Balassa-Samuelson Effect in Poland: Is Real Convergence a Threat to Nominal One?

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Introduction

In this article I try to estimate the so called Balassa-Samuelson effect (B-S) in Poland. The time span for my analysis is both the time of transforming the political system and restructuring the Polish economy aa well as preparing for EU accesion, which ultimately took place on May 1st, 2004. The estimate of B-S effect shows, what is the estimation relationship between observed tradable and non-tradable goods productivity growth differentials in Poland and EU, and inflation differentials between the two regions. It is important to measure the effect, since its magnitude is of great importance to a country willing to join the European Monetary Union. If the effect is substantial, then it may even pose serious threat to the possibility of obeying Maastricht convergence criteria. Specifically, it seems that in the presence of a strong B-S effect, the criteria of exchange rate stability and low inflation my be in contradiction to each other. The convergence criteria stated in Maastricht Treaty say, that:

- inflation can be no higher than 1.5 pp above the average of inflation rates of 3 countries of the EMU with the lowest inflation;
- long term government bonds interest rates can be no higher than 2 pp above average of 3 countries' rates of the EMU with lowest inflation;
- the exchange rate must be fixed for 2 years and may not move away from the parity for more than +15% and there can be no devaluation within this period;

  budget deficit must be no higher than 3% of GDP;

  public debt must not exceed 60% of GDP.

The theoretical Balassa-Samuelson model suggests, that if productivity grows faster in the tradable goods sector than in non-tradable goods sector, then we observe an increase in relative price of non-tradable goods. This is

a domestic effect only, but if we put it in the context of international economy, then we can draw some interesting conclusions. If relative productivity (of tradable to non-tradable goods) grows faster in Poland than in EU, then two effects are possible, depending on the exchange rate regime. First, if we have a fixed exchange rate regime, it implies a higher inflation rate in Poland than in EU and real appreciation of Zloty against Euro. Second, if we have a floating exchange rate regime, then we may have a combination of simultaneous higher inflation and nominal appreciation of Zloty against Euro. In the pre-EMU accession period, which is *de facto* the period of a fixed exchange rate regime, the Balassa-Samuelson effect (if it is strong) may pose a question of trade-off between (nominal) exchange rate stability and stability of price level[1]. On the other hand a restrictive monetary and fiscal policy may slow down the GDP growth and give rise to unemployment[2].

This problem is often referred to as the problem of nominal and real convergence. Real convergence means the 'real' process of catching-up richer economies by initially poorer ones, as is predicted by economic growth theory. Nominal convergence requires obeying formal rules stated by Maastricht Treaty—satisfying 'nominal' criteria of convergence. The problem may be formulated then as the convergence '*de jure*' vs. convergence '*de facto*'. The issue of Balassa-Samuelson effect became very popular recently in this context. The EU enlargement done in 2004 involved countries with low GDP per capita and low wages, with faster on average GDP growth than in old members of EU. The question is whether the process of fast real convergence is in danger because of 'nominal' convergence requirements? I will try to tackle with this question by estimating the size of Balassa-Samuelson effect in Poland. An increase of the relative price of non-tradable goods in the economy, which is behind the Balassa-Samuelson effect, may also arise in the situation of changing demand conditions. Apart from productivity growth differential, it may happen (especially during transition) that demand rise induced by increase in disposable income of individuals is biased towards non-tradables. This is connected with GDP per capita growth, higher standards of living, improving quality of non-tradables (especially services). The transition period magnifies all these effects, and we may expect that these demand-side effects will diminish gradually over time. The paper is organized as follows: first section is a short review of literature of the field, the second underlines theoretical background for the analysis; third discusses the issue of dividing the economy into tradable and non-tradable goods sectors; fourth briefly describes sources of data used in the estimation and gives a stylized facts background and fifth presents empirical verification. Summary, bibliography and appendix conclude the article.

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[1] Natalucci & Ravenna [2003] present the analysis of this problem in more formalized general equilibrium model

[2] See e.g. Orłowski [2001].

1. Short literature review

There is abundance of articles in the international economics literature discussing the Balassa-Samuelson effect. Beginning with Balassa [1964] and Samuelson [1964], there are very many different approaches to the problem. From the point of view of this article it is desirable to review the literature with special attention to inflation-exchange rate stability trade-off. It is also worth noting that for almost 40 years of empirical studies of the B-S effect, there are no clear-cut conclussions. Differences in outcomes are coming from different treatment of tradable and non-tradable goods sectors, different econometric techniques and different samples (countries, groups of countries and time horizons).

The first econometric study of a time series was presented by Hsieh in 1982. He studied the real exchange rate evolution for Germany and Japan vis a vis US Dollar in the period of 1954–1976. One of the most often cited atricles is the article by De Gregorio, Giovannini and Wolf [1994]. The authors analyze the impact on changes of productivity in tradables and non-tadables for 14 OECD economies in 1970–1985. They find that an observed higher inflation rate in non-tradales is a result of two causes. The first, is a shift of demand in favour of non-tradables (so called Baumol-Bowen effect) and the second, is faster productivity growth in tradables as compared to non-tradables. Authors also find that the role of the first factor is diminishing in the long run. Canzoneri et al. [1999] analyze the role of B-S effect in predicting the real exchange rate movements for 13 OECD countries during the period of 1970–1993. Using panel data cointegration techniques they found a stable relationship between relative productivity growth and real exchange rate evolution.

