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Productivity Growth and the Real Appreciation of the Accession Countries' Currencies

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Productivity growth and the real appreciation of the accession countries' currencies

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Abstract

In the process of catch-up growth the Czech Republic, Hungary and Poland have experienced a transition to the production of higher-quality goods. We incorporate this effect in a theoretical model of exchange rates and econometrically estimate its impact on equilibrium real exchange rates. We find support for our hypothesis that productivity increases in industry can be regarded as one source of the observed PPI-based real appreciation of the accession countries' currencies. The productivity gains experienced during economic catch-up occur as higher-quality goods are produced and imply an increased export capacity as well as import substitution. To some extent real appreciation can therefore be viewed as an equilibrium phenomenon.

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1. Introduction

The currencies of the accession countries have been on a path of real appreciation since the initial macroeconomic stabilisation was achieved in the early to mid-nineties. This real appreciation is often interpreted in terms of the catch-up process and the trend increase in non-tradables prices due to the Balassa-Samuelson effect.[1] However, it is not only the real exchange rate based on the consumer price index (CPI) that has appreciated substantially, but also the one calculated on the basis of traded goods. According to standard models the latter implies a loss of competitiveness that will have to be reversed at some point in the future.

This interpretation clashes with the fact that exports of the accession countries have risen in nominal and real terms almost as much as imports and that in some cases the current account deficits have even declined. Although trade integration is surely one reason for this trend in exports and imports, it cannot fully explain why exports increased in spite of the strong real currency appreciation measured in PPI terms. This suggests that there must be a factor of at least equal importance that is causing exports, ceteris paribus, to rise faster than imports.

The article puts forth and empirically tests the proposition that this factor, resulting from catch-up growth, is an increase in the capacity to generate higher export proceeds and at the same time reduce the demand for imported goods. The systemic change and the liberalisation of trade and capital movements laid the basis for growth spurred not only by an increase in volume, but also by a changing composition of GDP and of exports. In particular, the transition countries are catching up in the ability to produce goods of higher quality and technological content, requiring greater input of human capital. This increase in productivity – henceforth also called technological content of goods – results in an appreciation of the real equilibrium exchange rate.

Real convergence involving a change in the composition of GDP entails an increase in the general level of prices in the economy that cannot be interpreted as inflation. This is because goods of higher quality command higher prices without implying a loss of purchasing power. Therefore, despite higher prices, the shift to the production of higher-value-added goods should not be reflected in the price index or in the inflation rate, but rather in real GDP and labour productivity. However, making adjustments in the price indices to account for changes in quality

is fraught with difficulties. To some extent higher prices due to higher value added seem to show up in the inflation measure instead of the growth measure (see appendix). Insofar as price changes are the result of measurement problems and in actual fact mirror productivity increases the concomitant real appreciation is an equilibrium phenomenon. Given correct price measurement and zero inflation from other sources, the real appreciation caused by the increase in productivity during transition should come about through nominal appreciation. However, the transition countries have long been characterised by inflation that stems first and foremost from a stubborn wage-price spiral. The real appreciation hence occurred as nominal exchange rates depreciated less than the inflation differentials vis-à-vis the largest trading partners (EU) would have suggested.

Our article offers an alternative channel to the Balassa-Samuelson effect through which productivity affects the real exchange rate. The small weight of market services in the CPIs of the accession countries (cf. Égert et al. 2003) suggests that the Balassa-Samuelson effect can, at best, explain a small fraction of the observed appreciation of the CPI based real exchange rate; moreover, the Balassa-Samuelson effect can explain only the difference between the development of the CPI- and the PPI-based real exchange rate. To explain the real appreciation we extent a standard model of the current account and the real exchange rate for differences in innovation and test the effect that an increased technological content of goods has on the PPI-based real equilibrium exchange rate. This makes it possible to abstract from increases in the relative price of non-tradables along the lines of the Balassa-Samuelson model, which in themselves have no impact on the economy's competitiveness and the sustainability of the current account position.

The analysis differs from most existing studies of the real exchange rate of transition countries in that the latter concentrate on the impact of increases in non-tradable prices on the real exchange rate (e.g. Coricelli and Jazbec (2001), de Broeck and Slok (2001) as well as Halpern and Wyplosz (2001)).[2] Due to the focus on the PPI-based real exchange rate, our research also differs

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[1] Numerous articles study the importance of the effect for price developments in the transition and accession countries, e.g. Lommatzsch/Tober 2002.

[2] For a recent overview of the growing literature on the real exchange rates of transition and accession countries cf. Égert 2004.

from analyses within the macroeconomic balance framework that test the developments of the CPI-based real exchange rates.[3]

The effect that the productivity increase inherent in the shift to higher-quality goods has on equilibrium exchange rates is addressed in a slightly modified standard model of the current account and the real exchange rate. In what follows we first present the theoretical background of the analysis. In section 3 we turn to the econometric method and the data. Section 4 contains the results and section 5 concludes.

2. Modelling the real exchange rate of the accession countries

It has long been recognised that purchasing power parity (PPP) is a misleading concept for analysing real exchange rate developments of transition countries (Halpern and Wyplosz 1997).[4] Although this assessment is generally based on the view that the countries in the catch-up process experience a trend increase in the relative price of non-tradables, it also holds for the real exchange rate deflated by the PPI, a frequently used proxy for tradables' prices.

Models using the macroeconomic balance approach can incorporate deviations from PPP also for traded goods (Williamson 1994; Stein 1995; Lane and Milletti 2002). The real exchange rate is viewed as being determined by a number of long-term, medium-term and transitory factors, which may vary over time. It follows that the equilibrium real exchange rate may also be time-varying because it is determined by the long- and medium-term factors that move the actual real exchange rate.

The equilibrium exchange rate is defined as the one that simultaneously leads to internal and external balance. Internal balance refers to the labour and goods market. It requires full employment without inflationary pressures. External equilibrium refers to sub-balances of the balance of payments and is derived from the following identity:

$$\text{current account} = -\text{capital account}.$$

[3] For a summary of these studies, cf. Égert 2004.

