

The euro-dollar exchange rate and Dutch imports and exports

09

Oscar Lemmers and Mark Vancauteren

The views expressed in this paper are those of the author(s)
and do not necessarily reflect the policies of Statistics Netherlands

Discussion paper (09028)



Explanation of symbols

.	= data not available
*	= provisional figure
x	= publication prohibited (confidential figure)
–	= nil or less than half of unit concerned
–	= (between two figures) inclusive
0 (0,0)	= less than half of unit concerned
blank	= not applicable
2007–2008	= 2007 to 2008 inclusive
2007/2008	= average of 2007 up to and including 2008
2007/'08	= crop year, financial year, school year etc. beginning in 2007 and ending in 2008
2005/'06–2007/'08	= crop year, financial year, etc. 2005/'06 to 2007/'08 inclusive

Due to rounding, some totals may not correspond with the sum of the separate figures.

Publisher
Statistics Netherlands
Henri Faasdreef 312
2492 JP The Hague

Prepress
Statistics Netherlands - Grafimedia

Cover
TelDesign, Rotterdam

Information
Telephone +31 88 570 70 70
Telefax +31 70 337 59 94
Via contact form: www.cbs.nl/information

Where to order
E-mail: verkoop@cbs.nl
Telefax +31 45 570 62 68

Internet
www.cbs.nl

ISSN: 1572-0314

© Statistics Netherlands, The Hague/Heerlen, 2009.
Reproduction is permitted. 'Statistics Netherlands' must be quoted as source.

The euro-dollar exchange rate and Dutch imports and exports¹

Oscar Lemmers and Mark Vancauteren

Abstract

This empirical paper shows that a 10% higher euro (with respect to the US dollar) reduces the volume of Dutch exports of goods with 1.8%. The effects of a changing exchange rate on the volume of Dutch imports were negligible. The time series analysis, which takes into account factors such as demand, supply and prices, shows that these effects did not change significantly during the quarterly periods (q) 1978q1-2007q3. We also consider the effects of the exchange rate on re-exports and exports of Dutch products for the period 1996q1-2007q3. If the depreciation of the dollar was 10 percent point higher than in the preceding quarter, the volume of re-exports slowed down by 2.9% in the next quarter. The effects on the volume of exports of Dutch products were negligible.

Keywords: imports, exports, re-exports, exchange rate

1. Introduction

At the end of 2007, the euro appreciated quickly with respect to the dollar and subsequently depreciated again starting in August 2008. An appreciation of the euro with respect to the dollar makes Dutch products more expensive compared to those of the United States and other countries that pegged the exchange rate of their valuta to the dollar. Hence, exports are expected to decline. On the other hand, products from the United States become less expensive for Dutch buyers, hence the imports are expected to rise. Can these theoretical predictions also be validated empirically? And if changes of the exchange rate indeed affect the trade flows, what is the size of these effects?

This paper answers the following question:

What were the effects of a changing euro-dollar exchange rate on Dutch imports and exports of goods?

Approximately 20% of the Dutch GDP in 2004 was accounted for by exports of goods and energy (Mellens et al. (2007)). It is important to know the determinants of this important source of income and to know the size of their influence. Of course not only the exchange rate determines international trade, but factors such as demand, supply, domestic prices and world market prices are also important.

Given that only 5% of Dutch exports are destined for the United States, and only 8% of Dutch imports arrived from the United States, how is it possible, that Dutch

¹ The authors thank Bertrand Melenberg (Tilburg University), Eelke Wiersma, Gert-Jan Linders (both Free University Amsterdam), Marjolijn Jaarsma, Jasper Roos and Pascal Ramaekers (all Statistics Netherlands) for their comments on earlier versions of this paper. The remarks of the participants of the workshop “Research on Globalization by Statistics Netherlands”, where this research was presented, were also warmly welcomed. All errors that may have remained are on behalf of the authors.

exports and imports are possibly sensitive for changes of the euro-dollar exchange rate? A study of the Netherlands Bureau for Economic Policy Analysis (CPB, Central Economic Plan, 2004) mentions a few reasons why Dutch exports might be sensitive for the euro-dollar exchange rate:

- Many countries peg their valuta (completely or partially) to the dollar. When the dollar drops, their valuta drop as well and products from the Euro zone become more expensive.
- Dutch export firms compete worldwide, not only in the dollar area. For instance, a German firm will be inclined to buy American products rather than Dutch products when the dollar is low.
- Because other euro countries export less with a weak dollar, their economic growth slows down and hence they import fewer goods for consumption and intermediate products (which otherwise would have been used in the production process of an export good) from the Netherlands.

In addition, not only exports to the United States but also to other countries are often paid in US dollars. According to a report issued by the CBS (Rutten, 2007), it is shown that in the first quarter of 2006, one third of imports and one tenth of exports were paid in dollars while the remaining imports and exports were mostly paid in euros.

Similar arguments show that Dutch imports might be sensitive for changes in the exchange rate as well.

In the literature the following variables, which might influence the volume of imports and exports, often appear: GDP, import prices and export prices, domestic prices, world market prices and the exchange rate. The last variable can be put in the model as a nominal rate, or as real rate (nominal rate adjusted for the inflation of the country itself and of the most important trading partners).

Warner and Kreinin (1983) studied the impact of exchange rates on international trade of many countries, including the Netherlands, during the period 1972-1978. Their results differ per country and per flow. They concluded that for the period 1972-1978 the exchange rate for half of the countries did not have any influence on the imports, but did influence the exports of most of the countries. The exchange rate had a strong influence on Dutch imports and exports. Wang and Ji (2006) concluded that the Chinese Yuan did not have any influence on the imports or exports of China during the period 1986-2003. Aydin et al. (2004) studied the Turkish situation from 1987 up to 2003. Their conclusion was that the exchange rate influenced imports, but not exports.

