not be used due to their quantity structure dependence (UN, 1993). Empirical studies, which reveal substantial biases, support this view (Silver, 2009). Furthermore, the use of unit values could mislead economic interpretation (Bradley, 2004). Hence, Eurostat has recently started calculating a euro-area import price index to capture imported inflation (see EC, 2005).

Germany is one of the few countries in the fortunate position of being able to provide both price and unit value indices. The main empirical differences between these indices will be related to their respective conceptual and methodological characteristics. The impact on economic indicators, *viz* imported inflation, terms of trade and gross domestic product, will be quantified. With real time data it has been shown that the use of different data could lead to different economic policy decisions (Orphanides, 2001). This is all the more relevant, given the appreciation of the euro and the importance of foreign trade for the German economy.[1]

Unit value indices are a free by-product of customs controls.[2] This explains their wide international use, unlike genuine price indices. But they can differ considerably from genuine price indices meaning that unit value indices are subject

[1]The euro has gained approx. 25% against the US dollar in the last two years and is rising steadily. The balance of exports and imports of goods in 2007 amounts to over €200 billion and therefore, accounts for more than 8.5% of gross domestic product.

[2]In the European Union, intra-Community trade is captured directly from the enterprises unlike trade with third countries.

to a severe bias. Despite their widespread use, the nature of this bias is still not well understood. At the elementary level, *ie* before aggregating, the bias can be traced back to the covariance of prices and quantity relatives (Párniczky, 1974). At the aggregate level no such interpretation has yet been provided. Therefore, the aim of this paper is to derive a formal theory in order to quantify the sources of the unit value bias at the aggregate level.

The paper is organised as follows. Section 2 defines the notion and shows the differences of the indices with respect to the concepts. Section 3 summarises some empirical findings and their implications. These will be discussed by introducing a formal theory, which allows an empirical decomposition of the sources of the differences in the indices, in Section 4. Section 5 concludes.

2 Conceptual and methodological differences

The present paper does not deal with the so-called cost of living index and the economic theory of index numbers (Diewert, 1995). The focus is on calculating indicators of price movements in foreign trade, measuring the cost of goods, rather than the cost of utility/output preservation.

Definition 1 (Price Index) *Let p_{kj_kt} denote prices, q_{kj_kt} quantities and $v_{kj_kt} = p_{kj_kt} \cdot q_{kj_kt}$ values for the $j_k{}^{th}$ good in the k^{th} group of goods at time t. Then the Laspeyres price index is defined as the arithmetic average of price relatives with base period expenditure weights,*

$$P^L = \sum_{k=1}^{K} \sum_{j_k=1}^{n_k} \frac{p_{kj_kt}}{p_{kj_k0}} \cdot \frac{v_{kj_k0}}{\sum_{k=1}^{K} \sum_{j_k=1}^{n_k} v_{kj_k0}} = \frac{\sum_{k=1}^{K} \sum_{j_k=1}^{n_k} p_{kj_kt} \cdot q_{kj_k0}}{\sum_{k=1}^{K} \sum_{j_k=1}^{n_k} p_{kj_k0} \cdot q_{kj_k0}}. \qquad (1)$$

The unit value index should be distinguished from another index, unfortunately also known as "unit value index", but better referred to as Drobisch index.

Definition 2 (Drobisch Index) *Let* $Q_{kt} = \sum_{j_k=1}^{n_k} q_{kj_kt}$ *denote the sum of quantities of the* k^{th} *group of goods and* $V_{kt} = \sum_{j_k=1}^{n_k} v_{kj_kt}$ *the corresponding sum of values at time* t*. Then unit values for the* k^{th} *group of goods are derived as*

$$\tilde{p}_{kt} = \frac{V_{kt}}{Q_{kt}} = \frac{\sum_{j_k=1}^{n_k} v_{kj_kt}}{\sum_{j_k=1}^{n_k} q_{kj_kt}}. \tag{2}$$

Note that the summation takes place over j_k *only and not over* k*. If values and quantities were summated over all* K *groups of goods, the ratio of these "unit values" at time* t *and* 0*,* $\tilde{p}_t / \tilde{p}_0$*, would be the Drobisch index, defined as follows:*

$$P^D = \frac{V_t / Q_t}{V_0 / Q_0} = \frac{\sum_{k=1}^{K} V_{kt} / \sum_{k=1}^{K} Q_{kt}}{\sum_{k=1}^{K} V_{k0} / \sum_{k=1}^{K} Q_{k0}}. \tag{3}$$

This index is not considered here as it is of theoretical interest only, if at all. It cannot be compiled in practice but it is not infrequent for the Drobisch index to be mistaken for the unit value index (Balk, 1998). In such an index a total quantity covering all groups of goods, Q_t and Q_0, respectively, would be required. However, unlike total quantities for the k^{th} group of homogeneous goods, such a grand total for all K groups is not generally defined due to the absence of a common unit of measurement. One simply cannot add weights in kilograms, quantities in pieces and so on. Even if the unit of measurement is identical it is important that the summation makes sense economically (apples and oranges).[3]

[3]Glatzer *et al.* (2006) state that import prices in Austria amount to about €20 per kilogram. It sounds rather strange if unit values as such are an object of interest, as electric current for instance is measured in 1,000 kilowatt hours and not in kilograms.

Table 1: Conceptual differences between price and unit value indices

Conceptual characteristic	Price index	Unit value index	Expected effect
Weighting scheme	Laspeyres concept, genuine prices and constant base period weights (pure price comparison)	Paasche concept, unit values and updated current period weights (deflation)	Laspeyres price index greater than Paasche unit value index. Quantity structure dependence of the unit value index.
Survey method	Representative sample (10,000 price quotations per month)	Nearly exhaustive (15-20 million transactions per month)	Representative image of population of goods traded in unit value index but aggregation bias due to less homogeneous groups of goods.
Data recording	Fixed basket (price representatives)	Actually traded goods in ever-changing composition	Unit value index both more volatile and reflective of seasonal fluctuations.
Price measurement	Contract conclusion (establishment survey)	Border crossing (customs data)	Lead of the price index due to earlier recording of prices.
Quality adjustment	Yes, *inter alia* hedonic methods	None at all	Quality changes reflected in the quantity dimension rather than in the price dimension. Time series of price index smoother.