[4] PPP is also rejected for major currencies, cp. MacDonald (1999) and Stein (1999) as well as the literature cited within.

Long-run equilibrium requires the current account to be balanced, e.g. interest payments on foreign debt must be matched by a trade surplus. If this were not the case, foreign debt would increase continuously. The requirement of a zero current account balance in the long run can be motivated positively through feedback mechanisms between savings and asset markets as in the NATREX approach (Stein 1995, 1999; Stein and Sauernheimer 1996).[5]

The NATREX framework distinguishes between this long-term equilibrium and medium-term equilibrium. The medium-term NATREX is determined by the external macroeconomic balance condition relating the current account to the capital account:[6]

$$(1) \qquad NX - r^* FDEBT = S - I$$

The balance of net exports (trade balance) and net interest payments on foreign debt (or assets) has to equal capital flows as determined by savings-investment decisions.[7] The trade balance is dependent on the real exchange rate (depreciation improving net exports) and the level of GDP that determines the imports. Investment depends on Tobin's q-ratio, relating the productivity of capital to its replacement costs. Savings measured as social savings (private and government savings) equal GDP minus income payments to foreigners and consumption. Private consumption depends on the stock of physical capital producing income flows in line with capital productivity (positively), on the level of foreign debt (negatively) and the time preference of the agents (negatively). An increase in foreign debt reduces wealth (the capital stock plus foreign assets) and thereby raises savings in a dynamically stable system. Hence savings minus investment depends on the fundamentals capital productivity (determining at the same time investment and wealth) and thrift (savings ratio). The real exchange rate is called the medium-term equilibrium exchange rate (NATREX) if it implies that net exports plus net income payments from abroad equal capital flows resulting from investment and savings decisions. Although condition (1) requires that real interest rates have equalised in the two economies, it does not preclude current account deficits. To ensure that debt converges, i.e. that the capital flows which equalise real interest rates do not continue indefinitely, the model furthermore considers the evolution of the capital stock and foreign debt (assets).

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[5] Or normatively as in the FEER concept, cf. Williamson (1994).

[6] Capital flows do not include speculative flows; the NATREX abstracts from short-term movements.

[7] Note that all variables except interest and exchange rates are calculated as fractions of the GDP.

(2) $\Delta FDEBT = I - S - g$

where g is the growth rate of GDP. Net foreign assets thus change due to capital flows and GDP growth. The latter is described by the third equation

(3) $g = b^* I$

where b is the productivity of capital and the growth rate of GDP is determined by the capital productivity and the rate of investment.

A change in the capital stock or in foreign debt affects the current account and therefore the medium-term macroeconomic equilibrium. The medium-term NATREX leads to macroeconomic equilibrium with a given capital stock and foreign debt, but evolves as the foreign debt and capital stock evolve. The long-term NATREX eventually prevails as the capital stock and foreign debt converge to their long-run levels.

Two scenarios of a change in the underlying fundamentals deserve mention. The first is an increase in time preference. This reduction in savings causes the current account to deteriorate and foreign debt to increase. Initially the real exchange rate will appreciate to restore medium-term equilibrium. In the long run, however, the currency will depreciate: As foreign debt increases, interest payments rise so that macroeconomic balance will require real depreciation.

The second scenario involves higher productivity growth in one country than in the rest of the world. Investment will increase and, as in the previous scenario, the economy will experience current account deficits, real appreciation and an increase in the foreign debt. In contrast to the former scenario the real appreciation will be sustained if the increase in GDP and wealth compensates for the higher imports and the higher interest payments to the foreign country.

In a nutshell, the NATREX model can account for real equilibrium appreciation during periods of rapid growth. Initially caused by capital inflows due to higher real returns, the real appreciation is subsequently sustained by the ability of the country to repay its debt out of higher savings. The model focuses on asset markets and real interest rates; the equilibrium real exchange rate adjusts so as to establish equilibrium.

One can also analyse the effects of growth on the exchange rate from the perspective of the goods market and in particular the trade balance and current account. This may be more appropriate in the case of the transition and accession countries because import substitution and a

substantial increase in export capacity seem to be the driving force of their real appreciation.[8] Financial market efficiency and integration into the world market have evolved only slowly.

Below we show how increases in productivity may affect the trade balance and discuss the elasticity conditions that must hold for relatively high productivity growth to cause real equilibrium appreciation. We model a two-goods two-country economy and define external equilibrium in terms of the trade balance. This allows us to abstract from capital flows which simplifies matters but is not a necessary condition for our proposition to hold. It is, however, compatible with the long-term equilibrium of the NATREX model. On the supply side of the economy the level of production in each country is determined by capital, labour and total factor productivity, the latter being determined by the level of technology/innovation. All else equal, a higher level of technology implies a higher level of GDP. Each country consumes both goods but produces only one. The goods are assumed to be imperfect substitutes, so that demand for each good is dependent on its price. As this violates one of the assumptions of purchasing power parity (PPP), PPP does not hold in this model. To illustrate our point we need two additional assumptions: first we assume that productivity growth is higher in the home country than in the foreign country ($\Delta T > \Delta T^f$). All else equal GDP growth is then also higher in the home country. The second assumption is that the level of productivity is higher in the foreign country ($T^f > T$). From this second assumption it follows that the higher growth experienced by the home country can be characterised as catch-up growth.

The key hypothesis is that an increase in the technological content of the domestic good raises demand for it in both the home country and the foreign country.

The relative price of the domestic good is

$$(4) \qquad q = \frac{p \times e}{p^f}$$

where q and e are the real and nominal exchange rates respectively, defined as units of the domestic currency per units of the foreign currency. P denotes prices and the superscript f stands

[8] The latter is recognised e.g. in Simon/Darvas 2000 who estimate the potential output of Hungary based on the export performance.

for the foreign country. To derive the impact of a different rate of technological change we begin with the equilibrium condition of a balanced trade account:

(5) $TB = 0 = p \times x - p^f \times e \times m$,

where x are exports of the home country and m are its imports.