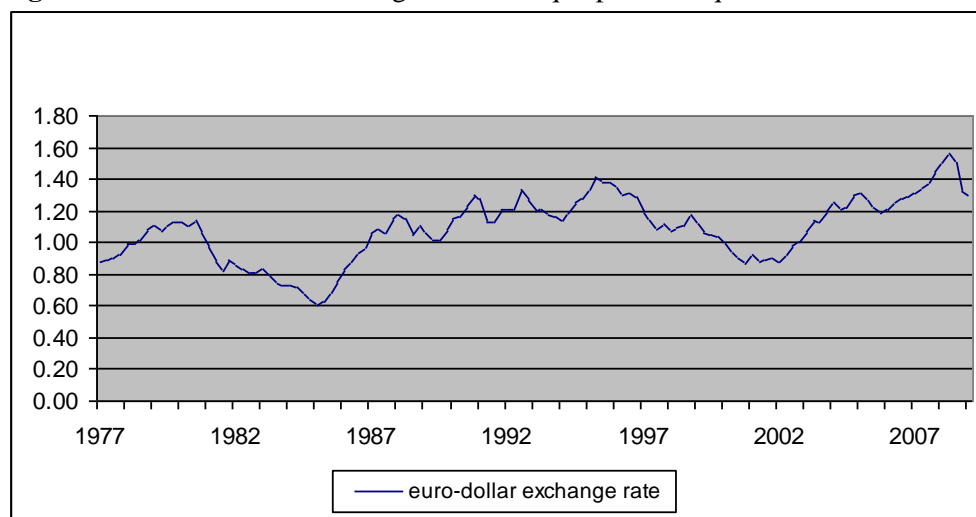
The CPB regularly publishes uncertainty scenarios such as “If the euro is 10 dollar cent higher next year than in our current projection, then exports will be 0.3% lower than the current prediction.” (CEP 2007). However, the CPB does not make any statements about the past. For prognoses as the one above the CPB uses an error correction model (see for example Engle and Granger, 1987), that among others, contains the relevant world trade, the price of domestically produced fabricates and the price of competing exports. This model is part of the macro econometrical model SAFFIER (see Kranendonk and Verbruggen, 2006), which the CPB uses for analyses and projections on short and medium term.

In this study, we consider the Dutch situation, using a long time series that also contains recent data. Based on econometrical analysis, we consider the influences of the euro-dollar exchange rate and other variables that might influence Dutch exports and imports. We estimate four equations: total imports, total exports, re-exports and

exports of products made in the Netherlands for different time frames. The paper also considers whether economic changes such as the introduction of the euro caused structural changes or that the influence of the exchange rate was constant during the years.

Before continuing with the econometrical analysis, it is useful to describe the evolution of the nominal euro-dollar exchange rate. Figure I shows this exchange rate from 1977 up to the first quarter of 2009. Up to 2001, the guilder-dollar rate was converted to the euro-dollar rate. The appreciation of the dollar during the period 1981-1985 was caused by a strong American fiscal policy during the Reagan period. In September 1985 the countries of the G5 concluded the Plaza agreement (see e.g. Krugman and Obstfeld, 2003), where a depreciation of the dollar was agreed. As we can see from the figure, the dollar depreciation lasted up to 1988. Then the Louvre agreement settled that the mutual exchange rates for G5-valuta would be kept within a fixed band width. The euro-dollar rate remained relatively stable up to 1995. Starting with 1996 up to 2002, we see a clear appreciation of the dollar with respect to the euro. During this period the economical growth in the United States was strong. From 2002 up to the second quarter of 2008 we see an appreciation of the euro versus the dollar. The cause of this trend is an aggressive American monetary policy supporting the American economy. This led to a greater supply of US dollars which resulted into a dollar depreciation. Starting in August 2008, the dollar appreciated against the euro.

Figure I. The euro-dollar exchange rate, 1977q1 up to 2009q1²



Source: Federal Reserve Bank of New York

2. Method

In this section we describe the equations that were used to derive the econometrical estimates. These equations are used to model total Dutch imports and exports for the period 1978q1 up to 2007q3. In section V we apply a variant of the export equation on both re-exports and exports of Dutch products.

A model with exchange rates and trade flows, without other variables, is too simplistic. Other factors, such as the economic situation in the Netherlands and that

² The guilder-dollar rate for 1977 up to 2001 was converted to a euro-dollar rate. From 1983 the Dutch guilder was pegged to the German mark.

in the rest of the world, influence Dutch exports as well. After a thorough investigation of the literature (see the Introduction for some references), variables that *might* influence the trade flows were put into the model.

Demand and supply

The volume of Dutch GDP and the production volume of the industrial countries are measures for the volume of demand and supply. The higher the Dutch GDP, the higher the demand for goods and the supply of goods, both nationally as internationally (imports and exports). The same goes for the production volume of the industrial countries.

Prices

Besides the volumes of demand and supply, prices of demand and supply play an important part as well. Dutch import- and export prices represent prices that the Dutch are willing to pay or ask on the international market. Similarly, the Dutch consumer price and the world export price represent the price level on the Dutch domestic market and the world market, respectively.

We use the gravity model of Tinbergen (1962), the Dutch winner of the Nobel Prize for economy. However, the model we use here does not contain the customary *logarithm*, but the *growth*³ of the variables. We will explain why later in this paper. The gravity model shows that the sizes of the economies of two areas promote mutual trade and that larger distances between them, for example price distance, constrain trade. If country A becomes more expensive with respect to country B, the import of goods from country B by country A will rise, but the exports of goods from country A to country B will decline.

The model for the growth of the import volume (omitting time subscripts):

$$M = \alpha_1 + \beta_1 \text{GDP} + \beta_2 \text{prod_i} + \beta_3 \text{CPI} + \beta_4 \text{Pr_i} + \beta_5 \text{rate} + \varepsilon \quad (1)$$

The model for the growth of the export volume (again omitting time subscripts):

$$X = \alpha_2 + \gamma_1 \text{GDP} + \gamma_2 \text{prod_i} + \gamma_3 \text{Pr_e_w} + \gamma_4 \text{Pr_e} + \gamma_5 \text{rate} + \varepsilon \quad (2)$$

The time-series models quantify the influence of a variable by estimating the matching constant β_i or γ_i . These can be interpreted as elasticities. An example: when the exchange rate is 1% higher, the import volume is β_5 % higher (ceteris paribus).