Definition 3 (Unit Value Index) *The Paasche unit value index is the harmonic average of unit value relatives with current period expenditure weights,*

$$\tilde{P}^P = \left(\sum_{k=1}^{K} \left(\frac{\tilde{p}_{kt}}{\tilde{p}_{k0}} \right)^{-1} \cdot \frac{V_{kt}}{\sum_{k=1}^{K} V_{kt}} \right)^{-1} = \frac{\sum_{k=1}^{K} \tilde{p}_{kt} \cdot Q_{kt}}{\sum_{k=1}^{K} \tilde{p}_{k0} \cdot Q_{kt}}. \tag{4}$$

Besides differing index formulae, there are conceptual differences in the practice of official price and unit value indices. Table 1 lists some of the most important ones and their hypothetical consequences. Prices are comparable over different periods in time as ideally the same good is observed (*panel structure*) but quantities are lacking (Pötzsch, 2004).[4] This is called the principle of pure price comparison (von der Lippe, 2007). Unlike prices, unit values do not strictly comply with this principle because they reflect the constantly changing universe of observed goods (*repeated cross sections*), which means goods cannot be matched over time (Blang, 2002).

3 Empirical findings

3.1 Differences in time series

For the reasons mentioned above, the time series of price and unit value indices differ remarkably. For a first graphical interpretation the *not* seasonally adjusted time series of price and unit value indices are drawn on the logarithmic scale in Figure 1 from January 2000 to December 2007 for exports and imports with base

[4] In fact, in practice a similar strategy is applied to the price index as to the unit value index. As price relatives and their respective weights are not observable for every single good traded, a Carli index ($\frac{1}{n_k} \cdot \sum_{j_k=1}^{n_k} p_{kj_kt} / p_{kj_k0}$) is calculated at the elementary level in Germany. Hence, the index compiled is a two-staged index with a sample Laspeyres index at the elementary level and base period expenditure weights at the aggregate level.

year 2000 = 100.[5] The data set comprises $T = 96$ observations of monthly data. The influence of the conceptual differences is quantified in the following.[6]

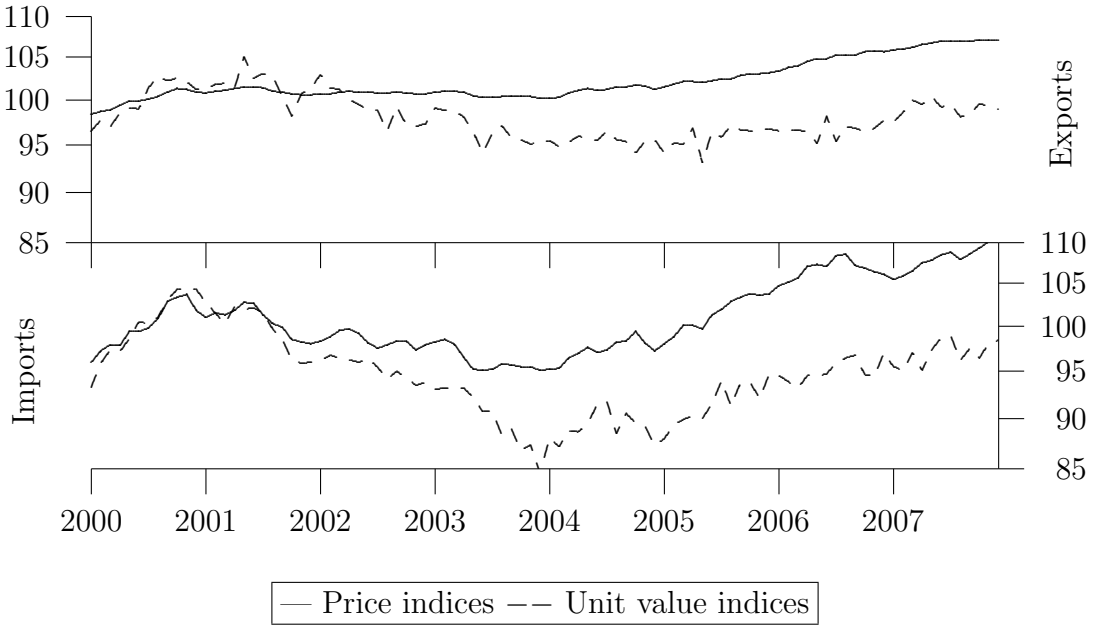

Figure 1: Time series of price and unit value indices

Discrepancy Over time, the gap between price and unit value index widens, with the unit value index being lower than the price index. This effect is stronger for imports than for exports. Theil's inequality coefficients of annual growth rates illustrate that the movement of the indices is far from synchronous. For exports, the coefficient is 0.55, the bias proportion to the mean squared error is more than 20%, the variance proportion is about 50%. The remainder is the covariance proportion, which measures unsystematic errors. For imports, the figures are 0.32, 35% and 20%, respectively.

[5]From 2005 onwards unit value indices are based on the year 2005 = 100. For the sake of comparability the indices are rebased to the year 2000 = 100.

[6]Detailed descriptions of the following results are given in Appendix A.1.