Equation (6) can be rewritten as

(6) $p \times x = p^f \times e \times m$.

Reformulating equation (3) in terms of growth rates yields

(7) $\dot{p} + \dot{x} = \dot{p}^f + \dot{e} + \dot{m}$.

Assuming the price of each good to be fixed in the respective currency, the equilibrium condition becomes:

(8) $\dot{x} = \dot{e} + \dot{m}$.

Our objective of determining the impact of relative productivity growth on real equilibrium exchange rates requires that we identify the factors that determine exports and imports. Exports of the home country depend positively on income in the foreign country as well as the technological content of the exported good and negatively on its relative price, i.e. the nominal exchange rate. Equation (9) is the total differential of the export function. It shows how a change in one of the determining factors of exports affects the export volume of the home country.

(9) $$dx = \frac{\partial x}{\partial y^f} dy^f + \frac{\partial x}{\partial tc} dtc + \frac{\partial x}{\partial \frac{p}{e}} \left(-\frac{p}{e^2} \right) de$$

Dividing equation (6) by x and rearranging the terms yields

(10) $\dot{x} = \varepsilon_y^x \dot{y}^f + \varepsilon_{tc}^x \dot{tc} + \varepsilon_e^x \dot{e}$,

so that a change in exports results from a change in the foreign country's income, a change in the technological content of the good as well as a change in the nominal exchange rate, and ε_y^x ε_{tc}^x and ε_e^x are the elasticities of export demand to changes in the three variables.

The elasticities of import demand to changes in domestic income, in technological content of the home good and in the relative price of the foreign good can be derived analogously. Imports are a positive function of domestic income, and a negative one of the technological content of the domestic good and the price of the foreign good expressed in the domestic currency. The total differential of the thus specified import function is

$$\dot{m} = \varepsilon_y^m \dot{m} + \varepsilon_{tc}^m \dot{tc} + \varepsilon_e^m \dot{e} \tag{11}$$

Substituting equations (10) and (11) into equation (8) yields (12)

$$\varepsilon_y^x \dot{y}^f + \varepsilon_{tc}^x \dot{tc} + \varepsilon_e^x \dot{e} = \dot{e} + \varepsilon_y^m \dot{m} + \varepsilon_{tc}^m \dot{tc} + \varepsilon_e^m \dot{e}, \tag{12}$$

which can be rewritten in terms of the exchange-rate effect of a change in the technological content of the domestic good as in (13).

$$\frac{\dot{e}}{\dot{tc}} = \frac{\varepsilon_{tc}^x - \varepsilon_{tc}^m - \varepsilon_y^m}{1 + \varepsilon_e^m - \varepsilon_e^x} \tag{13}$$

If the Marshall-Lerner condition holds, i.e. the sum of the domestic elasticity of demand for imports plus the foreign elasticity of demand for the country's exports exceeds unity $(\varepsilon_e^m + \varepsilon_e^x > 1)$, the effect of an increase in the technological content of the domestic good on the exchange rate is negative (the currency appreciates) if the numerator of equation (10) is positive. Real appreciation thus requires that the sum of the positive export elasticity to an increase in the technological content and the absolute value of the negative import elasticity to an increase in technological content exceeds the positive import elasticity to domestic demand. In such a setting, the rapid change in the quality (technological content) of goods during the growth process will ceteris paribus result in real appreciation of the currency.

3. Testing procedure

In line with the theoretical considerations, our main proposition is that the real currency appreciation experienced by the transition and accession countries is in part the result of changes in the export and import performance, which are, in turn, the result of catch-up growth; in

particular substitution of improved domestic products for imports along with the increased ability to sell domestic products (of higher quality) in foreign markets reduce pressure on the current account. This proposition is tested by first regressing exports and imports on their determinants, i.e. domestic and foreign final demand, domestic labour productivity (as a proxy for technological change and improved quality) and the real exchange rate. If the model can serve as a good approximation of the observed development, higher domestic final demand should raise imports, whereas labour productivity growth should lower imports. At the same time, labour productivity growth in itself increases exports.

We then estimate reduced-form equations of the real exchange rate with a special focus on the effect of labour productivity. In the real exchange rate equation the main focus is on the labour productivity differential between the transition/accession country and Germany as the benchmark. In addition we consider other determinants such as domestic and foreign final demand, foreign debt (relative to GDP) and real interest rate differentials, similar to the reduced-form estimates in the spirit of the BEER model of Clark and MacDonald (1998) and the NATREX model of Stein and Sauernheimer (1996). Higher foreign debt corresponds to a higher equilibrium real exchange rate (depreciation). Real interest rate differentials can pick up on two different developments: differences in the productivity of capital (as in the NATREX model) and cyclical differences (Baxter 1994, MacDonald 1997). In either case, real interest rate differentials will go hand in hand with current account deficits or surpluses, with a higher interest rate corresponding to a current account deficit.

As the variables involved are non-stationary, we start the econometric tests with ADF and Phillips-Perron stationarity tests. The results are presented in Table 6 of the appendix. The tests show that most data have the expected properties, i.e. they are integrated of order 1. For the rare exceptions we assume that this is due to the short sample. Therefore we treat all variables as being I(1).

The subsequent cointegration tests were carried out using the Johansen cointegration method. We first test the unrestricted VAR for the choice of lag length. Here we favour the Schwartz criterion as this lays great emphasis on parsimonious specification, which is required given the short samples at our disposal. We apply the LM test to check whether the specification contains significant autocorrelation. Specifications of higher order than suggested by the Schwartz

criterion are chosen if the test indicates autocorrelation in the residuals. Parameters are determined by the vector error correction mechanism.

The tests are performed for quarterly data starting at the time when official quarterly data on GDP and its components became available, i.e. 1994 in the case of the Czech Republic, and 1995 for Hungary and Poland. We model the real exchange rate vis-à-vis the D-mark, which means that we use the nominal exchange rate towards the German mark until the end of 1998 and towards the euro from 1999 onwards, whereas the producer prices are German producer prices for the entire period. The real interest rate differentials and the productivity differentials are measured relative to Germany throughout the period examined. This seems appropriate given that the German mark was (one of) the anchor currencies when the currencies were pegged to an anchor, and Germany is the largest trading partner of all considered countries. Furthermore Germany is a good proxy for the Euro Area given its share in the Euro-Area's GDP of more than 30 %.