The analyses of B-S effect for the Central and Eatern European countries were most often performed using a sample of a group of countries (data availability problems). One of the empirical studies concerning the theoretical contradiction of low inflation and nominal exchange rate stability is done by Orłowski [2001]. The author adopts a B-S model and simulates some economic variables (GDP growth, unemployment rate, inflation) within a number of scenarios. The conclussions are as follows: inflation consistent with high GDP growth (at 6% yearly on average) is 3.9% for the period of 2008–2010. On the other hand, the estimated GDP growth consistent with low inflation (within the convergence criteria band) is 2.6%. Therefore, there seems to be some trade-off between nominal and real convergence. The author argues to reconsider the inflation convergence criterion to be applied to tradable goods only, which would rule out the B-S effect problem. There are many studies of the B-S effect for the CEE countries by Balazs Egert [2002, 2003]. In the first article he studied the B-S effect for Czech Rep., Hungary, Poland, Slovakia and Slovenia, using panel cointegration techniques. The author assumed for simplicity, that productivity growth of non-tradables is the same for the whole group of countries, therefore he only studied the evolution of productivity in the tradable goods sector, approximated by industry. I this

study the implied inflation difference between Poland and Germany, resulting from the B-S effect was in the range of 1,51 to 3,25 pp. The author also suggests that the real exchange rate appreciation for the studied countries was not fully explained by the productivity differential. Mihaljek and Klau [2004] offer an interesting study of the impact of relative productivity differential on the inflation difference between any given country and the Eurozone. The sample covered six countries (Croatia, Czech Rep., Hungary, Poland, Slovakia and Slovenia) during the period of 1992–2001. The authors' calculations seem to indicate that there is no significant impact of the observed relative productivity differentials on inflation differentials. The study does not confirm the relative productivity differential impact on domestic inflation rates. The conclussion is therefore, that the B-S effect should not be a problem for the nominal convergence criteria for these countries.

Natalucci and Ravenna [2002] offer a theoretical paper drawing of a general equilibrium framework, which is calibrated. The authors draw the following conclussions. First, in the fixed exchange rate regime it is not possible to satisfy exchange rate convergence criterion and the inflation rate at the same time. Second, they argue that high relative productivity differential of candidate countries with respect to the Eurozone, may impose additional costs of exchange rate stabilization policy. These costs may show up in the form of inflation or output gap instability. Błaszkiewicz et al. [2004] also try to estimate the B-S effect for CEE countries (period 1994–2003). Using panel data techniques (FMOLS—Fully Modified Ordinary Least Squares) they find that the B-S effect may be responsible for a higher inflation in Poland than in the Eurozone. The size of the effect is not higher than 2pp.

Some empirical studies of the B-S effect confirm the relationship between relative productivity evolution and real exchange rate changes, and some do not. There is a variety of approaches and methods, which results in quite mixed conclussions about the size of the B-S effect. The discrepancy of results may be explained by problems with data construction, tradable and non-tradable goods sectors definitions, proper measure of productivity and prices. Estimates of the B-S effect for CEE countries show that the typical size of the B-S effect is about 1–2pp.

2. Theoretical framework

The economy can be divided into two sectors: tradable goods sector—which is the sector where production is partly being exported or it competes with imported goods; and non-tradable goods sector—which is the rest of the economy, where there are no exports and no competition with imported goods takes place[3]. The 'Balassa-Samuelson' effect, formulated first by Balassa [1964] and Samuelson [1964], describes deviations from Purchasing

[3] The choice of criteria of division is always somehow arbitrary decision.

Power Parity stemming from international differences in productivity growth between tradable and nontradable goods sector. They show that real exchange rate changes are proportional to changes in the prices of non-tradable goods relative to tradables. A theoretical model that will be developed here follows this conclusion. It is a common fact (empirical observation), that productivity grows faster in the tradable goods sector than in non-tradable goods. We assume, that the 'Law of one price' (LOOP) holds for tradable goods sector, and it doesn't necessarily hold for non-tradables. By LOOP, we have a tradable goods prices equalization (by international competition), as measured in terms of common currency. This conclusion however, need not be true for non-tradables, and it seems consistent with empirical observations: the higher GDP per capita prices of services tend to be higher. The increase in productivity in the tradable goods sector leads to increase of wages (and this is not detrimental to competitiveness). Under the assumption of perfect labor mobility, it implies that wages increases not only in the tradable goods sector, but in non-tradables as well. Producers of non-tradable goods, when labor costs rise, will have to increase final goods prices, which leads to an increase in relative price of non-tradables (in terms of tradables). And this in turn leads to a higher overall economy-wide price level, since prices of non-tradables are part of an economy-wide price index.

Let's formalize the model. The overall price level for the whole economy can be expressed as weighted average of price levels for tradable and non--tradable sectors:

$$P = P_T^{\alpha} P_{NT}^{1-\alpha} \tag{1}$$

$$P^* = P_T^{*\alpha^*} P_{NT}^{*1-\alpha^*} \tag{1a}$$

where P_T—is the tradable goods price index, P_{NT}—non-tradable goods price index, α—tradable goods share in GDP. Asterisks denote variables for foreign economies throughout the article. Real exchange rate is expressed as the relative price of foreign goods with respect to domestic goods, where E is the nominal exchange rate (defined as the amount of domestic currency per one of foreign).

$$Q = \frac{EP^*}{P} \tag{2}$$

Next we take logs of equations (1) and (1a), plug them into equation (2) (also in logs), and we denote variables in logs with lowercase letters to obtain:

$$q = e + \alpha^* p^{*T} + (1-\alpha^*) p^{*NT} - \alpha p^T - (1-\alpha) p^{NT} \tag{3}$$