Volatility It is particularly noteworthy that unit value indices are more volatile than price indices. This is due to the fact that they also reflect structural changes. To account for a possible instationarity of the time series, a Hodrick-Prescott filter with smoothing parameter $\lambda = 14,400$ is applied. For unit value indices, the root mean squared error, here error means deviation, to their Hodrick-Prescott trend series is one and a half (imports) to three times (exports) higher than for price indices. Imports are more volatile than exports for both types of indices.

Seasonality By the same token, unit value indices reflect seasonality much more. Seasonal adjustment with the X-12-ARIMA method allows the standard deviation of the seasonal component to be calculated to indicate the magnitude of seasonality the indices are exposed to. Results are very close to those for the volatility of the indices. Seasonality is higher for unit value than for price indices and greater for imports than for exports, both roughly of the same magnitude as volatility.

Heterogeneity The degree of heterogeneity of groups of goods is another source of empirical differences between the indices. It is conjectured that a unit value sub-index differs more from the aggregate index than the corresponding price sub-index if the division in question is less homogeneous. Based on disaggregated data of a commodity classification (double-digit units of the German *Product Classification for Production Statistics 2002*), the root of the mean R^2 between the overall index and its (up to) 31 sub-indices has been calculated.[7] The results show a higher degree of homogeneity for the price index than for the unit value index especially for exports. Possibly a lower level of aggregation might deliver clearer results.

[7]Data for this analysis were only available up to the end of 2006.

Lead Prices are recorded earlier than unit values, leading to the hypothesis that the price index' annual growth rate is a sound leading indicator for the unit value index' one. Although to some degree correlations increase and root mean squared errors decrease by shifting the price index one month forward compared to contemporary indices, the pattern is neither sufficiently pronounced nor are correlations and root mean squared errors systematically improved. Therefore, the assumption turned to be untenable. Price indices' movements are worse forecasters of unit value indices' ones than the *naïve*, same change one-month forecasts, despite the higher volatility of unit value indices.

Quality adjustment The assumption that quality adjustment will result in smoother price movements could be verified because the Federal Statistical Office carried out a special analysis of its import price data on data processing goods, *viz* desktops, notebooks, working storage and hard disks, from January 2003 to January 2006. Volatility, in terms of the coefficient of variation, of the price index' monthly growth rates was reduced substantially, in the order of a half to a sixth, by quality adjustments. However, these goods might not be representative of the effect of quality adjustment on other goods in foreign trade.

3.2 Consequences for imported inflation, terms of trade and gross domestic product

For the following analyses the annual growth rates of the aforementioned indicators are calculated using either the price or unit value index.[8]

[8] With not seasonally adjusted data it is common to use annual rather than monthly or quarterly growth rates. The time series of annual growth rates are compared graphically in Appendix A.2.

Imported inflation Import prices influence domestic inflation *via* a simple transmission mechanism. Rising prices for imported goods lead to higher costs for producers. Then, if the price elasticity of final demand is low, as in the case of crude oil products for instance, this cost increase is passed on to consumers. Eventually, consumer prices rise as well. Identification of cost push inflation (like imported inflation) as opposed to demand pull inflation is crucial for central banks. The resulting inflation rates for imports vary enormously. The inflation rates judged by the unit value index are, on average, one and a half percentage points lower than those gauged by the price index. As a result, the unit value index may be systematically underestimating the contribution to inflationary pressures. However, the measurement of inflation only comprehends domestic goods, not foreign ones. In addition, the sign of inflation rates depending on which of the two indices was used was different in about 5% of cases.

Terms of trade Commodity terms of trade are defined as the ratio of export to import prices of goods. They reflect a real exchange relationship, *ie* how many foreign goods could be bought with one unit of domestic goods. If import prices rise faster than export prices, less foreign goods can be bought for the same unit of domestic goods. Hence, the terms of trade worsen. As long as the Marshall-Lerner condition holds, this scenario leads to an increase in the real balance of exports and imports and thus real gross domestic product.[9] As a result of the greater drop in the import than the export unit value index, terms of trade changes based on unit value indices are on average half a percentage point higher than those

[9]The Marshall-Lerner condition states that for the worsening of the terms of trade to have a positive effect on the current account (normal reaction), in particular the trade balance, the sum of absolute price elasticities of demand for exports and imports must be greater than one.

based on price indices. In over 20% of cases the sign of month-on-month changes differed between the two indices. Unit value indices appear to draw too optimistic a picture of trade power.

Gross domestic product Real gross domestic product is the most important economic indicator and is associated with the growth and wealth of an economy. It measures the domestic market value added of all goods and services produced.[10] In contrast to monthly price indices with a fixed base year, real gross domestic product is a quarterly chain index.[11] For deflation purposes, monthly indices are averaged over a quarter, and the balance of exports and imports of goods (*not* services) is deflated with either the price or unit value index. Unit value indices as deflators lead to lower growth rates of real gross domestic product, on average by one-tenth of a percentage point. The sign of growth rates depending on which of the two indices was used was unequal in more than 5% of cases. It can be concluded that, as for imported inflation and terms of trade, unit value indices understate true economic development.

4 Decomposition of discrepancy

4.1 Formal theory

The formal theory is built upon the fact that the value index V is the product of the Paasche price index P^P and the Laspeyres quantity index Q^L, as well as of

[10] Gross domestic product is the sum of the expenditure components consumption, gross investment, government spending, and the balance of exports and imports.
[11] Chaining is performed with the annual overlap technique, *cf* von der Lippe (2001).

the corresponding unit value indices, $\tilde{P}^P$ and $\tilde{Q}^L$, respectively.[12]

$$V = P^P \cdot Q^L = \tilde{P}^P \cdot \tilde{Q}^L \tag{5}$$

One might be tempted to explain the fact that, as a rule, unit value indices fall short of the corresponding prices indices with a formula found by von Bortkiewicz (1923), according to which the covariance C between price and quantity relatives is given by

$$C = V - P^L \cdot Q^L = Q^L \cdot \left(P^P - P^L\right). \tag{6}$$

Whenever the covariance is negative, the Paasche formula yields lower values than the Laspeyres formula. It is often said that the Laspeyres formula tends to overrate the price movement, much as the Paasche formula underrates it, which is referred to as the Laspeyres effect L.

$$L := \frac{P^P}{P^L} = \frac{C}{P^L \cdot Q^L} + 1 \tag{7}$$

It should be borne in mind that the comparison in question is not between the Paasche *price index* and the Laspeyres price index but between the Paasche *unit value index* and the Laspeyres price index. Under such conditions a second component of the discrepancy comes into play, which may well reinforce but could also counteract the Laspeyres effect. This factor is called structual component S and refers to changing quantity structures.