The data used and their sources are summarised in Table 5 in the appendix. All data are seasonally adjusted. Where seasonally adjusted series were not available, the series were adjusted using Tramo Seats. All series except for interest rates are normalised to 1 in the first included quarter and transformed in natural logarithms.

4. Estimated Equations

Export and import equations

As a first step we ascertain whether labour productivity is a factor that determines the import and export development of the countries examined. According to the proposed model, higher labour productivity (which stands for improved quality and technology of the domestic products) should lead to import substitution, whereas exports should be boosted. The tests were performed with labour productivity measured in terms of industrial production as well as GDP. Productivity in industry is a suitable proxy for quality changes given that exports and imports involve traded goods and industrial products are the ones most easily traded. Overall productivity, i.e. GDP per employed person, is also a suitable indicator, mainly because imports may compete with the overall supply rather than merely the supply of industrial goods (an increased share of income may be spent on services, which have become available only during the growth process). We

used series for exports and imports from two different sources, trade statistics (registering goods transactions) and national accounts (including goods and services), as well as in nominal and in real terms with a preference given to real series to economise on degrees of freedom.

For the Czech Republic the following cointegration relationships were determined for exports and imports:

TABLE 1: Export and import equations for the Czech Republic

		Coefficient *Test statistic*	Coint. test Trace statistic
Czech Republic *1994:1 – 2003:1*	Exports, real (trade stat; prices CNB) German final demand, real CR productivity, manufacturing	1.00 -2.55 -0.64	 -12.14 -7.90
Cointegration test	*No lags*	*35.4460**	
Czech Republic *1994:1 – 2003:1*	Exports, real (nat.acc.; prices CNB) German final demand, real CR productivity, entire economy	1.00 -1.85 -1.71	 -7.11 -5.56
Cointegration test	*2 lags*	*30.4786**	
Czech Republic *1994:1 – 2003:1*	Imports, nominal, trade statistics Import prices, CNB Czech final demand, real CR productivity, entire economy	1 -1.42 -2.56 1.20	 -22.9 -11.21 2.43
Cointegration test	*1 lag*	*47.782**	

** indicates significance at the 1 % level, * significance at the 5 % level.

Czech export revenues increase with German final demand and also with higher labour productivity in industry. Using productivity measured in terms of GDP, as in the second equation, yields similar results. These findings are in line with the suggested model: labour productivity seems to be a suitable proxy for higher non-price competitiveness of Czech goods. The real exchange rate is not included in the equation. The reason is that the Johansen method first determines the number of independent cointegration relationships; if more than one such relationship exists, they have to be separated and investigated independently.

For imports, the preferred equation relates nominal imports to import prices, Czech final demand and labour productivity measured in terms of GDP. Again, the productivity and demand variables have the expected sign, and the econometric procedure precluded the inclusion of an additional variable such as the real exchange rate.

The results for Hungary are also in support of our hypothesis. Productivity in industry is found to augment the effect of foreign demand on exports. As regards imports, the productivity differential towards Germany is found to reduce the positive effect of domestic final demand. As in the case of the Czech Republic the determined relationships do not contain the real exchange rate. This does not in any way imply that exports and imports are not effected by their price relative to foreign goods.

TABLE 2: Export and import equations for Hungary

		Coefficient *Test statistic*	Coint. test Trace statistic
Hungary *1995:3 – 2003:1*	Exports, real (SNA) German final demand, real HU productivity, manufacturing D972	1.00 -2.04 -0.76	 -7.246 -5.943
Cointegration test	*1 lag*	*47.1914*[1]	
Hungary *1995:3 – 2003:1*	Imports, real (trade statistics, imp. pr.) Hungarian final demand, real Productivity differential, manufacturing	1.00 -3.02 1.81	 -10.64 4.24
Cointegration test	*No lags*	*32.07174**	

[1] 47.21 is the critical values for significance at the 5 % level.

** indicates significance at the 1 % level, * significance at the 5 % level.

For Poland, the export equation includes only productivity in industry. For imports we found a relationship containing labour productivity and GDP with the expected signs.[9]

[9] GDP can be viewed as a proxy for domestic demand but also as a determining factor in its own right if exports give rise to imports.

TABLE 3: Export and import equations for Poland

		Coefficient *Test statistic*	Coint. test Trace statistic
Poland *1995:1 – 2003:1*	Exports**,** real (trade stat.) PL productivity, manufacturing	1.00 -1.16	 -33.6
Cointegration test	*1 lag*	*16.8468**	
Poland *1995:1 – 2003:1*	Imports, nom. (trade stat.) Import prices PL GDP, real PL productivity, manufacturing	1.00 -0.46 -5.00 0.48	 -1.92 -8.38 3.32
Cointegration test	*1 lag*	*57.9881***	

** indicates significance at the 1 % level, * significance at the 5 % level.

Real exchange rate equations

To gauge the effect of the shift to higher-quality goods on the exchange rate we next estimate reduced-form equations for the real exchange rates. In addition to the differential in labour productivity we included variables that are either motivated by the import and export equations (domestic and foreign demand) or by their frequent consideration in reduced-form models (such as foreign debt, real interest differential). However, as in the case of the import and export equations, additional variables were included only until 1 cointegration relationship was found.

For the Czech Republic, the productivity differential calculated on the basis of GDP is significant for the determination of the real exchange rate. It is the only variable included in the cointegration vector that causes real appreciation. The other two included series are foreign debt and the differential between Czech and German final demand, both of which cause the real exchange rate to depreciate.