The variables in (1) and (2) are defined as the growth of respectively:

- M, the volume of Dutch imports
- X, the volume of Dutch exports
- GDP, the volume of the general domestic product of the Netherlands
- Prod_i, the production volume of the industrial countries
- Pr_e_w, the world export price, also a proxy for international inflation
- Pr_e, export price of the Netherlands
- Pr_i, import price of the Netherlands

³ For example, $X = \frac{X_t - X_{t-4}}{X_{t-4}}$, where t is a quarter

- CPI, the consumer price index of the Netherlands
- Rate, the nominal euro-dollar exchange rate

Both models contain the *growth* of every variable with respect to the same quarter of a year before. It is not possible to put the *level* (or the logarithm of the level) in the model. We explain why. An important assumption while applying a linear regression model is that the variables are stationary. Variables in a standard regression model, where the observations are independent, usually fulfill this condition. However, in a time series, where two successive observations are always highly correlated, the *level* of the variable will not always fulfill the stationary condition. For example, the Dutch GDP, the volume of the exports and the consumer price index all grow during time. Therefore, these variables do not fulfil the stationary condition.

Granger and Newbold (1974) showed that a linear regression model with two non-stationary variables can lead to the wrong conclusion, namely that there is a relation between the variables even though this is not the case. To circumvent the problem of non-stationary variables, we use the *growth* of the aforementioned variables. The growth in a given quarter with respect to the same quarter a year before is generally stationary. Also, the quarterly growth of a variable has the advantage that it is season independent, whereas the level of the same variable is not. The appendix contains for every growth variable the result of the augmented Dickey-Fuller test for stationarity. Apart from the growth of the CPI, all growth variables were stationary.

Besides the models mentioned here, other models were considered as well. These contained several time lags for the explaining variables, and other variables such as the growth of the producer price index. These models did not lead to substantially different conclusions as far as the influence of a change in the exchange rate was concerned.

3. Data

The data sources were the Federal Reserve Bank of New York, the Organization for Economic Cooperation and Development (OECD) and the International Monetary Fund (IMF). The data are on a quarterly basis, starting in the first quarter of 1977 and ending in the third quarter of 2007. The Federal Reserve Bank provided the nominal exchange rate (dollar per euro), the OECD the Dutch consumer price index (CPI), the IMF provided the other data: volume of Dutch exports, imports and GDP, production volume of the industrial countries and the export price of the Netherlands and the world.

These data are, except for the exchange rate, in the form of an index. Because the model contains the *growth* of the variables, it is not a problem that not all indices have the same base year. Besides for data for the CPI, the OECD was also the source for the values of the index for the Dutch GDP in 1998 as well, because the IMF-data for that year were negligent.⁴ The volume of the world income (world GDP) is not available. Following Bahmani-Oskooee and Niroomand (1998), we use the

⁴ The IMF-series for the GDP in the last quarter of 1997 up to the first quarter of 1999 was 88, 102, 103, 104, 104 and 95. The OECD-data for the GDP in 1997 and 1999 were very similar to the IMF-data for these years, hence the replacement of the 1998 IMF data by the OECD data seems reasonable.

production volume of the industrial countries (see the appendix for a list with countries) as a proxy.

4. Results

This section contains, besides a description of the data, the estimates of the aforementioned econometric models.

Table I and II show that especially in the model of imports many of the explaining variables are strongly correlated. Even though, the models did not have any problems with multicollinearity. The mean variance inflation factor (vif) was 2.07 in the model of imports while the highest vif was 2.64 (for the variable import price). The mean vif was 3.89 in the model of exports, here the highest vif was 7.28 (for the variable rate). The rule of thumb in literature (see for example Kutner et al., 2004) is that only in the case of a vif above 10 a correction for multicollinearity is necessary.

Table I. For every growth variable the mean (in percent), standard deviation and correlations⁵ with other variables in the import model, based on 119 observations during the period 1978q1-2007q3

	Mean	sd	(1)	(2)	(3)	(4)	(5)	(6)
(1) imports	4.8	4.9	1					
(2) GDP	2.4	1.8	0.51***	1				
(3) prod_i	2.1	2.8	0.55***	0.56***	1			
(4) CPI	2.6	2.7	-0.56***	-0.42***	-0.39***	1		
(5) import price	1.5	7.5	-0.28**	0.07	0.20	0.51***	1	
(6) exchange rate	2.1	12.8	0.26*	-0.06	0.01	-0.42***	-0.66***	1

Table II. For every growth variable the mean (in percent), standard deviation and correlations with other variables in the export model, based on 119 observations during the period 1978q1-2007q3

	Mean	sd	(1)	(2)	(3)	(4)	(5)	(6)
(1) exports	5.1	4.2	1					
(2) GDP	2.4	1.8	0.40***	1				
(3) prod_i	2.1	2.8	0.56***	0.56***	1			
(4) export price	1.7	6.8	-0.06	0.01	0.15	1		
(5) export price_w	3.0	7.5	0.02	-0.10	0.20	0.06	1	
(6) exchange rate	2.1	12.8	-0.03	-0.06	0.01	-0.63***	0.64***	1

The results of estimating the equations for imports and exports are shown in table III. All variables have the expected sign. The coefficients of the production volume and the prices of imports and exports are all significant. From the results it also follows that the volumes of imports and exports are not sensitive for the CPI and the world export price, respectively.

⁵ Here and in the following tables ***, **, * stand for statistically significant on the 1%, 5% or 10% level respectively. While calculating the significance for correlations, always a Bonferroni-correction was made to adjust for making many comparisons.

Table III. Estimates for the coefficients in the models (the α_i , β_i and γ_i) and the matching t-values (based on Newey-West standard errors), for the period 1978q1-2007q3

	Volume of imports Coefficient (t-value)	Volume of exports Coefficient (t-value)
GDP	0.66 (1.98)*	0.28 (1.58)
Prod_i	0.75 (4.98)***	0.77 (4.44)***
Import price CPI	-0.20 (-1.91)*	
Export price		-0.31 (-2.60) **
Export price_w		0.18 (1.49)
Exchange rate	0.01 (0.11)	-0.18 (-1.99) **
Constant	0.03 (1.60)	0.03 (5.43) ***
N	119	119
F	13.12***	15.71***
R ²	0.52	0.39

It turns out that only the exports are sensitive for changes of the exchange rate. A 1% higher euro yields a 0.01% higher import volume (*ceteris paribus*). The 95% confidence interval for the exchange rate is (-0.09, 0.10). Therefore, the exchange rate elasticity of the import volume is not statistically different from zero.