[12] The missing definitions are $V = \frac{\sum_{k=1}^{K}\sum_{j_k=1}^{n_k} p_{kj_kt}\cdot q_{kj_kt}}{\sum_{k=1}^{K}\sum_{j_k=1}^{n_k} p_{kj_k0}\cdot q_{kj_k0}} = \frac{\sum_{k=1}^{K}\tilde{p}_{kt}\cdot Q_{kt}}{\sum_{k=1}^{K}\tilde{p}_{k0}\cdot Q_{k0}}$,
$P^P = \frac{\sum_{k=1}^{K}\sum_{j_k=1}^{n_k} p_{kj_kt}\cdot q_{kj_kt}}{\sum_{k=1}^{K}\sum_{j_k=1}^{n_k} p_{kj_k0}\cdot q_{kj_kt}}$, $Q^L = \frac{\sum_{k=1}^{K}\sum_{j_k=1}^{n_k} p_{kj_k0}\cdot q_{kj_kt}}{\sum_{k=1}^{K}\sum_{j_k=1}^{n_k} p_{kj_k0}\cdot q_{kj_k0}}$ and $\tilde{Q}^L = \frac{\sum_{k=1}^{K}\tilde{p}_{k0}\cdot Q_{kt}}{\sum_{k=1}^{K}\tilde{p}_{k0}\cdot Q_{k0}}$.

$$S := \frac{\tilde{P}^P}{P^P} = \frac{Q^L}{\tilde{Q}^L} \tag{8}$$

Both effects show up in the discrepancy D between the Paasche unit value index and the Laspeyres price index.

$$D := L \cdot S = \frac{\tilde{P}^P}{P^L} = \left(\frac{C}{P^L \cdot Q^L} + 1 \right) \cdot \frac{Q^L}{\tilde{Q}^L} \tag{9}$$

Therefore, their interaction, as visualised in Figure 2, must be studied to analyse the discrepancy.

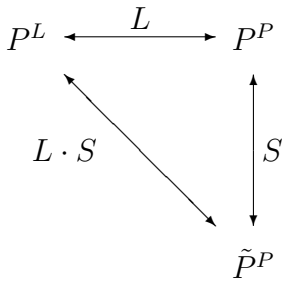

Figure 2: Interaction of L and S effect

Moreover, both effects can contribute either negatively or positively to the discrepancy, which gives rise to the idea of a contingency table, shown in Table 2, and the question of which of the quadrants is more likely. These are arranged as in a coordinate system so that one can draw a time path of both effects against each other.

Table 2: Contingency table of L and S effect

	$L < 1$	$L > 1$
$S > 1$	2^{nd} quadrant: L and S partially cancel each other out so that D is indeterminate	1^{st} quadrant: D is unequivocally greater than one as L and S mutually reinforce
$S < 1$	3^{rd} quadrant: L and S act in unison towards D less than one	4^{th} quadrant: a negative S effect can offset a positive L effect, D is indefinite

4.2 Data analysis

In addition to the aforementioned indices, Laspeyres price index P^L and Paasche unit value index $\tilde{P}^P$, the Federal Statistical Office calculates an implicit national account deflator, or to put it another way a Paasche price index P^P, on a quarterly basis. This allows an empirical decomposition of the components of the discrepancy. To this end, monthly indices are averaged over a quarter. Figure 3 depicts natural logarithms of the discrepancy and both effects, approximately reflecting the discrepancy in per cent and contributions to it in percentage points, respectively.[13] The Laspeyres effect is significantly negative. Over time this effect becomes larger, so that it accounts for about five percentage points of the discrepancy for exports and about ten for imports. Apart from the beginning of the time series, the structural component amplifies the discrepancy. It is much more erratic than the Laspeyres effect, which was to be expected given the nature of quantity structure dependence. Its influence on the discrepancy is roughly of the same size as the Laspeyres effect, except for the recent past. In terms of the scheme in Table 2, at the beginning the situation is as described in the second

[13]This follows from taking natural logarithms of Equation (9), $\ln D = \ln L + \ln S \approx \tilde{P}^P/P^L - 1$.

quadrant, with outliers in the first and fourth quadrant. But after a short time, the third quadrant persistently dominates.[14]