TABLE 4: Real exchange rate equations for Czech Republic, Hungary and Poland

		Coefficient *Test statistic*	Coint. test *Trace statistic*
Czech Republic *1994:1 – 2003:1*	Real exchange rate towards Germany Productivity differential, manufact. Foreign debt/GDP ratio Differential in final demand	1.00 4.39 -0.16 -1.03	 4.69 -2.51 -2.14
Cointegration test	*1 lag*	55.007*	
Hungary *1995:3 – 2003:1*	Real exchange rate towards Germany Productivity differential, manufact. HU GDP, real	1.00 1.85 -1.71	 3.71 -2.55
Cointegration test	*1 lag*	33.5472*	
Poland *1995:1 – 2003:1*	Real exchange rate towards Germany Productivity differential, manufact. Real interest rate differential	1 0.43 0.01	 12.23 6.81
Cointegration test	0 lag	34.8999*	

** indicates significance at 1 % level, * significance at 5 % level.

For Hungary, the determined equation for the real exchange rate includes the productivity differential in industry as well as GDP as a proxy for higher imports resulting from higher growth.

For Poland, the real exchange rate equation includes labour productivity in industry and the real interest rate differential. This supports the result of the export equation, where cointegration was found for labour productivity alone (not considering additional factors such as foreign demand).

Our results show that although the currencies of the transition countries have appreciated considerably in PPI-terms, they are not as overvalued as the inflation differentials and the nominal appreciation would suggest. There are three main reasons for this, all of which are linked to the productivity increases realised in the process of economic catch-up. First, a higher technological content of domestic goods will lead to import substitution in favour of these goods. Second, as long as quality adjustments to the inflation measure are insufficient, there will be an understatement of productivity growth and an overstatement of inflation. Third, productivity increases lead to real appreciation as the capacity to generate higher export revenues increases.

The high growth in export revenue and import substitution only rarely resulted in nominal appreciation of the exchange rate because the transition countries faced not only the mentioned adjustments in the domestic producer prices but also higher inflation rates due to a price-wage

spiral. Therefore real appreciation mainly occurred as the currencies nominally depreciated less than implied by the inflation differential.

5. Conclusion

In this paper we analysed whether labour productivity growth can be regarded as a source of real equilibrium appreciation for the countries in the transition process. The hypothesis is that real appreciation results from a growing capacity of these countries to produce goods of higher quality and thus higher valuation on the part of domestic and foreign consumers.

First we examined the effect of labour productivity on exports and imports. We found that increased labour productivity is a significant independent source of higher exports. This contrasts with standard trade models, according to which exports depend primarily on foreign demand and relative prices. An increase in labour productivity furthermore seems to reduce imports, as the higher quality of domestic goods shifts consumers' preferences from foreign goods towards domestic goods. This relationship lends support to our assumption that labour productivity is a suitable proxy for the rising non-price competitiveness of transition countries. We then estimated reduced-form exchange rate equations and found that labour productivity is a long-term determinant of the real exchange rate based on traded goods prices.

It follows from our analysis that the trend increase in the accession countries' prices towards the price levels of the EU and Germany may result not only from prices of non-traded goods as suggested by many papers devoted to the Balassa-Samuelson effect. The latter see this effect as the main determinant of the trend appreciation during economic catch-up. Given that labour productivity also affects the price of traded goods (measured in terms of foreign currency), the observed relationship between the CPI-based real exchange rate and labour productivity in industry is more likely to stem from the prices of both traded and non-traded goods in the CPI. This is all the more so as the share of market non-tradables in the consumer baskets of transition countries is small.

Our results show that the real currency appreciation in the accession countries is in part due to buoyant export revenue and import substitution as production shifts to higher-quality goods. To some extent the real appreciation can therefore be viewed as an equilibrium phenomenon. This observed phenomenon should be most pronounced in the phase of the transition and the early

catch-up process, when the shift in consumers' preferences as well as the restructuring of the economies is greatest. Future research with longer time series is required to test for this presumed structural break.

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Appendix

TABLE 5 Included variables

Czech Republic

Variable		Source
Real exports	exports from the trade statistics minus export prices, in CZK	Trade statistics: MEI Export prices: CNB
	exports from the national accounts minus export prices, in CZK	National accounts: Eurostat Export prices: CNB
German final demand	Domestic final demand = GDP + imports from the national accounts, in EUR, 1995 prices	Eurostat
Productivity in Czech manufacturing	Industrial production divided by employees in manufacturing	MEI
Czech producer prices		IFS
German producer prices		IFS
Nominal exchange rate, Czech koruna /German mark-euro		IFS
Imports	Imports as measured in the trade statistics, in CZK	Trade statistics: MEI Import prices: CNB
Czech final demand	Domestic final demand = GDP + imports from the national accounts, in CZK, 1995 prices	Eurostat
Productivity entire economy	GDP in 1995 prices divided by total employment	Eurostat
Foreign debt ratio	Foreign debt at the end of period divided by current GDP	Foreign debt: CNB Current GDP: Eurostat

Hungary

Variable		Source
Real exports	Exports in 1995 prices from national accounts	Eurostat
Productivity in industry	Industrial production divided by employees in manufacturing	MEI
German final demand	Domestic final demand = GDP + imports from the national accounts, in EUR, 1995 prices	Eurostat
Hungarian producer prices		KSH
German producer prices		IFS
Nominal exchange rate, Hungarian forint /German mark, euro		IFS
Real imports	Imports from trade statistics divided by import price index	Trade statistics: MEI Import prices: IFS
Hungarian final demand	Domestic final demand = GDP + imports from the national accounts, in HUF, 1995 prices	Eurostat
Productivity differential towards Germany, GDP	Real GDP divided by total employment	Eurostat
Productivity differential towards Germany in industry	Hungarian productivity as indicated above; Germany: industrial production divided by total employment in industry	MEI (Hungarian series; German industrial production) Eurostat (German employment)
Real GDP Hungary		Eurostat