Differentiating the above expression with respect to time, yields the rates of change of variables under study. Let's use the following simplifying notation: $\frac{d\ln Y}{dt} = \frac{\dot{Y}}{Y} = \hat{y}$.

$$\hat{q} = \left(\hat{e} + \hat{p}^{*T} - \hat{p}^{T}\right) + \left(1-\alpha^{*}\right)\left[\hat{p}^{*NT} - \hat{p}^{*T}\right] - (1-\alpha)\left[\hat{p}^{NT} - \hat{p}^{T}\right] \tag{3a}$$

We assumed, that the 'Law of one price' (LOOP) holds for tradable goods sector. From this assumption it follows that:

$$\hat{p}^{T} = \hat{e} + \hat{p}^{*T} \tag{4}$$

and it becomes evident, that the first expression on the right hand side of the equation (3a) simply reduces to zero. Therefore, we can write that:

$$\hat{q} = \left(1-\alpha^{*}\right)\left[\hat{p}^{*NT} - \hat{p}^{*T}\right] - (1-\alpha)\left[\hat{p}^{NT} - \hat{p}^{T}\right] \tag{5}$$

From equation (5) we can see that when $\hat{p}^{NT} - \hat{p}^{T} > \hat{p}^{*NT} - \hat{p}^{*T}$ then we observe a real domestic currency appreciation[4].

We further assume perfect mobility of capital and labor in the economy under study. Furthermore, we assume, that production functions can be expressed by a Cobb-Douglas functions of the following form:

$$Y^{T} = A^{T} L_{T}^{\alpha^{T}} K_{T}^{1-\alpha^{T}} \tag{6}$$

where: Y—production, L—labor employment, K—capital, α—represents share of labor costs in total costs of production and A—technology parameter. Under the assumption of perfect competition, final goods prices equalize marginal cost of production. On the other hand, perfect mobility of factors leads to equalization of factor prices. Profit maximization leads to the following four conditions:

$$W = A^{T}\alpha^{T}\left(\frac{K_{T}}{L_{T}}\right)^{1-\alpha^{T}} \tag{7}$$

$$W = \frac{p^{NT}}{p^{T}} A^{NT}\alpha^{NT}\left(\frac{K_{NT}}{L_{NT}}\right)^{1-\alpha^{NT}} \tag{8}$$

$$R = A^{T}\left(1-\alpha^{T}\right)\left(\frac{K_{T}}{L_{T}}\right)^{-\alpha^{T}} \tag{9}$$

[4] Assuming that tradable goods sector's share in GDP is similar in both countries.

$$R = \frac{p^{NT}}{p^{T}} A^{NT}\left(1-\alpha^{NT}\right)\left(\frac{K_{NT}}{L_{NT}}\right)^{-\alpha^{NT}} \tag{10}$$

and we complete the supply side with the two full employment conditions:

$$K_T + K_{NT} = K \tag{11}$$

$$L_T + L_{NT} = L \tag{12}$$

where: W—wage rate and R—rental rate for capital, expressed in terms of tradable goods price. Leaving aside some transformations (one should take logs of equations (7)–(10), then differentiate them with respect to time, and equalize expressions for factor prices changes) we can derive the so called domestic version of Balassa-Samuelson effect, also called Baumol-Bowen effect as:

$$\hat{p}^{NT} - \hat{p}^{T} = \frac{\alpha^{NT}}{\alpha^{T}}\hat{a}^{T} - \hat{a}^{NT} \tag{13}$$

It follows from the above expression, that when productivity in tradable goods sector grows faster than in non-tradable goods sector, then prices of non-tradables relatively to tradables increase. It is worth noting, that this conclusion may not hold, if tradable goods sector is more labor intensive than the non-tradable one, i.e. when $\alpha^{NT} < \alpha^{T}$. But in opposite situation, i.e. $\alpha^{NT} > \alpha^{T}$, even a small difference of relative productivity growth may lead to an increase of the relative price of non-tradable goods. We can conduct similar reasoning for a foreign economy, writing the same equations marked with (*). Doing so, we can plug equation (13) in Foreign country version, into equation (5). Next we can substitute equation (2) after taking logs and differentiating it with respect to time, and we derive the expression for inflation differentials between home and foreign country, given by:

$$\hat{p} - \hat{p}^{*} = \hat{e} + (1-\alpha)\left[\frac{\alpha^{NT}}{\alpha^{T}}\hat{a}^{T} - \hat{a}^{NT}\right] - \left(1-\alpha^{*}\right)\left[\frac{\alpha^{*NT}}{\alpha^{*T}}\hat{a}^{*T} - \hat{a}^{*NT}\right] \tag{14}$$

The difference in inflation rates can therefore be expressed as a sum of two elements: domestic currency depreciation rate and the difference between domestic $\left(\hat{a}^{T} - \hat{a}^{NT}\right)$ and foreign $\left(\hat{a}^{*T} - \hat{a}^{*NT}\right)$ relative productivity growth. According to our theoretical Balassa-Samuelson effect framework, three cases may be at work, when we think about Poland (as Home) and EU (as Foreign):

	productivity difference	exchange rate change*
1.	0	0
2.	+	–
3.	–	+

Note: For simplicity it is assumed that $\alpha = \alpha^{*}$, $\alpha^{NT} = \alpha^{T}$, $\alpha^{*NT} = \alpha^{*T}$. * indicates appreciation.