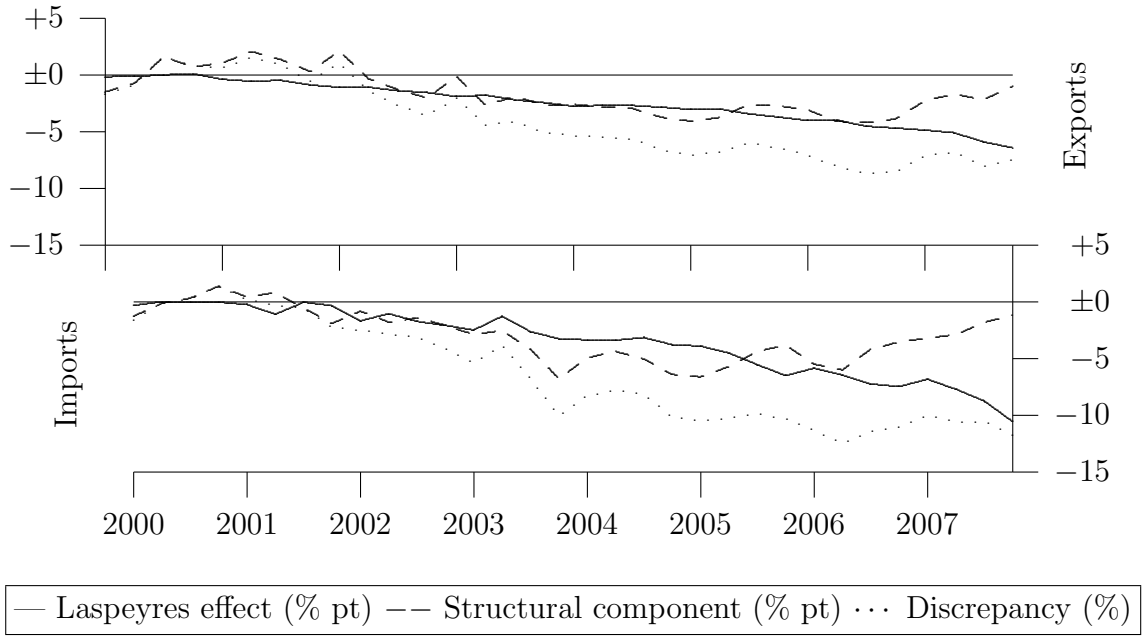

Figure 3: Decomposition of discrepancy between price and unit value indices

By assuming a two goods model, one can examine L and S in isolation. *Ceteris paribus*, *ie* if the budget is fixed, a price increase of one good yields substitution to the other, relatively cheaper one. The substitution effect is the reason for the negative Laspeyres effect or $C < 0$. This is a well-known phenomenon, although its dimension has not been quantified until now. However, the price increase has an income effect as well: real income declines. This might counteract the positive substitution effect on the relatively cheaper good, so that less units of both goods are bought. This is mirrored by the structural component, the substantial innovation in this analysis, which is much less familiar.

[14] Appendix B includes graphs showing the time paths of the Laspeyres effect and structural component.

By writing S out, the source of the negative structural component becomes apparent. Note that prices of period t do not appear in S.

$$S = \frac{\sum_{k=1}^{K} \sum_{j_k=1}^{n_k} p_{kj_k0} \cdot q_{kj_kt}}{\sum_{k=1}^{K} \sum_{j_k=1}^{n_k} p_{kj_k0} \cdot q_{kj_k0} \cdot \frac{\sum_{j_k=1}^{n_k} q_{kj_kt}}{\sum_{j_k=1}^{n_k} q_{kj_k0}}} \tag{10}$$

For the structural component to be negative, *ie* $S < 1$, changes in the quantity of relatively expensive goods have to be disproportionately small, *ie* their quantities have to decline more and increase less, respectively. In turn, changes in the quantity of relatively cheap goods have to be disproportionately large. This follows from the weights assigned to base period prices in Equation (10) and the fact that disproportionately small changes in the quantity necessarily also imply disproportionately large ones. To reiterate, the structural component is independent of price changes and therefore the explanation of this effect works without recourse to current period prices.

$$\tilde{P}^P < P^P \iff \frac{q_{kj_kt}}{q_{kj_k0}} < \frac{\sum_{j_k=1}^{n_k} q_{kj_kt}}{\sum_{j_k=1}^{n_k} q_{kj_k0}},\ p_{kj_k0} \text{ relatively high} \tag{11}$$

For the two goods model a graphical interpretation in terms of microeconomics can be presented. C_0 and C_t are the budget constraints, I_0 and I_t the isoquants in Figure 4. Considering the L and S effect simultaneously, a price increase of good A entails a reduction in real income. Although the price for good A rises, the intensity q_A/q_B increases as the use of the relatively expensive good B falls disproportionately as laid out in Equation (11). Quantity shares of the – in period 0 – relatively expensive good B shifted to the – in period 0 – relatively *cheap* good A, even though the former became relatively *cheaper* in period t.

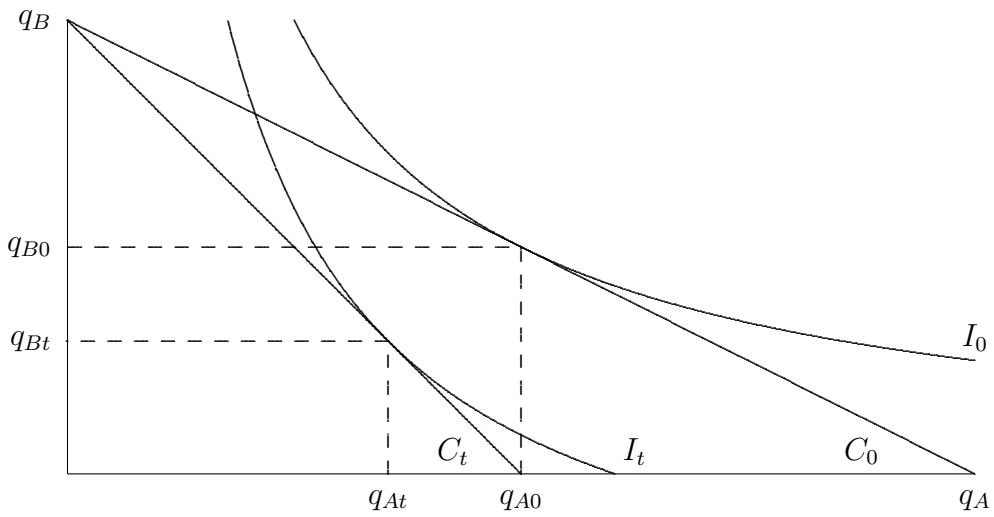

Figure 4: New optimal use of goods after an isolated price increase

5 Conclusion

Prices are among the most important business cycle indicators. The current discussion on monetary policy and inflationary pressures underlines their importance. Hence, it seemed to be worthwhile to examine the method statistical agencies use to calculate price indices.