A 1% higher euro resulted into a 0.18% lower volume of exports (*ceteris paribus*). The 95% confidence interval for the exchange rate elasticity is (-0.3635, -0.0005). Therefore, the exchange rate elasticity of the export volume is just statistically different from zero on the 5% level. This derived elasticity is equal to the elasticity in a scenario of the CPB (Kranendonk and Verbruggen, 2006, p. 58). However, these results cannot be compared properly. The CPB uses a completely different model, also because its goal is to make a projection while the goal of this model is to look back on the past thirty years.

The residuals were normally distributed in both models. We corrected for autocorrelation and heteroskedasticity of the error-term by using the method of Newey and West (1987), with lag length 8. Another solution for the problem of autocorrelation would be a dynamic model, by adding a lagged variable of the dependent variable to the model. However, this method did not have any effect on the exchange rate elasticity.

Does the exchange rate elasticity change during the years?

An important (and disputed) economical hypothesis is the decoupling theory; see e.g. the IMF World Economic Outlook of April 2007. This theory states that the European economy is coupled to its American counterpart, but that this dependence is decreasing more and more. This is caused by the success of other economies, such as the Chinese economy, which are advancing more and more. If Dutch foreign trade in the past reacted more (or in the opposite way, less) on the growth of the euro-dollar exchange rate, this gives further prove (or another counter argument, respectively) for this decoupling hypothesis.

One of the assumptions in the time series model is that the derived coefficients are constant through time. In reality these coefficients might change during the years. Therefore it was studied whether there were any structural changes in the coefficients. This question is not unimportant because structural breaks may be

connected to certain policy regimes (such as the introduction of the Euro) that have occurred. This might change the structure of the econometric models. At first, we pinpoint structural breaks that are visible in the data. Afterwards, we study whether the introduction of the Euro lead to a structural change of the trade flows.

Three graphical methods were used in order to derive these possible structural breaks: the CUSUM-test (cumulative sum, see e.g. Cameron, 2005), the CUSUMSQ-test (cumulative sum of squares, see e.g. Cameron, 2005) and the Quandt-test (Quandt, 1958).

The CUSUM-test functions in the following way: from the coefficients based on data up to $t-1$, a prediction for the dependent variable on time t is derived. This yields a residual. The CUSUM-test considers the cumulative sum of these residuals (after standardization). If the prediction errors are random, then they will cancel out against each other, hence their cumulative sum will remain within certain bounds. In a graph it becomes clearly visible whether this is the case or not. The CUSUMSQ-test functions in a similar way.

The Quandt-test functions in the following way: for every t the data consists of two groups: the observations up to time t and the observations starting from time $t+1$. Accordingly, we estimate the regressions for these two sub periods and substitute the results in an expression derived by Quandt. The time t that this expression attains the maximum is the maximum likelihood estimate for the moment in time that the first regression equation passes into the second one. This indicates that there might be a break point at that moment in time.

Table IV. Exchange rate elasticity per sub period of 1978q1-2007q3, level of significance based on Newey-West standard errors

Period	Volume of imports	Volume of exports
	Coefficient (t-value)	Coefficient (t-value)
1978q1-1986q2	0.04 (0.58)	-0.11 (-0.72)
1986q3-1994q4	-0.05 (-1.10)	-0.11 (-1.17)
1995q1-2007q3		-0.05 (-0.20)
1995q1-2001q4	0.25 (5.13)***	
2002q1-2007q3	-0.11 (-1.28)	
1978q1-2007q3	0.01 (0.11)	-0.18 (-1.99)**

The tests show that during the period 1978q1-2007q3 four different sub periods can be identified for the imports and three for the exports. The first two periods, 1978q1-1986q2 and 1986q3-1994q4, for the imports and exports coincide.

Table IV shows that during the sub period 1995q1-2001q4 a 1% less expensive dollar caused a 0.25% higher import volume. In addition it can be seen that only one coefficient for a sub period is statistically significant different from 0. A possible reason is that a sub period consists of fewer observations than the whole period, hence the uncertainty margins will be larger. The exchange rate elasticities for the exports are closer to 0 in every sub period than they are in the whole period, but this remains within the uncertainty margins.

An alternative model explicitly allows for the exchange rate elasticity of the imports or exports to change non-linearly through time. Here a third degree model was chosen. It does not only contain the term $\gamma \cdot \text{rate}$, but the term $(\gamma_1 + \gamma_2 \cdot \text{time} + \gamma_3 \cdot \text{time}^2 + \gamma_4 \cdot \text{time}^3) \cdot \text{rate}$. The third degree model is used more often (see e.g. Kort et al., 2008), because it is far more flexible than a linear or quadratic model. The result of this model is that the export growth reacted in a constant way to changes of the exchange rate from 1978 up to 1982. Afterwards, the growth of the exports became more insensitive, to react stronger to changes of the exchange rate starting from 2002. In this alternative model the exchange rate elasticity of the imports decreases from 1978 up to 1985, and steadily increases afterwards. From 2000 it decreases again. There are large margins around the estimates, hence it is impossible to draw any firm conclusions about a possible change of the exchange rate elasticity during the years.

Did the introduction of the euro affect Dutch external trade?

In 2002 the euro was introduced as a legal tender in 12 EU-countries, among them the Netherlands. Starting from 1999, the mutual exchange rates between each of these countries' currency were already pegged against the euro. After the introduction of the euro, firms saved on transaction costs. Furthermore, they did not have to seek coverage against valuta risks anymore, another saving on the transaction costs. Therefore, trading became less expensive, hence it was expected that trade would grow even more.

Period I	Period II	Period III
Up to 1998	1999 up to 2001	Starting from 2002
no fixed exchange rates no euro	fixed exchange rates no euro	euro

Three comparisons between periods were made:

1. Between period I and II, before and after the introduction of fixed exchange rates for valuta of the euro countries
2. Between period II and III, before and after the introduction of the euro (in 2002)
3. Between period I and III, before 1999, when no fixed exchange rates nor the euro existed, and starting from 2002, when this was the case

The time series models show that the growth rate of the exports, after adjustment for the growth of the exchange rate, the growth of the Dutch GDP and so on and so on, did not differ much between the periods. Chow-tests show that this growth rate and also the exchange rate elasticity for each of the three comparisons above statistically do not differ between the first and the second period. The uncertainty margins are larger than the observed effects. Hence, it is impossible to make any firm conclusions about a time changing influence of the exchange rate on the exports of the Netherlands.