Third case is not an interesting one, since empirical observations show that productivity grows faster in Poland than in EU. Case no. 1 assumes no relative productivity growth differential between Poland and EU, which is also less likely to happen. The most interesting and relevant for our analysis is the second case. It shows that given expected positive relative productivity growth differential in favor of Poland, we can expect a nominal exchange rate appreciation in Poland (assuming stable inflation difference). But this may be in contradiction with convergence criteria of exchange rate stability. The case of perfect compliance with both inflation and exchange rate criteria is shown in case 1, when we observe no relative productivity growth differential between Poland and EU.

3. Data: tradable and non-tradable goods

Restriction of data availability is the leading cause of loss of freedom in choosing variables and estimation methods. Researchers are therefore often restricted to use only variables that they have and methods that can be used in such cases. The most important thing to do first, when it comes to empirical verification of the Balassa-Samuelson theoretical model, is to divide the economy into tradable and non-tradable goods sectors. This intellectual concept needs to be confronted with reality. The next thing to do, is to calculate relevant variables for the two sectors previously defined. The main variables are price levels and productivity measures. Some authors conclude that this task is hardly possible with satisfactory precision (see e.g. Groen & Lombardelli [2004]). Nevertheless, we have to bear in mind, that all implications are always biased by sectors division scheme[5].

There are as many division criteria as many authors. De Gregorio, Giovannini and Wolf [1994] assume that a given sector is tradable, whenever its export share of production exceeds 10%. But this division rules out sectors, which exhibit strong import competition, which should also be treated as tradable, because we may expect the 'Law of one price' to hold. Orłowski [2001] adopts criterion which takes standard deviation of price indices measured in common currency of many sectors of given economies into account. Every sector for which standard deviation is lower than 20% is accounted as tradable. In this article, I treat a sector as tradable, when export share of its production or import penetration ratio is higher than 10%[6]. Tradable goods sector consists of all sections of manufacturing and coal mining[7]. The remaining part of economy is considered as non-tradable. Table 1 presents val-

[5] Dividing economy into tradables and non-tradables will always be somehow imprecise also because many goods referred as being tradable, contain some non-tradable component such as transport services, and so on.

[6] See Table 6 in the appendix.

[7] More disaggregated yearly data show that Food and Tobacco industry should be considered nontradable, but quarterly data, which I use for estimation are more aggregated, and it was impossible to decompose value added. Thus whole manufacturing was considered tradable.

ues of import penetration ratio and export share of production for sectors defined this way for the period of 1992–2001.

Table 1.

Export share of production and import penetration ratio for tradable (*T*) and non-tradable (*NT*) goods sectors, 1992–2001

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Tradables										
X_{sh}	22.21	24.51	26.89	27.60	27.17	27.70	29.86	30.78	34.06	36.81
M_{pen}	27.18	30.26	31.72	32.66	36.31	39.89	42.34	43.51	45.06	45.39
Non-tradables										
X_{sh}	1.86	1.48	1.68	1.54	1.50	1.83	1.47	1.33	1.30	1.31
M_{pen}	1.62	1.83	2.00	1.88	2.18	2.05	1.84	1.63	1.52	1.42

Note: export share of production—X_{sh}.; import penetration ratio—M_{pen}.
Source: Own calculations based on [STAN OECD Database, 2003].

4. Data and stylized facts

4.1. Data sources

The following data sources are used in this article:

- Main data source: quarterly data for EU15 and Poland—Eurostat, New Cronos online database, 1995(1)–2004(2);
- Price indices: Industrial CPI, Services CPI—Eurostat;
- International Financial Statistics IMF;
- STAN Industry Database (OECD) CD-ROM 2003—trade data, productivity, employment, value added data available at 2-digit ISIC level;
- Main Economic Indicators (OECD)—data on price indices.

4.2. Stylized facts

Table 2.

Labor productivity, 1992–2002

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1992 = 100											
T	100.00	110.77	121.39	130.63	142.27	157.75	166.68	186.05	211.89	217.16	225.18
NT	100.00	103.10	105.32	108.96	110.50	111.55	113.11	119.33	124.26	126.34	128.85
previous year = 100											
T	–	110.77	109.58	107.61	108.91	110.88	105.66	111.63	113.89	102.49	103.70
NT	–	103.10	102.15	103.46	101.42	100.95	101.40	105.50	104.14	101.67	101.99

Source: Own calculations based on: [OECD, *STAN database*, 2003].

Data presented in table 2 indicate constant growth of labor productivity (measured as the relationship of value added to employment) in Poland. For the whole economy, productivity grew by 48.5% between 1992 and 2002. It is quite evident that the productivity growth rate was much higher in tradable goods sector, and the data suggests it reached 125%, whereas for non-tradable goods sector it was only 29% during the same time period. The basic presumption of the Balassa-Samuelson effect holds. We do observe an increasing relative productivity growth in tradable goods sector in Poland.

The data also shows that employment in tradable goods sector decreased by 42%, but real production increased by 56% at the same time. Non-tradable goods sector employment decreased by 12% and real production increased by 28%. Next step is to look at the evolution of the relative price of non-tradables with respect to tradables. If productivity growth in tradable goods sector leads to an increase of wages which spreads on the whole economy, then we should also expect a rise of the relative price of non-tradables over time. This should also contribute to real appreciation of domestic currency. Figure 2 shows the evolution of the relative price of non-tradables in Poland and in UE15 between 1995(1) and 2004(2).