In particular, foreign trade prices have a threefold effect on other indicators, which was quantified. Domestic inflation is affected *via* the import prices of goods. Commodity terms of trade as a measure of trade power alike are influenced. Lastly, the real trade balance of goods and thus real gross domestic product depends on the deflator. It was shown that the choice of the index formula has a significant effect on all three indicators due to the drop in unit value indices.

As the impact of the formula chosen is so momentous for economic policy making, a formal theory was developed. It allows the price and unit value index concepts, which are in place in Germany now to be compared. Empirical data

analysis revealed the sources of the discrepancy between these concepts. An economic interpretation was given to explain a Laspeyres effect as well as a structural component, constituting the observed unit value bias. Evidence was found for both negative substitution and income effects in foreign trade.

It is an open question why and how these effects arise at the micro level. Presumably, generally increasing prices create a preference for lower priced goods or even benefit low wage countries in the course of globalisation.

References

Balk, B. (1998), "On the Use of Unit Value Indices as Consumer Price Subindices", *Proceedings of the Fourth Meeting of the International Working Group on Price Indices*, Washington DC, 22-24 April 1998.

Blang, D. (2002), "Neuberechnung von Außenhandelsvolumen und -indizes auf Basis 2000", *Wirtschaft und Statistik*, July 2002, pp 575-584.

von Bortkiewicz, L. (1923), "Zweck und Struktur einer Preisindexzahl", *Nordisk Statistisk Tidskrift*, Vol 2, pp 369-408.

Bradley, R. (2004), "Pitfalls of Using Unit Values as a Price Measure or Price Index", *Journal of Economic and Social Measurement*, Vol 30, pp 39-61.

Diewert, E. (1995), "Axiomatic and Economic Approaches to Elementary Price Indexes", *NBER Working Paper*, No 5104.

European Commission (2005), "Regulation (EC) No 1158/2005 of the European Parliament and of the Council of 6 July 2005 amending Council Regulation (EC) No 1165/98 concerning short-term statistics", *Official Journal of the European Union*, L191, pp 1-15.

Glatzer, E., Gnan, E., Valderrama, M. (2006), "Globalisierung und ihre Auswirkungen auf Import- und Erzeugerpreise in Österreich", *Geldpolitik & Wirtschaft*, Q3/06, pp 28-49.

International Monetary Fund (2008), *Export and Import Price Index Manual*, http://www.imf.org/external/np/sta/tegeipi/index.htm, 10 April 2008.

von der Lippe, P. (2001), *Chain Indices – A Study in Price Index Theory*, Statistisches Bundesamt, Wiesbaden.

von der Lippe, P. (2007), *Index Theory and Price Statistics*, Lang, Frankfurt.

Orphanides, A. (2001), "Monetary Policy Rules Based on Real Time Data", *American Economic Review*, Vol 91, pp 964-985.

Párniczky, G. (1974), "Some Problems of Price Measurement in External Trade Statistics", *Acta Oeconomica*, Vol 12, pp 229-240.

Pötzsch, K. (2004), "Die Indizes der Außenhandelspreise auf Basis 2000", *Wirtschaft und Statistik*, May 2004, pp 511-524.

Silver, M. (2009), "Do Unit Value Export, Import, and Terms of Trade Indices Represent or Misrepresent Price Indices?", *IMF Staff Papers*, Vol 56, pp 297-322.

United Nations (1993), *System of National Accounts*, United Nations, New York.

A Empirical findings

A.1 Differences in time series

Table 3: Discrepancy

	Exports	Imports
Theil's inequality coefficient (U)	0.55	0.32
Root mean squared error ($RMSE$)	2.23%	2.54%
MSE bias proportion	21.11%	34.28%
MSE variance proportion	47.70%	19.15%
MSE covariance proportion	31.20%	46.57%

$$U := \frac{\sqrt{\sum_{t=1}^{T}\left(\Delta P^{L} - \Delta \tilde{P}^{P}\right)^{2} \Big/ T}}{\sqrt{\sum_{t=1}^{T}\left(\Delta P^{L}\right)^{2} \Big/ T} + \sqrt{\sum_{t=1}^{T}\left(\Delta \tilde{P}^{P}\right)^{2} \Big/ T}}, 0 \leq U \leq 1$$

Table 4: Volatility

	Exports	Imports
$RMSE$: Price indices (PI)	0.45	1.55
$RMSE$: Unit value indices (UVI)	1.40	2.12

Table 5: Seasonality

	Exports	Imports
Standard deviation: PI	0.11	0.30
Standard deviation: UVI	0.37	0.55

Table 6: Heterogeneity

	Exports	Imports
Root of the mean R^2: PI	0.58	0.38
Root of the mean R^2: UVI	0.30	0.31

Table 7: Lead

	Exports	Imports
ρ: contemporary	0.72	0.90
ρ: one-month lead	0.73	0.90
ρ: *naïve* one-month	0.74	0.90
$RMSE$: contemporary	2.24%	2.56%
$RMSE$: one-month lead	2.22%	2.53%
$RMSE$: *naïve* one-month	1.87%	1.94%

Table 8: Quality adjustment

		W/o QA		W/ QA	
	n	$\overline{\Delta P^L}$	CV	$\overline{\Delta P^L}$	CV
Desktops	84	−0.907%	5.013	−2.169%	1.925
Notebooks	186	−1.319%	3.287	−2.125%	1.744
Working storage	190	−0.888%	12.171	−2.322%	2.122
Hard disks	100	−1.585%	4.502	−2.684%	1.727