5. Are exports of Dutch products more sensitive to changes of the exchange rate than re-exports?

In 2008, Dutch exports consisted for approximately 55 percent of exports of Dutch products, and for 45 percent of exports of goods that were earlier imported, the so called re-exports. From the literature, which is more extensively discussed below, it follows that re-exports usually are less sensitive for fluctuations of the exchange rate than exports of domestically produced goods. Here we study whether this prediction also holds for the Dutch situation. Ideally, we would also make a separate analysis of the imports for production and consumption in the Netherlands and the imports for re-export. Unfortunately, the necessary information about the import prices of goods that are to be re-exported is missing.

Dees (2001), Kusters and Verbruggen (2001) and Abeyasinghe and Yeok (1998) all conclude that products with a high import component, such as re-exports, are more sensitive for fluctuations of the exchange rate than domestically produced goods. Dees states that imports of intermediate goods and services are delivered against a world market price, which also determines the price of re-exports. If these world market prices are expressed in American dollars, the euro-dollar exchange rate has no influence at all on the re-exports. Because for re-exports the purchasing value and the selling value *measured in dollars* remains the same. However, for exports of Dutch products, the largest part of the production costs was made in the Netherlands. A depreciation of the euro with respect to the dollar leads to a decrease of production costs expressed in dollars, which improves the international competing position.

Dees showed that the exchange rate elasticity (to be precise: the real exchange rate elasticity) of the Chinese export volume strongly differed for “processing trade” and “ordinary trade” during the period 1994 up to 1999. Here “processing trade” are the exports of goods that were produced with raw materials, parts and/or components which were imported earlier in order to be processed or assembled and subsequently exported. Thus, these goods contain a very high import component. The import component of goods in the remaining category, “ordinary trade”, is far lower. Dees found values of 0.15 and 0.48 for respectively the real exchange rate elasticity of “processing trade” and “ordinary trade”.

Abeyasinghe and Yeok (1998) studied the influence of the terms of trade (a proxy for the real exchange rate) on the exports of Singapore during the period 1975-1992. They showed that the larger the import content in the export of products, the smaller the influence of the trade of terms. They found a negligible influence of the trade of terms on re-exports (with a nearly complete import content) but a large influence on the exports of services (with almost no import content). The Singaporean situation differs from the Dutch one because Singapore has its own valuta and the Netherlands do not have that anymore. For products with low import contents (such as services) an appreciation of the Singaporean dollar causes a deterioration of the Singaporean competing position with respect to the rest of the world. On the other hand, an appreciation of the euro only causes a worsening of the Dutch competing position with respect to countries that do not belong to the euro zone. Therefore, it is conjectured that the influence of the exchange rate is larger on goods produced in Singapore than on goods produced in the Netherlands.

We use another variant of the gravity model for re-exports and exports of Dutch products. Now, the model does not contain volume and price of Dutch exports, but volumes and prices of exports of Dutch products and re-exports. The growth of most variables is not stationary, see table X in the appendix, which contains the results of the augmented Dickey-Fuller test for stationarity. As we explained earlier, a

standard regression model with non-stationary variables is not possible. Therefore the model does not contain the *growth*, but the *acceleration* of some variables: the growth in a given quarter minus the growth in the preceding quarter⁶. The acceleration of a variable is denoted by Δ . The fit of the models was much better when the acceleration of the depreciation in the preceding quarter (denoted by $L\Delta rate$) was put into the model instead of the acceleration of the depreciation.

The model for the growth of the export volume of Dutch products (DPV):

$$DPV = \alpha_1 + \beta_1 \Delta GDP + \beta_2 Prod_i + \beta_3 \Delta Pr_e_w + \beta_4 \Delta Pr_dpv + \beta_5 L\Delta rate + \varepsilon \quad (3)$$

The model for the growth of the Dutch re-export volume (DRV):

$$DRV = \alpha_2 + \gamma_1 \Delta GDP + \gamma_2 Prod_i + \gamma_3 \Delta Pr_e_w + \gamma_4 \Delta Pr_drv + \gamma_5 L\Delta rate + \varepsilon \quad (4)$$

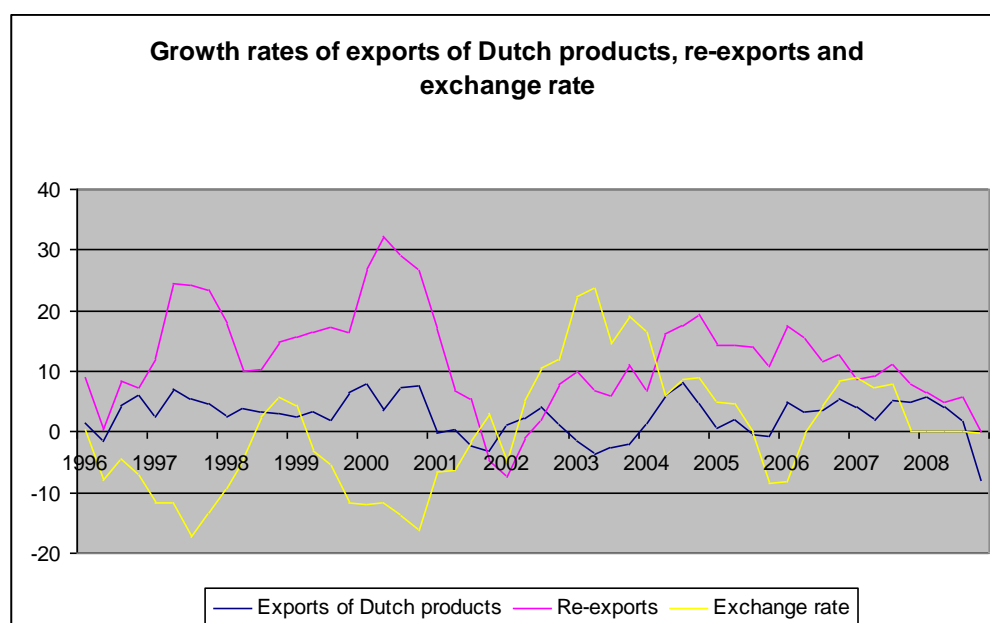
The data used covers the period 1996q1 up to 2007q3 (the third quarter of 2007). Data concerning the Netherlands, namely GDP, price and volume of exports of Dutch products and re-exports, are now supplied by Statistics Netherlands. Other data, namely world production, world export price and exchange rate, again are supplied by the IMF and the Federal Reserve Bank.