Table 3 presents average growth rates of given variables for the period of 1995–2004 for Poland and EU15. It seems that the average growth rate of labor productivity in the tradable goods sector was higher than in the non-tradable goods sector by 5.68pp[8]. On average, prices in the non-tradable goods sector were growing faster than in the tradable goods sector by 2.99pp. Relative labor productivity grew faster also in EU15 countries, but by only 1.4%, and the prices of non-tradables grew faster than prices of tradables by only 1.24pp.

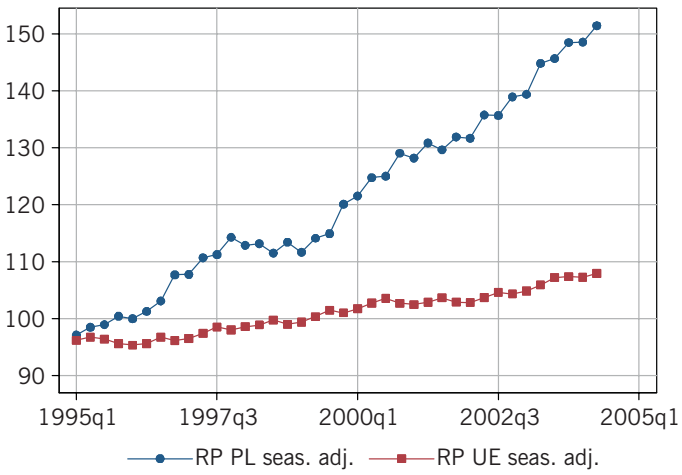

Figure 1.

Relative labor productivity in Poland and EU15, 1995(1)–2004(2)

[8] For yearly data from OECD *STAN database* 2003, this growth rates difference is 5.93 pp.

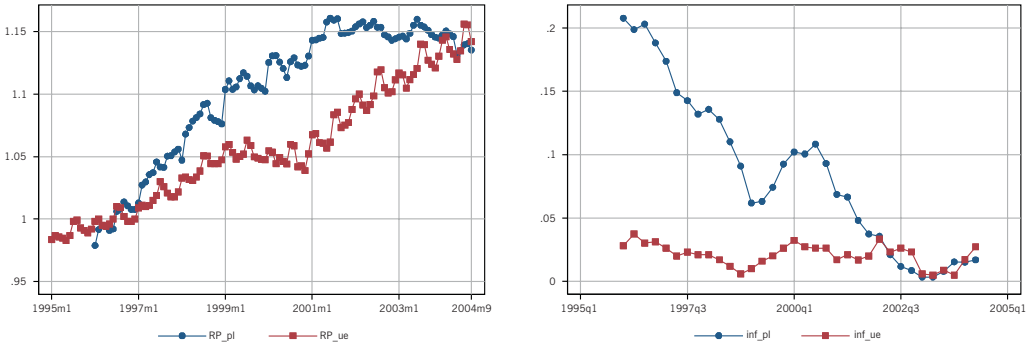

Figure 2.

Relative non-tradables prices and inflation in Poland and EU15, 1995(1)–2004(2)

Table 3.

Yearly average growth rates of selected variables in tradable (T) and non-tradable (NT) goods sectors for Poland and EU15, 1995–2004

	Poland	EU15
Employment (T)	–3.53	–0.73
Employment (NT)	–0.31	1.47
Labor productivity (T)	9.45	2.29
Labor productivity (NT)	3.77	0.89
Inflation (T)	6.42	1.38
Inflation (NT)	9.41	2.62

Source: Own calculations based on Eurostat, New Cronos *on-line*, 2004.

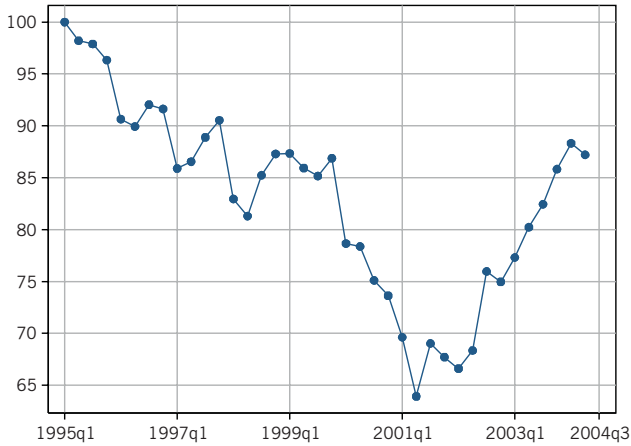

Figure 3.

Real exchange rate of Zloty against Ecu/Euro (decrease indicates appreciation)

5. Empirical estimation of Balassa-Samuelson effect

The theoretical model derived in section 2 will now be econometrically estimated. Therefore, I use equation (14) as a basic formulation for econometric verification. Changing notation, it can be rewritten as:

$$\Delta_4 p_t = \beta_0 + \beta_1 \Delta_4 e_t + \beta_2 \Delta_4 RLP_t + \varepsilon_t$$

where all lowercase variables are expressed in logs, and:

$$RLP_t = \left[\ln\left(\frac{LP^T}{LP^{NT}}\right)_t - \ln\left(\frac{LP^{*T}}{LP^{*NT}}\right)_t \right]$$

is the international relative productivity differential. First, we have to check the integration order of variables, in order to determine the stationarity of time series we use. Therefore we conduct the Augmented Dickey-Fuller test, to test for stationarity. Results are presented in the table below.

Table 4.