A.2 Consequences for imported imported inflation, terms of trade and gross domestic product

Table 9: Consequences

	Imported inflation	Terms of trade	Gross domestic product
Observations	84	84	28
Mean	−1.49% pt	+0.50% pt	−0.07% pt
Median	−1.61% pt	+0.31% pt	±0.00% pt
Standard deviation	2.07% pt	2.15% pt	0.51% pt
Minimum	−6.95% pt	−3.71% pt	−1.20% pt
Maximum	+4.87% pt	+6.05% pt	+0.80% pt
Number of unequal signs	4	17	2

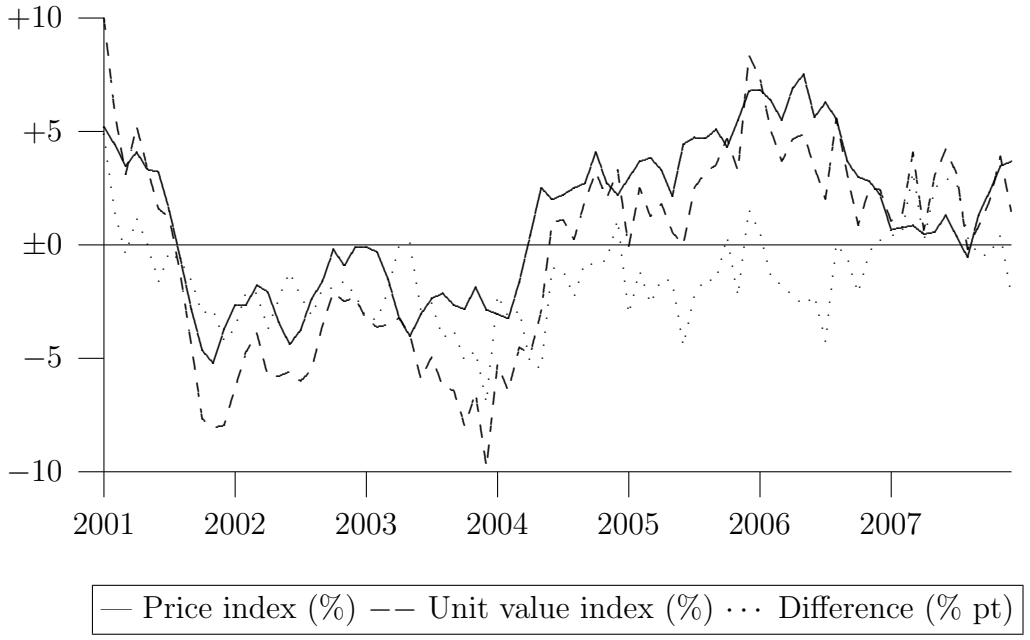