3. Poland

Variable		Source
Real exports	exports from the trade statistics minus export prices, in PLN	Trade statistics: MEI Export prices: IFS
Productivity in industry	Industrial production divided by employees in industry	MEI
Imports	imports as measured in the trade statistics, in PLN	Trade statistics: MEI
Import prices		IFS
Polish producer prices		IFS
German producer prices		IFS
Nominal exchange rate, new Polish zloty /German mark-euro		IFS
Real GDP Poland		Eurostat
Productivity differential towards Germany in industry	Polish productivity as indicated above, for Germany: industrial production divided by total employment	MEI (Poland; German industrial production) Eurostat (German employment)
Real interest rate differential, deflated by PPI		Treasury bills from IFS; producer prices as indicated above

TABLE 6: Unit root tests (ADF and Phillips-Perron tests)

Czech Republic

		ADF Test including constant	ADF test including trend and constant	PP test including constant	PP test including trend and constant
Real Exports according to SNA	Levels	-1.5979	-2.8751	-1.6903	-2.7430
	Differences	-6.0840		-6.8324	
Real exports according to trade statistics	Levels	-0.8855	-2.7026	-1.2124	-2.6208
	Differences	-5.8988		-5.8253	
Final demand Germany	Levels	-1.2894	0.1406	-1.5682	-0.4405
	Differences	-2.095		-4.2130	
Productivity in industry	Levels	-1.1560	-2.9337	-1.1327	-3.1186
	Differences	-5.6725		-5.6725	
Imports according to trade statistics, nom.	Levels	-1.4827	-2.1540	-2.6640	-2.7505
	Differences	-4.3691		-4.3756	
Import prices CNB	Levels	-2.5643	-2.7396	-2.0537	-1.7419
	Differences	-3.0604		-3.12	
Final demand Czech Republic	Levels	-1.699	-2.5079	-1.4293	-2.6715
	Differences	-5.0894		-5.1799	
Productivity entire economy	Levels	-0.2703	-2.2682	-1.1550	-2.4481
	Differences	-2.2682		-2.3454 (I2)	
Real exchange rate	Levels	-1.04834	-3.8895	-1.0524	-2.6290
	Differences	-4.7614		-4.5781	
Productivity growth in GDP difference	Levels	-1.0047	-1.7457	-1.0665	-2.1447
	Differences	-4.5712		-4.5259	

towards Germany					
Foreign debt/GDP ratio	Levels Differences	-1.8464 -5.3004	-0.7578	-1.8464 -5.3906	-0.6644
Difference in final demand 1995 prices CR-Germany	Levels Differences	-0.8818 -5.4708	-1.5994	-0.9717 -5.6522	-1.9861

Hungary

		ADF Test including constant	ADF test including trend and constant	PP test including constant	PP test including trend and constant
Exports according to SNA, 1995 prices	Levels Differences	-2.6783 (10%) -3.7912	-0.3862	-2.3464 -3.864	-0.6548
Productivity, industry (IPSALM)	Levels Differences	-0.5494 -3.7474	-2.4933	-1.0275 -3.7737	-1.9184
Real imports, trade statistics (imports - import prices of IFS)	Levels Differences	-2.0080 -5.7886	-0.9954	-3.2671 -5.7705	-0.6822
Final demand Hungary	Levels Differences	0.0959 -3.8919	-1.6645	0.0188 -3.7201	-0.9732
Real exchange rate	Levels Differences	-2.3417 -5.3517	-2.5544	-1.1662 -5.3346	-1.8971
Productivity growth differential (GDP) towards Germany	Levels Differences	-1.0738 -5.2858	-1.3643	-1.0692 -5.3013	-1.3643
GDP Hungary 1995 prices	Levels Differences	-0.4232 -3.0011 (5%)	-2.4103	-0.1321 -2.9379 (10%)	-2.5517
Productivity growth differential IPSPD towards Germany	Levels Differences	-0.4198 -5.3305	-2.5776	-0.2867 -6.1045	-2.7115

Poland

		ADF Test including constant	ADF test including trend and constant	PP test including constant	PP test including trend and constant
Real exports	Levels Differences	0.1669 -6.4991	-2.4717	0.2566 -6.4991	-2.4352
Productivity in industry (IP)	Levels Differences	-0.2347 -4.8273	-3.5092 (10%)	-0.2707 -4.8155	-2.3250
Imports, trade statistics	Levels Differences	-3.6731 (1%) -4.4509	-1.9416	-3.7115 (1%) -4.6083	-1.9435
Import prices; IFS	Levels Differences	-4.7289 -8.2175	-4.8428	-4.6816 -7.9177	-4.5127

Real GDP Poland	Levels Differences	-3.2737 -1.6268	-2.3725	-2.8341 -1.8951	-0.9342
Real exchange rate	Levels Differences	-2.1452 -6.6562	-2.8297	-2.1455 -6.5830	-1.0069
Productivity growth differential towards Germany, IP	Levels Differences	-0.2347 -4.8273	-3.5092 (10%)	-0.2707 -4.8155	-2.3251
Real interest rate differential	Levels Differences	-2.9922 (5%) -3.3421	-2.7963	-2.3647 -3.3889	-1.8140

Underestimation of GDP

In the text we argue that the countries in transition and in the catch-up process encounter difficulties in quality adjustment which result in an underestimation of real growth and of real convergence. We illustrate this point using Czech statistics on nominal and real GDP. These provide conflicting information on the impact of net exports and domestic demand on GDP growth, implying that the price adjustment of GDP components, in particular of exports, causes real GDP growth to be systematically underestimated.

Table 7 shows data on nominal and real GDP in levels and growth rates as well as the contributions of exports and imports to GDP. On the left side the table GDP, exports X and imports M are in prices of 1995. Net exports (NX) are exports minus imports. The "share net exports in GDP" is calculated as net exports divided by GDP. The five columns on the right hand side contain the same time series in current prices.