Augmented Dickey-Fuller test (ADF) for variables integration

Variable	$\Delta_4 p_t$	$\Delta_4 e_t$	$\Delta\Delta_4 e_t$	$\Delta_4 RLP_t$
ADF	–3.594	–1.793	–6.898	–3.392
Critical value (5%)	–3.567	–3.568	–3.572	–2.983

Augmented Dickey-Fuller test statistics allow us to conclude that variables: $\Delta_4 p_t$ and $\Delta_4 RPL_t$, which are the inflation difference and productivity difference are stationary, whereas the variable indicating yearly change of exchange rate ($\Delta_4 e_t$) becomes stationary after differencing this time series once. Estimation equation therefore takes the Autoregressive form with Distributed Lags (ADL), and can be written in the following way:

$$\Delta_4 p_t = \alpha_0 + \alpha_1 \Delta_4 p_{t-1} + \alpha_2 \Delta\Delta_4 e_t + \alpha_3 \Delta_4 RLP_t + \alpha_4 \Delta_4 RLP_{t-1} + \varepsilon_t \qquad (15)$$

The above stated model can be derived from the more general one, given by:

$$\Delta_4 p_t = \beta_0 + \beta_1 \Delta_4 p_{t-1} + \beta_2 \Delta_4 e_t + \beta_3 \Delta_4 e_{t-1} + \beta_4 \Delta_4 RLP_t + \beta_5 \Delta_4 RLP_{t-1} + \varepsilon_t$$

with constraint: $\beta_2 = -\beta_3$

If $\beta_2 = -\beta_3$, then $\Delta_4 e_t - \Delta_4 e_{t-1} = \Delta\Delta_4 e_t$. After estimation of unconstrained model the following hypothesis was tested:

$$H_0: \beta_2 = -\beta_3$$

and appropriate critical value was $F(1,27) = 1.70$, for which the *p-value* equals 0.204, which is too much to reject the null hypothesis stated before. Estimation of model given by (15) yields the following results:

Table 5.

Estimation results

Variable	α	(S. E.)
LS4.ln*P* (α_1)	0.721***	(0.131)
DS4.E (α_2)	0.033	(0.035)
S4.*RLP* (α_3)	0.154**	(0.068)
LS4.*RLP* (α_4)	–0.047	(0.074)
Const (α_0)	–0.010*	(0.006)
Diagnostics Tests		*p-value*
N	29	
R2	0.71	
F(4,24)	14.85	(0.000)
DW(4,28)	1.59	
Breusch-Pagan	0.41	(0.525)
Breusch-Godfrey $\lambda(1)$	3.02	(0.082)
$\lambda(2)$	3.58	(0.167)
$\lambda(3)$	3.69	(0.296)
$\lambda(4)$	6.51	(0.164)
Ramsey RESET *F*(3,21)	0.70	(0.560)
Jarque-Bera	0.30	(0.863)

Durbin-Watson statistic is 1.59, while the upper critical value for 29 observations and 4 estimated parameters is 1.73, the lower equals 1.12, which means the test is inconclusive. The Breusch-Godfrey test, based on Lagrange Multipliers, which assumes null hypothesis of no autocorrelation gives no reasons to reject this hypothesis, since *p-values* are reasonably high. Breusch-Pagan test for heteroschedasticity of error term indicates there is no reason to reject the null-hypothesis of homoschedasticity. Ramsey RESET test indicates that the functional specification of the model is correct. Normality of error terms was tested using Jarque-Bera test, which does not allow for rejecting the null hypothesis of normality.

After estimation of this model, two basic conclussions can be drawn. First, if we assume that $E(\Delta_4 e_t) = 0$ (fixed exchange rate regime) and the relative productivity continues to grow faster in Poland than in EU15 by the value of

the average difference for 1995–2004, i.e. about 4.28 pp, then the inflation difference between Poland and EU15 implied by the model, should be[9]:

$$\Delta_4 p^* = \frac{\alpha_0 + (\alpha_3 + \alpha_4)\Delta_4 RLP^*}{1 - \alpha_1} = 1.61$$

This means, that if relative productivity in Poland continues to grow as fast as the average rate for the last 10 years, then inflation in Poland may be higher than in EU15 by ca. 1.61pp, which is slightly more than Maastricht criteria of convergence band. It should be noted however, that this difference value is calculated against EU15 countries average, not against the three best performing economies, regarding inflation. It is reasonable to expect that the inflation reference values are lower than EU15 averages. It is therefore reasonable to expect slightly higher difference of inflation rates between Poland and the reference values resulting from Balassa-Samuelson effect.

Second, if we consider a different scenario, assuming that prices in Poland grow at the same rate as in EU15 (The National Bank of Poland may wish to stabilize inflation at EU15 level in order to meet inflation criteria of convergence), this means that $E(\Delta_4 p_t) = E(\Delta_4 p_{t-1}) = 0$. If at the same time, The NBP wants to meet exchange rate criteria, so that $E(\Delta_4 e_t) = 0$, then the relative productivity growth difference between Poland and EU15 implied by the model is equal to:

$$0 = \alpha_0 + (\alpha_3 + \alpha_4)\Delta_4 RLP^*$$

$$\Delta_4 RLP^* = -\frac{\alpha_0}{\alpha_3 + \alpha_4} = 0.09$$

Summary

The main goal of this article was to estimate the so called Balassa-Samuelson effect in Poland for the transformation period. As expected, a catching-up economy like Poland's, exhibits higher productivity growth than more developed countries, especially EU15. This productivity growth is mainly located in the tradable goods sector, which means that we observe a relative productivity growth. This relative productivity growth is also higher in Poland than in EU15. Theoretical predictions of the Balassa-Samuelson model indicate that in such a situation as this one, this relative productivity difference translates into real appreciation of Polish Zloty against the Euro. In fully floating exchange rate regime this is not a matter of problem. The issue of Balassa-Samuelson effect became more popular recently, because of its theoretical implications for nominal and real convergence incoherence. It may be shown, that for fast growing economies it can be difficult to meet two