Figure 5: Inflation rates of imports

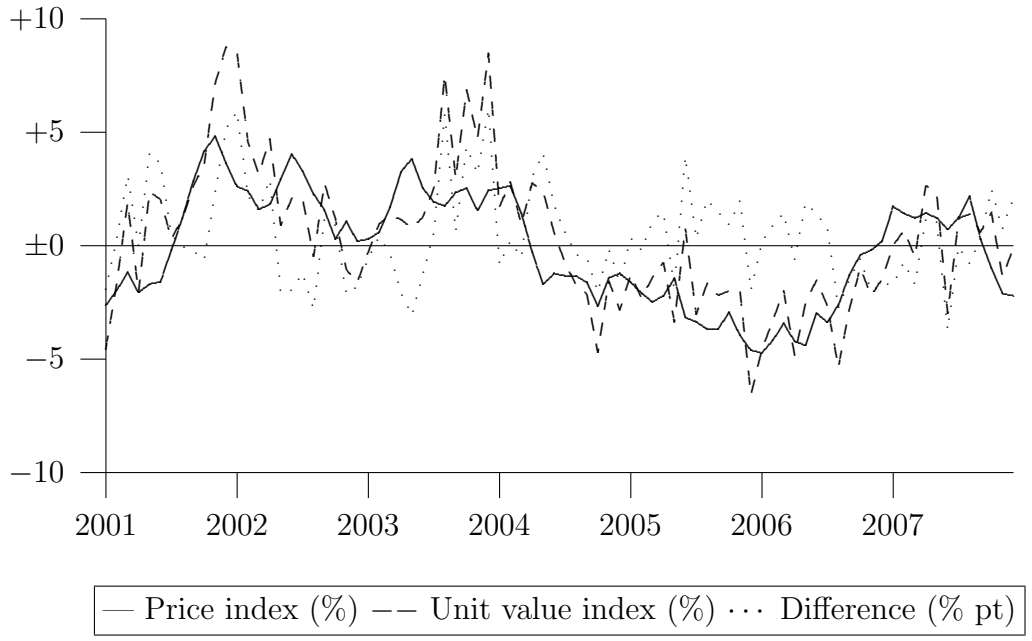

Figure 6: Month-on-month changes of commodity terms of trade

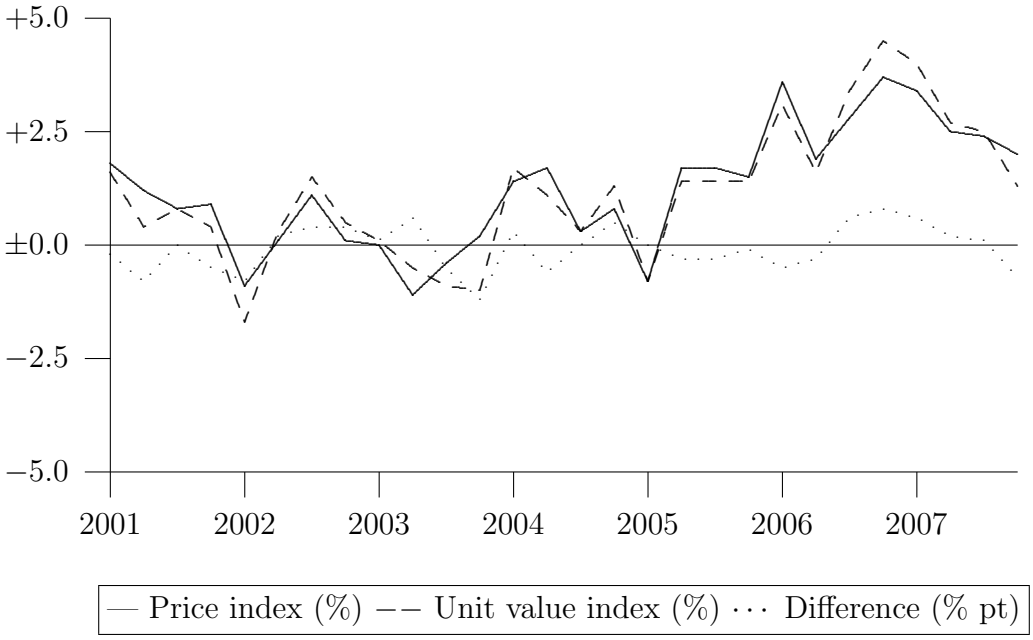

Figure 7: Growth rates of real gross domestic product

B Decomposition of discrepancy

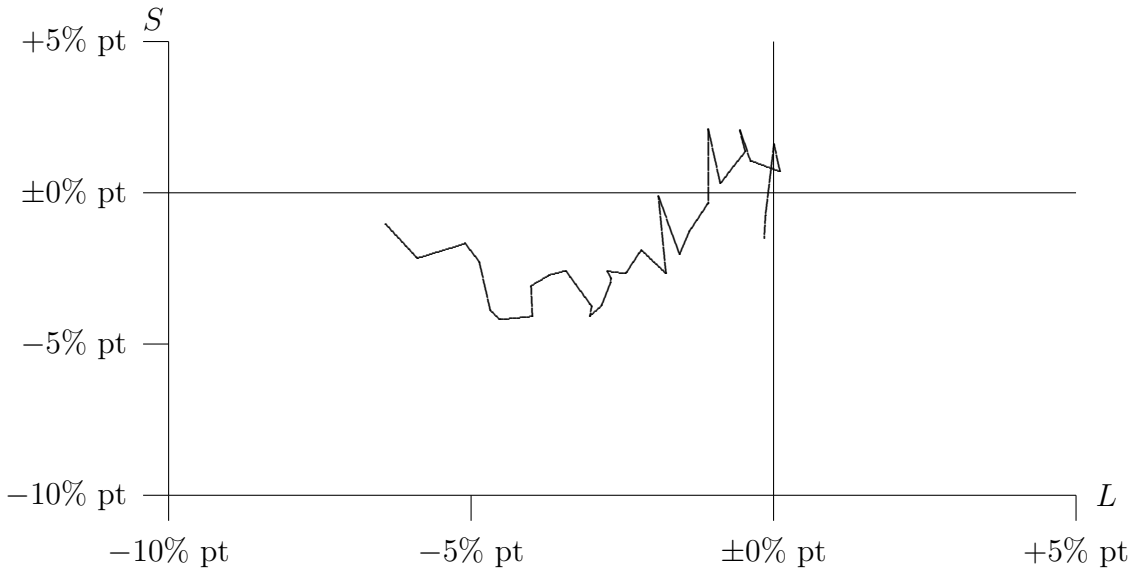

Figure 8: Time paths of L and S effect for exports

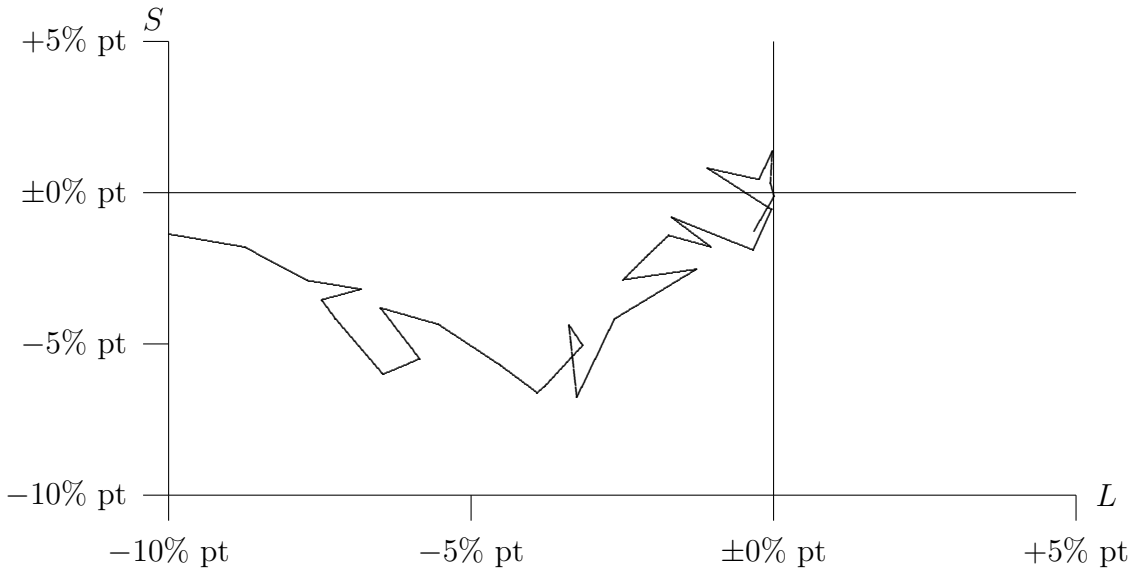

Figure 9: Time paths of L and S effect for imports