Table 7: Development of nominal and real GDP, Czech Republic 1994-2003

	Prices of 1995					Current prices				
	GDP 95	X 95	M 95	NX 95	share net exports/GDP	GDP CUR	X CUR	M CUR	NX CUR	share net exports/GDP
					in millions CZK					
1994	1303644	635010	665440	-30430	-2.3	1182784	597082	628770	-31688	-2.7
1995	1381049	740751	806458	-65707	-4.8	1381049	740751	806458	-65707	-4.8
1996	1440350	801846	914210	-112364	-7.8	1566968	823257	923654	-100397	-6.4
1997	1429329	875266	988042	-112776	-7.9	1679921	949695	1049661	-99966	-6.0
1998	1414422	962607	1052971	-90364	-6.4	1839088	1080930	1102998	-22068	-1.2
1999	1421043	1021331	1110054	-88723	-6.2	1902293	1152607	1176937	-24330	-1.3
2000	1467285	1195460	1298373	-102913	-7.0	1984833	1385905	1452170	-66265	-3.3
2001	1512626	1337411	1474672	-137261	-9.1	2175238	1539324	1598024	-58700	-2.7
2002	1542221	1374435	1537886	-163451	-10.6	2275609	1483015	1535620	-52605	-2.3
2003	1587182	1466074	1654235	-188161	-11.9	2410123	1590961	1647116	-56155	-2.3
					growth rates					
1995	5.9	16.7	21.2	115.9		16.8	24.1	28.3	107.4	
1996	4.3	8.2	13.4	71.0		13.5	11.1	14.5	52.8	
1997	-0.8	9.2	8.1	0.4		7.2	15.4	13.6	-0.4	
1998	-1.0	10.0	6.6	-19.9		9.5	13.8	5.1	-77.9	
1999	0.5	6.1	5.4	-1.8		3.4	6.6	6.7	10.3	
2000	3.3	17.0	17.0	16.0		4.3	20.2	23.4	172.4	
2001	3.1	11.9	13.6	33.4		9.6	11.1	10.0	-11.4	
2002	2.0	2.8	4.3	19.1		4.6	-3.7	-3.9	-10.4	
2003	2.9	6.7	7.6	15.1		5.9	7.3	7.3	6.7	
					contributions to growth					
1995	5.9	8.1	10.8	-2.7		16.8	12.1	15.0	-2.9	
1996	4.3	4.4	7.8	-3.4		13.5	6.0	8.5	-2.5	
1997	-0.8	5.1	5.1	0.0		7.2	8.1	8.0	0.0	
1998	-1.0	6.1	4.5	1.6		9.5	7.8	3.2	4.6	
1999	0.5	4.2	4.0	0.1		3.4	3.9	4.0	-0.1	
2000	3.3	12.3	13.3	-1.0		4.3	12.3	14.5	-2.2	
2001	3.1	9.7	12.0	-2.3		9.6	7.7	7.3	0.4	
2002	2.0	2.4	4.2	-1.7		4.6	-2.6	-2.9	0.3	
2003	2.9	5.9	7.5	-1.6		5.9	4.7	4.9	-0.2	

Source: Cesky statisticky urad/Eurostat; calculations of the authors.

According to Table 7, net exports were negative in nominal terms throughout the period examined, but its share in nominal GDP decreased significantly during the period of slow growth in 1998 and 1999. By contrast, in real terms the share of net exports in GDP remained high even during the period of slow growth and reached a record high of 11.9 % in 2003 – when it amounted to just 2.3 % in nominal terms.

This discrepancy suggests that the price adjustment too large so that real export growth is underestimated by the Czech Statistical Office. If real exports are calculated so that the net exports' share in GDP is equal to that determined for the nominal series, aggregate growth over the period of 1994-2003 would amount to 34 % instead of the official 22 %. Growth rates in the past three years would amount to 6 %, 4 % and 4.5 %, respectively, instead of the officially determined 3 %, 2 % and 3 %.

Tables 8-10 show the corresponding data for Hungary, Poland and the Euro Area. In the case of Hungary and the Euro Area, the share of net exports in GDP is approximately the same when calculated in current or constant prices. In Poland, the differences are at times also quite substantial, however**,** the change in the impact of net exports on growth is similar**.**

Table 8: Development of real and nominal GDP, Hungary 1995-2002

	Prices of 1995					Current prices				
	GDP 95	X 95	M 95	NX 95	share net exports/GDP	GDP CUR	X CUR	M CUR	NX CUR	share net exports/GDP
					in millions HUF					
1995	5614043	2493464	2484879	8585	0.2	5614042	2493465	2484880	8585	0.2
1996	5689253	2807584	2743963	63621	1.1	6893935	3341845	3309976	31869	0.5
1997	5949437	3434841	3377829	57012	1.0	8540669	4709179	4621816	87363	1.0
1998	6238452	4085393	4228645	-143252	-2.3	10087434	6316021	6465118	-149097	-1.5
1999	6498813	4593626	4793163	-199536	-3.1	11393500	7423038	7728440	-305402	-2.7
2000	6836303	5556627	5721801	-165174	-2.4	13172293	9863133	10371013	-507880	-3.9
2001	7098980	6047839	6066173	-18334	-0.3	14849622	11041583	11265807	-224224	-1.5
2002	7345123	6274833	6435524	-160691	-2.2	16743688	10944740	11321424	-376684	-2.2
					growth rates					
1996	1.3	12.6	10.4	641.1		22.8	34.0	33.2	271.2	
1997	4.6	22.3	23.1	-10.4		23.9	40.9	39.6	174.1	
1998	4.9	18.9	25.2	-351.3		18.1	34.1	39.9	-270.7	
1999	4.2	12.4	13.3	39.3		12.9	17.5	19.5	104.8	
2000	5.2	21.0	19.4	-17.2		15.6	32.9	34.2	66.3	
2001	3.8	8.8	6.0	-88.9		12.7	11.9	8.6	-55.9	
2002	3.5	3.8	6.1	776.5		12.8	-0.9	0.5	68.0	
					contributions to growth					
1996	1.3	5.6	4.6	1.0		22.8	15.1	14.7	0.4	
1997	4.6	11.0	11.1	-0.1		23.9	19.8	19.0	0.8	
1998	4.9	10.9	14.3	-3.4		18.1	18.8	21.6	-2.8	
1999	4.2	8.1	9.0	-0.9		12.9	11.0	12.5	-1.5	
2000	5.2	14.8	14.3	0.5		15.6	21.4	23.2	-1.8	
2001	3.8	7.2	5.0	2.1		12.7	8.9	6.8	2.2	
2002	3.5	3.2	5.2	-2.0		12.8	-0.7	0.4	-1.0	

Sources: Központi Statistikai Hivatal/Eurostat, calculations of the authors.