[9] Orłowski [2001] estimates, that assuming 6% GDP growth rate, the Balassa-Samuelson effect in fixed exchange rate regime can contribute to a higher inflation in Poland than in EU15 by 2.4 to 4.2 pp. Other estimates are significantly lower—from 1 to 2 pp.

convergence criteria (inflation stability and fixed exchange rate) at the same time. Accession of Poland to EU may even speed up its growth, and further aggravate this problem.

A theoretical model was formulated and then it was estimated using standard time series methods. Obtained estimates for quarterly data for the period of 1995(1)–2004(2) show, that the incoherence of the two convergence criteria may be a small problem for Poland, if joining EMU takes place very soon. There are potentially other reasons (public finance system problems), which may make the road to adopting Euro even more winding, but this was not the concern of this short article. We need to be very careful when formulating a policy implication, since the assumptions of the theoretical model we use here are very strong. The 'Law of one price' may not hold perfectly even in tradable goods sector, or it may not hold in the short run. In the short run (if not even medium run) labor mobility may be limited, which may prevent wages from economy-wide equalization. It seems that the B-S effect estimates are sensitive to definition of tradable and non-tradable goods sectors as well. The Balassa-Samuelson effect estimations need further research. Possible extensions and applications involve labor market adjustment during the process of 'nominal' convergence on the road to joining monetary union.

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Appendix

Table 6.

Export share of production and import penetration ratios in selected manufacturing sections —averages for 1992–2001

Industry	ISIC Rev.3	M_{pen}	X_{sh}
Total manufacturing	15–37	32.4	26.0
Food products and beverages	15	9.6	10.0
Tobacco products	16	2.0	4.7
Textiles	17	54.0	31.1
Wearing apparel, dressing and dying of fur	18	31.4	68.9
Leather, leather products and footwear	19	38.2	37.0
Wood and products of wood and cork	20	9.3	29.4

Industry	ISIC Rev.3	M_{pen}	X_{sh}
Pulp, paper and paper products	21	44.0	26.9
Printing and publishing	22	10.2	3.7
Coke, refined petroleum products and nuclear fuel	23	14.3	9.9
Chemicals and chemical products	24	49.2	26.4
Rubber and plastics products	25	33.2	17.5
Other non-metallic mineral products	26	17.5	15.5
Basic metals	27	31.3	42.2
Fabricated metal products	28	26.3	27.2
Machinery and equipment, n.e.c.	29	53.5	28.2
Office, accounting and computing machinery	30	82.9	19.5
Electrical machinery and apparatus, nec	31	45.2	41.5
Radio, television and communication equipment	32	61.0	36.4
Medical, precision and optical instruments	33	48.8	14.2
Motor vehicles, trailers and semi-trailers	34	48.8	36.8
Other transport equipment	35	28.1	52.1
Manufacturing nec; recycling	36–37	24.5	43.0

Export share of production—X_{sh}
Import penetration ratio—M_{pen}
Source: Own calculations based on: OECD, *STAN database*, 2003.