The appendix contains tables that describe the data in the two models. These tables contain for every growth variable the number of observations, the mean (in percent), the standard deviation and correlations with other variables in the relevant model.

Before we turn to the results, figure II shows the evolution of changes of the exports of Dutch products, re-exports and the euro-dollar exchange rate. The slopes in this figure can be interpreted as accelerations. An acceleration of the exchange rate can be interpreted as a faster depreciation or appreciation of the dollar versus the euro. The growth rate of exports of Dutch products has, contrary to the growth of re-exports, not changed much between 1996 and 2008. Around 2002, a period of low conjuncture, the three growth rates more or less coincided. Then the growth rates were negative.

⁶ For example $\Delta GDP_t = \frac{GDP_t - GDP_{t-4}}{GDP_{t-4}} - \frac{GDP_{t-1} - GDP_{t-5}}{GDP_{t-5}}$

Figure II. Growth rates of exports of Dutch products, re-exports and exchange rate, 1996 up to 2008



Source: Statistics Netherlands and adaptation of data Federal Reserve Bank

The results of the estimation of the models (3) and (4) are given in table V. The coefficients of the production volume of the industrial countries are strongly significant. An acceleration of the growth of the exchange rate in the preceding quarter has no influence on the exports of Dutch product. However, it plays a part for re-exports. When the growth rate of the exchange rate accelerates by 1 percent point, the volume of the re-exports decreases by 0.29 percent in the next quarter. This result is almost significant on the 5% level.

Table V. Estimates for the coefficients in the models and the matching t-values (based on Newey-West standard errors), for the period 1996q1-2007q3

	Volume exports Dutch products	Volume re-exports	Volume total Dutch exports
	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)
Δ GDP	-0.27 (-0.60)	-1.74 (-1.13)	-0.84 (-1.12)
Prod _i	0.70 (4.92) ***	2.50 (6.67) ***	1.42 (9.58) ***
Δ Export price	0.15 (1.20)	-0.86 (-1.67)	-0.28 (-1.51)
Δ Export price _w	-0.02 (-0.10)	-0.63 (-2.03) **	-0.22 (-1.27)
L Δ rate	-0.02 (-0.35)	-0.29 (-1.99) *	-0.16 (-2.10) **
Constant	1.37 (2.22) **	8.13 (6.44) ***	4.10 (6.72) ***
N	45	45	45
F	7.10 ***	15.76 ***	45.38 ***
R ²	0.44	0.66	0.70

In both models the residuals were normally distributed. Correction for autocorrelation and heteroskedasticity of the error-term took place by using the method of Newey and West (1987), with lag length 4. In the model for exports of Dutch products the highest variance inflation factor (vif) was equal to 1.47, in the model for re-exports the highest vif was 1.32. That is far below the 10 that is considered allowable.

6. Discussion

Changes of the euro-dollar exchange rate do not have any effects on Dutch imports, but they do on exports. The first is in contradiction with the theory (see e.g. the Mundell-Fleming model that describes small, open economies such as the Netherlands, Mundell (1962) and Fleming (1962)), which states that a more expensive euro would cause higher imports. After all, approximately one third of Dutch imports are paid for with dollars, and the rest mostly with euros (Rutten, 2007). Still, other empirical studies show as well that this theory is not always confirmed in practice. It is possible that this is caused by the different composition of the product package of imports and exports. For example, the Dutch imports of raw materials, such as crude oil, are far larger than the exports. It is likely that raw materials are less sensitive for the exchange rate than final products, because they are necessary to produce. The demand is therefore more inelastic. For raw materials it is also impossible to use products of lower quality and still achieve the same result in the end. However, many Dutch export products are final products, and for these type of products such substitutions are possible. A smaller car will take you to your destination, a smaller television set has an image as well and confection clothing dresses you just like a custom made suit.

Adding lagged variables does not improve the models for total imports and exports. This confirms the results of Warner and Kreinin (1983), who studied for different countries the sensitivity of imports during the period 1972-1978 to exchange rates and prices. They found that in small, open economies (such as the Netherlands) there were no lagged effects, or at most a small lag length for the exchange rate. Producers and merchants now agree on a price for the goods that will be delivered in the next quarter, but they don't do that based on the *current* exchange rate. They do it based on the *expected* exchange rate. This diminishes the influence of fluctuations of the exchange rate. Another way of protecting themselves against this phenomena, is buying insurance against (large) changes of the exchange rate.

The influence of the Dutch GDP on the exports is not statistically significant. Furthermore, this GDP-elasticity of 0.28 is not that large. This differs from the results of standard gravity models, where the GDP of a country quite often is very significant, with elasticities between 0.5 and 1. The GDP does not properly reflect the level of demand and supply of the Dutch economy, because a relatively large part of the imports and exports consists of re-imports/re-exports. These products are not destined for, or made in, the Dutch domestic market. When the economical situation in the Netherlands is bad, but that of the world is still in good shape, the re-exports will continue to grow. Hence the imports and exports will still continue to grow. Therefore we made a separate analysis for the exports of Dutch products and the re-exports.

Contrary to most countries, in the Netherlands the export price is not an ideal proxy for the production price. This is because a growing part of the goods exported by Dutch firms is not produced locally. In 1995, 33% of the exports consisted of re-exports, in 2007, this share grew to 47%. Because the majority of the costs of re-exports have been made elsewhere, the value added in the Netherlands is relatively

small. Mellens et al. (2007, p. 27) estimated that in 2004 1 euro re-exports contains 9 eurocent added value, whereas 1 euro exported Dutch product contains 61 eurocent added value. It might have been preferable to include the producer prices in the model as well, but the time series on Dutch producer prices was not as long as the other time series.

This paper shows what happens with the *volume growth* of the imports and exports, but it tells nothing about the *margins* and the *profits* of importers and exporters. With a depreciating dollar an exporter is threatened to lose market share, because his products are becoming more expensive with respect to exporters in dollar countries. Therefore he is rapidly inclined to give up part of his profit margins, hoping for better days to come. Anderton (2003) showed that during the period 1989-2001 only 50 up to 70 percent of the changed exchange rate was passed through in the imports of fabricates by the euro zone. In what degree do the Dutch importers and exporters adjust their margins? And how large is the influence on their profits?

Alternative models, which do not much differ from those that were used in this paper, contain the real exchange rate or consider the quarter-on-quarter growth. These analyses were not made. Below we explain why.