Table 9: Development of real and nominal GDP, Poland 1995-2003

	Prices of 1995					Current prices				
	GDP 95	X 95	M 95	NX 95	share net exports/GDP	GDP CUR	X CUR	M CUR	NX CUR	share net exports/GDP
					in millions PLN					
1995	329567	78172	70935	7237	2.20	329567	78172	70935	7237	2.20
1996	349663	87378	90593	-3215	-0.92	414425	94192	100224	-6032	-1.46
1997	373442	99984	110970	-10986	-2.94	504133	120408	140782	-20374	-4.04
1998	391274	119663	132210	-12547	-3.21	589361	155874	184879	-29005	-4.92
1999	407311	116170	133705	-17535	-4.31	652517	160787	199904	-39117	-5.99
2000	423410	143663	154436	-10773	-2.54	723886	201548	248867	-47319	-6.54
2001	427641	148072	146203	1869	0.44	760595	210585	238562	-27977	-3.68
2002	433715	155526	150500	5025	1.16	780450	231409	257535	-26126	-3.35
2003	450142	176946	162829	14117	3.14	814969	276651	296946	-20296	-2.49
					growth rates					
1996	6.1	11.8	27.7	-144.4		25.7	20.5	41.3	-183.4	
1997	6.8	14.4	22.5	241.7		21.6	27.8	40.5	237.8	
1998	4.8	19.7	19.1	14.2		16.9	29.5	31.3	42.4	
1999	4.1	-2.9	1.1	39.8		10.7	3.2	8.1	34.9	
2000	4.0	23.7	15.5	-38.6		10.9	25.4	24.5	21.0	
2001	1.0	3.1	-5.3	-117.3		5.1	4.5	-4.1	-40.9	
2002	1.4	5.0	2.9	168.9		2.6	9.9	8.0	-6.6	
2003	3.8	13.8	8.2	180.9		4.4	19.6	15.3	-22.3	
					contributions to growth					
1996	6.1	2.8	6.0	-3.2		25.7	4.9	8.9	-4.0	
1997	6.8	3.6	5.8	-2.2		21.6	6.3	9.8	-3.5	
1998	4.8	5.3	5.7	-0.4		16.9	7.0	8.7	-1.7	
1999	4.1	-0.9	0.4	-1.3		10.7	0.8	2.5	-1.7	
2000	4.0	6.7	5.1	1.7		10.9	6.2	7.5	-1.3	
2001	1.0	1.0	-1.9	3.0		5.1	1.2	-1.4	2.7	
2002	1.4	1.7	1.0	0.7		2.6	2.7	2.5	0.2	
2003	3.8	4.9	2.8	2.1		4.4	5.8	5.0	0.7	

Source: GUS, Eurostat, calculations of the authors.

Table 10: Development of real and nominal GDP, Euro Area 1994-2003

	Prices of 1995					Current prices				
	GDP 95	X 95	M 95	NX 95	share net exports/GDP	GDP CUR	X CUR	M CUR	NX CUR	share net exports/GDP
					in millions EUR					
1994	5281641	1467348	1383941	83407	1.6	5155754	1424486	1348497	75988	1.5
1995	5399345	1581335	1489512	91824	1.7	5399346	1581335	1489513	91823	1.7
1996	5476136	1652074	1538876	113198	2.1	5632526	1672061	1554277	117784	2.1
1997	5604366	1825608	1678780	146828	2.6	5755995	1848047	1707631	140416	2.4
1998	5765441	1959852	1846251	113601	2.0	5992502	1970513	1839808	130705	2.2
1999	5927933	2064354	1986150	78204	1.3	6268179	2077841	1986639	91202	1.5
2000	6134989	2318832	2204667	114165	1.9	6576111	2448717	2392089	56629	0.9
2001	6232783	2396860	2242150	154710	2.5	6842570	2564613	2451160	113454	1.7
2002	6286998	2432223	2239301	192922	3.1	7073287	2595403	2413747	181656	2.6
2003	6314119	2431966	2273646	158321	2.5	7254037	2582365	2422002	160363	2.2
					growth rates					
1995	2.2	7.8	7.6	10.1		4.7	11.0	10.5	20.8	
1996	1.4	4.5	3.3	23.3		4.3	5.7	4.3	28.3	
1997	2.3	10.5	9.1	29.7		2.2	10.5	9.9	19.2	
1998	2.9	7.4	10.0	-22.6		4.1	6.6	7.7	-6.9	
1999	2.8	5.3	7.6	-31.2		4.6	5.4	8.0	-30.2	
2000	3.5	12.3	11.0	46.0		4.9	17.8	20.4	-37.9	
2001	1.6	3.4	1.7	35.5		4.1	4.7	2.5	100.3	
2002	0.9	1.5	-0.1	24.7		3.4	1.2	-1.5	60.1	
2003	0.4	0.0	1.5	-17.9		2.6	-0.5	0.3	-11.7	
					contributions to growth					
1995	2.2	2.2	2.0	0.2		4.7	3.0	2.7	0.3	
1996	1.4	1.3	0.9	0.4		4.3	1.7	1.2	0.5	
1997	2.3	3.2	2.6	0.6		2.2	3.1	2.7	0.4	
1998	2.9	2.4	3.0	-0.6		4.1	2.1	2.3	-0.2	
1999	2.8	1.8	2.4	-0.6		4.6	1.8	2.5	-0.7	
2000	3.5	4.3	3.7	0.6		4.9	5.9	6.5	-0.6	
2001	1.6	1.3	0.6	0.7		4.1	1.8	0.9	0.9	
2002	0.9	0.6	0.0	0.6		3.4	0.4	-0.5	1.0	
2003	0.4	0.0	0.5	-0.6		2.6	-0.2	0.1	-0.3	

Source: Eurostat; calculations of the authors.

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