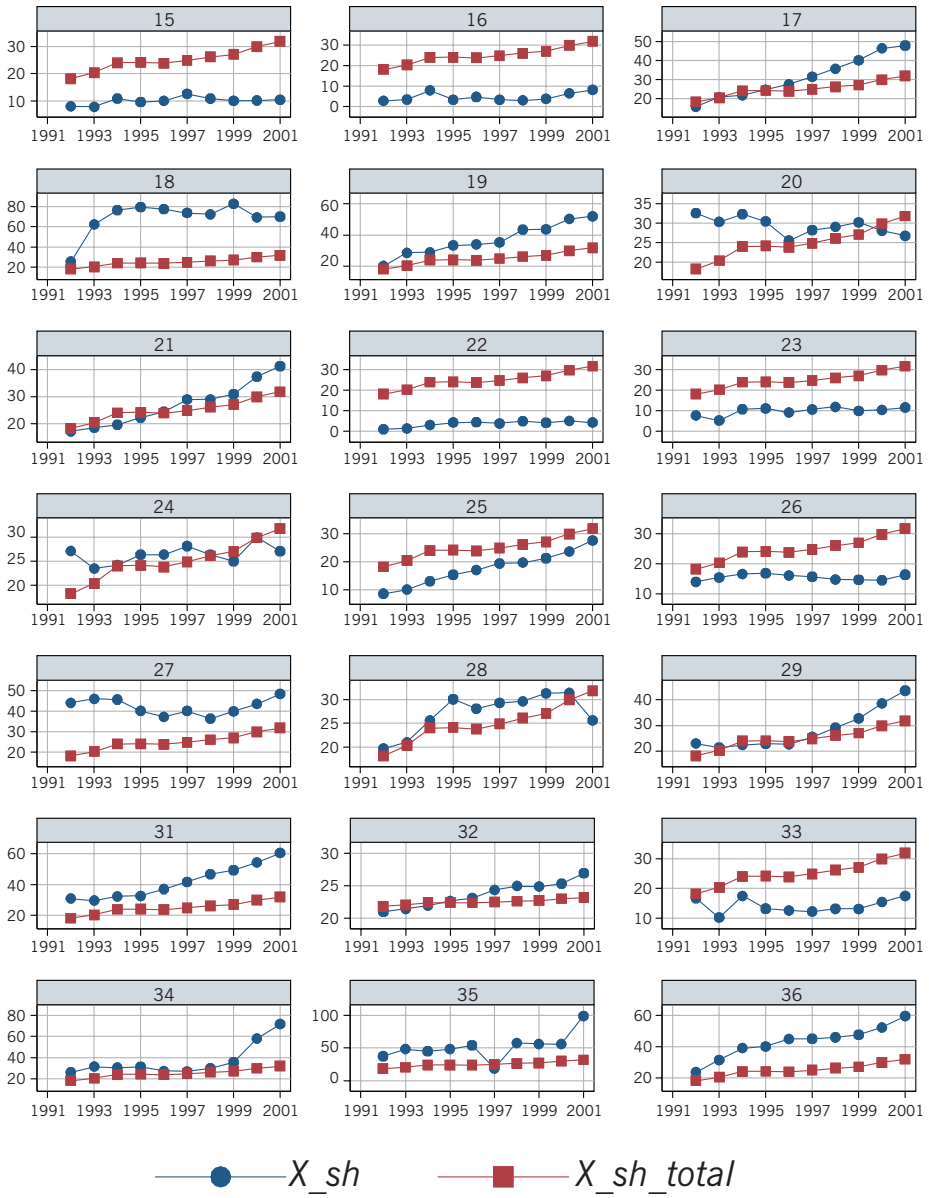

Figure 4.

Export share of production in manufacturing

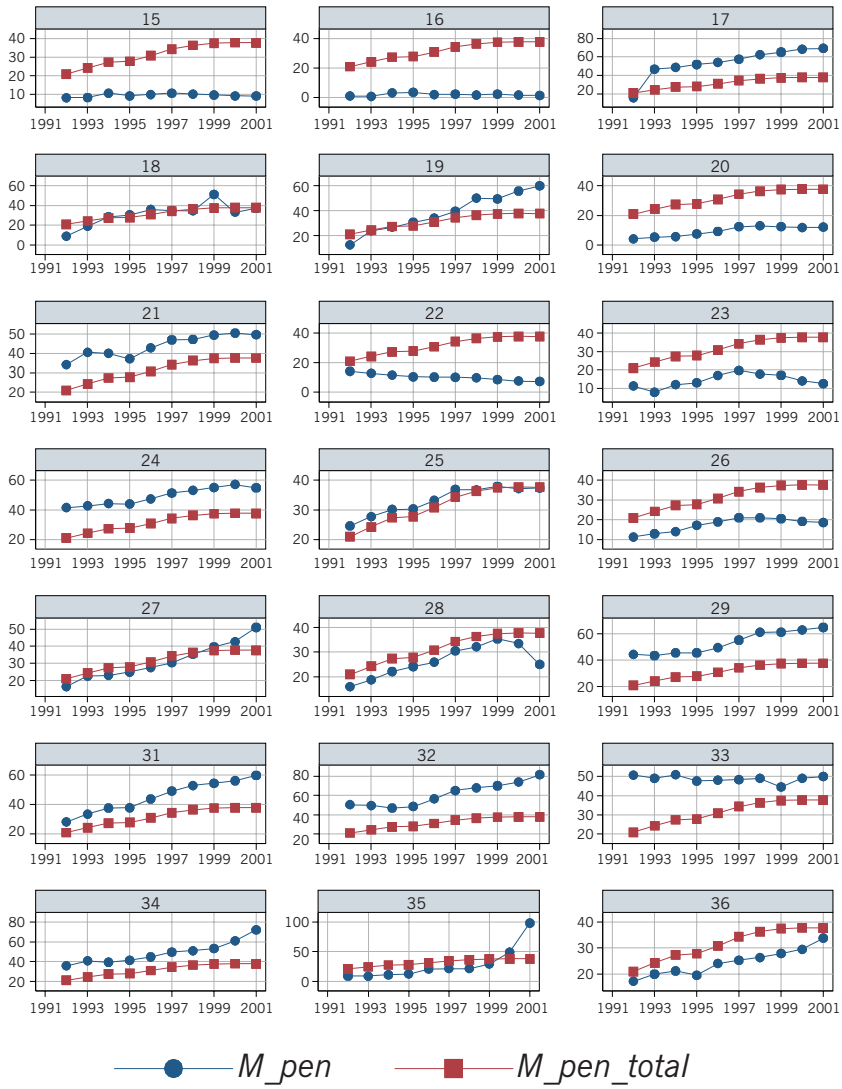

Figure 5.
Import penetration ratio in manufacturing

Abstract In this article I try to estimate the Balassa-Samuelson effect for Poland during the transition period. I try to answer the question about the difference in inflation between Poland and EU that can be attributed to productivity growth differentials. Expected further faster growth of tradable goods productivity in Poland as compared to EU, apart from other factors, can contribute to real appreciation of Polish zloty and/or a higher inflation rate. Both of these results can negatively influence the possibility of compliance to Maastricht convergence criteria. My calculations for the period 1995(1)–2004(2) (quarterly data) that higher relative productivity growth in Poland than in EU translated to a higher inflation in Poland by 1.6pp than EU15 average.