The real exchange rate (REER) is the exchange rate with respect to a basket of important valuta, adjusted for inflation. In a formula:

$$\text{REER} = \text{koers} * \frac{\text{CPI}_d}{\text{CPI}_w}$$

Here the CPI_d and CPI_w denote the domestic price level and the world price level, respectively. Warner and Kreinin (1983) note that adding only the *ratio* between domestic price level and world price level to the model has some disadvantages. For example, it assumes that the influence of changes in the domestic price level and the world price level is the same, only opposite: a 1% lower domestic price level would have the same effect on trade as a 1% higher world price level. Therefore, they prefer the specification of the model that is used in this paper, which has the two variables in the model separately. This model quantifies the effect of changes in the nominal exchange rate, the domestic prices and the world prices separately. This also has the advantage that the results are easier to interpret.

The growth in a given quarter with respect to the same quarter a year before represents a medium term effect, whereas the quarter-on-quarter growth would yield information about the short term effect. Unfortunately, the data do not allow making a model with quarter-on-quarter growth. The independent growth variables would then be too strongly correlated. The consequence would be that, because of this multicollinearity, it would be impossible to quantify the influence of each variable separately.

The models for exports of Dutch products and re-exports now contain the acceleration of several variables, what doesn't make interpretation any easier. Alternatives would have been error correction models (ECM) or co-integration. These models cleverly use the existing long term equilibria between the independent variables. That means that first, this long term equilibrium has to be estimated, in order to estimate the eventual model afterwards. The time series available (47 observations) is far too short to do that. For example, Cheung and Lai (1993) note that the often used Johansen test for co-integration needs at least 100 observations to draw reliable conclusions.

The growth of the production by industrial countries (a proxy for the demand for goods in the world) is strongly significant in both models, and has the largest influence in the model for re-exports. De Jong et al. (2008) already indicate that re-exports are more sensitive to the economic situation, because it contains a relatively large share of luxury goods such as computers and consumer electronics, and that consumers especially downsize their expenses on these products when the economic situation is bad.

In the literature (see Dees, who described the Chinese situation, and Abeysinghe and Yeok, who described the Singapore situation), domestically produced exports are more sensitive for fluctuations of the exchange rate than re-exports or another form of exports that consist for a large part of imports. In the Dutch situation we find exactly the opposite. It is possible that this appeared because far different models have been used. In the literature always appear models with the *growth* of the exchange rate, whereas here we were forced to put the *acceleration* of the exchange rate in the model.

It is not clear whether the GDP belongs in the re-exports model, because it is the sum of all goods and services produced in the Netherlands. Therefore, it is not a perfect proxy for the supply by the Netherlands of re-exports products, which have not been made domestically, but were imported earlier. The GDP was added to the re-exports model anyway, to maintain the comparability of this model with the model for exports of Dutch products. The results of the re-exports model without the GDP did not differ much from those of the model that contained the GDP.

7. Conclusions

When the euro was 10% lower (with respect to the dollar), the export volume of goods was 1.8% higher. The effect of a changing exchange rate on the volume of imports was negligible. These effects on the imports and exports did not change significantly during the period 1978q1-2007q3. An acceleration of the depreciation of the dollar during the period 1996q1-2007q3 had almost no effect on the growth of exports of Dutch products, but had negative effects on the growth of the volume of re-exports.

This research can be continued in several ways. We make three suggestions, together with a clarification.

Study the link between exchange rates and trade with different regions

A question that is asked time after time, is whether trade flows to different regions of the world (European Union, United States of America, Asia and so on) react differently on changes of the exchange rate. It is expected that a weaker dollar causes a lower growth of exports to the VS. The theory states that this, because national economies are more and more interwoven by globalisation, would have consequences for the exports of the Netherlands to other countries as well. Because American firms would buy less final products in Germany, German firms would buy fewer intermediates in the Netherlands. If it would turn out that the growth of exports to euro countries such as Germany, Belgium and France decreases when the dollar depreciates, this would support this globalisation hypothesis.

Study the link between exchange rates and trade in different products

It is expected that a change of the exchange rate has different effects on (e.g.) trade in metals than on trade in flowers and flower bulbs. The present paper concentrates on macro level, whereas research on micro level might yield a lot of information.

Which Dutch products, which economic sectors, have a lot, which ones not that much to fear from changes of the exchange rate?

Quantify the extent of exchange rate pass through

Changing exchange rates have effects on the size of Dutch imports and exports. But in what extent are they passed through? What are the consequences on trade margins? When a Dutch merchant completely passes through the higher exchange rate to his American customers, they might switch to another supplier. Therefore, to protect his market share a merchant will often charge his customers only a part of the higher exchange rate. There is extensive literature about this exchange rate pass-through, but not yet about the Dutch situation.

Literature and sources

Abeyasinghe, T. and Yeok, T.L. (1998) Exchange rate appreciation and export competitiveness. The case of Singapore. *Applied Economics* 30, 51-55.

Anderton, B. (2003) Extra-Euro area manufacturing import prices and exchange rate pass-through. ECB working Paper no. 219.

Aydin, F., Ciplak, U. and Yücel, E. (2004) Export Supply and Import Demand Models for the Turkish Economy. The Central Bank of the Republic of Turkey, Research Department Working Paper No 04/09.

Bahmani-Oskooee, M. and Niroomand, F. (1998) Long-run Price Elasticities and the Marshall-Lerner Condition Revisited. *Economics Letters* 61, 101-109.

Cameron, S. (2005), *Econometrics*, McGraw-Hill Education, Berkshire, United Kingdom.

Grote invloed dollar ondanks beperkte afzet op Amerikaanse markt. CEP 2004, p. 81, Centraal Planbureau.

Onzekerheidsvarianten: lagere dollarkoers en sterkere loonstijging. CEP 2007, p. 22, Centraal Planbureau.

Cheung, Y.-W. and Lai K.S. (1993) Finite-sample sizes of Johansen's likelihood ratio tests for cointegration. *Oxford Bulletin of Economics and Statistics* 55, 313-328.

Chow, G. (1960) Tests of Equality between sets of coefficients in two linear regressions. *Econometrica* 28, 591-605.

Dees, S. (2001) The real exchange rate and types of trade. Heterogeneity of Trade Behaviours in China. Paper presented at the workshop on China's economy, CEPIL, Paris.

Engle, R.F. and Granger, C.W.J. (1987) Co-integration and error-correction: representation, estimation and testing. *Econometrica* 55, 251-276.

Federal Reserve, <http://www.federalreserve.gov/RELEASES/H10/hist/>, data extraction on the 16th of December 2008.

Fleming, M. (1962) Domestic financial policies under fixed and floating exchange rates. IMF Staff Papers 9: 369-379.

- Granger, C.W.J. and Newbold, P. (1974) Spurious regressions in econometrics. *Journal of Econometrics* 2, 111-120.
- IMF, International Financial Statistics, data extraction on the 21st of April 2008.
- De Jong, J., Suyker W. and Verbruggen, J.P. (2008) Decemberraming 2008: zwaar weer op komst. CPB Memorandum 209.
- Helbling T. et al. (2007) Decoupling the train? Spillovers and cycles in the global economy. In: IMF World Economic Outlook, April 2007.
- Kort, P., Melenberg, B., Plasmans, J. and Vancauteren M. (2008) Total factor productivity growth and competitive behaviour under variable returns to scale. Mimeo, Tilburg University.
- Kranendonk, H. and Verbruggen, J. (2006) SAFFIER, een 'multi purpose'-model van de Nederlandse economie voor analyses op korte en middellange termijn. CPB Document 123.
- Krugman, P.R. and Obstfeld, M. (2003) International Economics, theory and policy, sixth edition, Addison Wesley.
- Kutner, M.H., Nachtsheim, C.J., and Neter, J. (2004) Applied Linear Regression Models, 4th edition, McGraw-Hill Irwin.
- Mellens, M.C., Noordman H.G.A. and Verbruggen, J.P. (2007) Wederuitvoer: internationale vergelijking en gevolgen voor prestatie-indicatoren. CPB Document 143.
- Mundell, R. (1962) Capital mobility and stabilization policy under fixed and flexible exchange rates. *Canadian Journal of Economic and Political Science* 29, 475-485.
- Newey, W.K. and West, K.D. (1987) A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55, 703-708.
- OESO, Main Economic Indicators, data extraction on the 18th of July 2008.
- Quandt, R.E. (1958) The estimation of the parameters of a linear regression system obeying two separate regimes. *JASA* 53, 873-880.
- Rutten, R. (2007) Project Invoicing Currency NL. Final Report on Grant Agreement 53102.2005.001-2005.752.
- Tinbergen, J. (1962) Shaping the World Economy. New York: The Twentieth Century Fund.
- Wang, J. and Ji, A.G. (2006) Exchange rate sensibility of China's bilateral trade flows. BOFIT Discussion Papers 19.
- Warner, D. and Kreinin, M.E. (1983). Determinants of International Trade Flows. *The review of Economics and Statistics* 65, 96-104.

Appendix

Table VI. The countries, whose production is included in the IMF indicator “production volume industrial countries”

- Australia
- Belgium
- Canada
- Germany
- Denmark
- Finland
- France
- Greece
- Ireland
- Italy
- Japan
- Luxemburg
- The Netherlands
- New Zealand
- Norway
- Austria
- Portugal
- Spain
- United States of America
- United Kingdom
- Sweden
- Switzerland

The next table shows for every growth variable in the models for total imports and exports the results of an augmented Dickey-Fuller test without trend. This tests the null hypothesis that the series are non stationary against the alternative hypothesis that the series are stationary around a mean. The optimal lag length is determined using the Schwarz criterion. The test rejects the null hypothesis for all variables, except for the growth of the CPI. Therefore, these variables are all stationary during the period 1978q1-2007q3.

Table VII. Results of tests for non-stationarity of growth variables in models for imports and exports

	Optimal lag length	Statistics
Imports	1	-3.405***
Exports	4	-2.702***
GDP	5	-2.681***
Prod_i	1	-5.531***
Exchange rate	4	-2.414**
Import price	4	-2.767***
CPI	4	-1.078
Export price	4	-2.642***
Export price world	1	-3.051***

The next tables concern the analysis for exports of Dutch products and re-exports during the period 1996q1-2007q3. Table VIII and IX show for every growth variable the number of observations, mean (in percent), standard deviation and correlations with other variables in the model. Table VIII concerns exports of Dutch products, whereas Table IX concerns re-exports.

Table VIII

	N	Mean	sd	(1)	(2)	(3)	(4)	(5)	(6)
(1) Dutch products	47	2.7	3.1	1					
(2) Δ GDP	46	0.0	0.7	0.05	1				
(3) prod_i	47	2.1	2.6	0.64***	0.23	1			
(4) Δ export price	46	0.1	2.5	0.37	0.23	0.45**	1		
(5) Δ export price_w	46	0.1	2.4	0.05	0.02	0.01	-0.02	1	
(6) L Δ rate	45	0.2	5.4	-0.27	-0.33	-0.33	-0.46**	-0.06	1

Table IX

	N	Mean	sd	(1)	(2)	(3)	(4)	(5)	(6)
(1) re-exports	47	12.8	8.3	1					
(2) Δ GDP	46	0.0	0.7	-0.02	1				
(3) prod_i	47	2.1	2.6	0.75***	0.23	1			
(4) Δ export price	46	0.0	1.5	0.17	0.20	0.38	1		
(5) Δ export price_w	46	0.1	2.4	-0.07	0.02	0.01	-0.30	1	
(6) L Δ rate	45	0.2	5.4	-0.36	-0.33	-0.33	-0.21	-0.06	1

Many variables, such as the growth of the GDP, are stationary during the period 1978-2007, but not during the sub period 1996-2007. As explained before, in this case the acceleration of the growth has been considered. To be precise: the growth in a given quarter minus the growth in the preceding quarter. Table X shows that these accelerations (denoted by " Δ ") are stationary indeed.

Table X. Results of tests for non-stationary growth variables in models for exports of Dutch products and re-exports

	Optimal lag length	Statistics	Optimal lag length (Δ)	Statistics (Δ)
Exports Dutch products	3	-4.166***		
GDP	1	-1.489	1	-3.405**
Prod_i	1	-4.328***		
Export price Dutch products	4	-2.407	3	-5.416***
Export price world	1	-2.018	1	-3.555**
L_exchange rate	4	-2.128	3	-3.213**
Exports re-exports	1	-2.953*		
Export price re-exports	2	-3.411**	1	-3.075*