THE RELATIONSHIP BETWEEN PRODUCTIVITY AND PRICES: THE CASE OF UKRAINE

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Abstract

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This paper aims at estimating the Balassa-Samuelson (B-S) effect in Ukraine. The B-S effect highlights the relationship between relative productivity in a small open economy's traded and non-traded goods sectors and relative prices in these two sectors. The existence of a positive relationship would indicate that inflation would be, the extent found, driven by productivity growth, which would have implications for monetary policy in Ukraine. To test the relationship between relative productivity and prices, a multivariate time series approach was used (cointegration analysis and error correction models). The data on gross value added and employment disaggregated to 19 economic sectors was used for computing the relative productivity of tradable and non-tradable goods sectors. Two different proxies for prices and six different proxies for relative productivity were constructed for the purposes of testing B-S effect. The results indicate that the relationship between relative prices and relative productivity of tradable and non-tradable goods sectors is weak in Ukraine.

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B-S effect – Balassa-Samuelson effect
CV – cointegration vector
ECM – error correction model
LHS – left hand side
RER – real exchange rate
RHS – right hand side
TFP – total factor productivity
VAR – vector autoregressive
VECM – vector error correction model

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GLOSSARY

Balassa-Samuelson (B-S) effect: The impact on a small country's consumer price level of an increase in the productivity in the tradable sector.

Dual productivity changes: The ratio of relative productivity changes between the two countries.

Dual inflation: Different inflation behaviour followed by tradable and non-tradable goods

External transmission mechanism: The pass-through from productivity differences through the difference in relative prices towards the real exchange rate.

Internal transmission mechanism: The relationship that links the productivity differential to the relative price of non-tradable goods in terms of tradable goods in the country.

Relative productivity changes: Productivity change in the non-tradable goods sector relative to the tradable goods sector productivity within one country.

Real Exchange Rate (RER): Relative price between a domestic and foreign commodity basket.

Total factor productivity (TFP): TFP is a productivity measure involving all factors of production. Other traditional measures of productivity, such as labour productivity in a factory, fuel productivity in power stations, and land productivity in farming, are what are known as partial measures of productivity.

Relative productivity: means productivity of tradable goods sector relative to the non-tradables goods sector

Relative prices means prices of non-tradable goods sector expressed in terms of prices of the tradable goods sector.

Chapter 1

INTRODUCTION

A key issue for transition countries is the extent to which inflation is purely a monetary phenomenon, or whether it reflects rising productivity. This question is of particular concern for countries acceding to the European Union, since they must at some point set themselves on the path to meet the so-called Maastricht criteria in order to be able to adopt the euro. The concern for transition countries is that the inflation they experience may reflect, in whole or in part, rising productivity, and therefore policies to reduce inflation to meet the Maastricht criteria could in fact impede the development of the economy. Various studies have therefore tried to estimate this catch-up in prices as a result of rising productivity in these economies using as a basis the so-called Balassa-Samuelson theory.

However, this issue is also relevant for other transition economies in that it has implications for the conduct of monetary policy. Rising inflation or a steady appreciation of the exchange rate as a result of rising productivity does not require the same monetary policy response as when they are not productivity driven. Ukraine is an attractive candidate to study the relationship between relative productivity and relative prices using the Balassa – Samuelson (B-S) theoretical framework on account of the fact that inflationary pressure has been high in recent years in Ukraine (in 2003 the prices increased by more than 8%), and productivity gains are expected to be substantial. Ukraine is expected to experience substantial productivity gains as it moves towards a market economy. Since the overall level of development in Ukraine lags behind that of developed countries, there is great potential for productivity convergence between Ukraine and advanced economies. Moreover, the removal of distortions inherited from central planning is expected to lead to additional transition-specific productivity gains, since under central planning, productivity levels were lower than those in the market-oriented economies of the same level of development. Indeed real productivity was growing in the last eight years with the average rate of 7.5% in Ukraine.

The B-S theory initially, by dividing the economy into two sectors – a tradable goods sector and a non-tradable goods sector – tries to connect price changes with total factor productivity (TFP) changes in the respective sectors. Intuitively, this connection can be explained in the following way. According to this theory, productivity in the tradable goods sector grows faster than in the non-tradables sector, since the tradable goods sector is usually more capital intensive and exposed to foreign competition. This leads to an increase in real wages in the tradables sector. In the long run, given high labour mobility between sectors within the economy, the higher wages in the tradable sector will cause a labour force outflow from the non-tradables sector. To prevent this outflow, the non-tradable goods producers will have to raise wages artificially. As a result, wages in the non-tradables sector increase unjustifiably, that is, un-supported by the sector's productivity growth, which will cause inflationary pressure on prices of non-tradables. Thus, the B-S model tries to capture inflationary pressures in non-tradable goods prices. The concept itself is often referred to as a B-S effect.

This study aims at determining the extent to which relative productivity gains translate into relative price increases in Ukraine. The research questions are: (a) to determine the strength of the relationship between relative productivity and relative prices; and (b) to estimate the additional pressure that productivity may cause on the price level in Ukraine. These questions are of a concern for policy making institutions responsible for controlling inflation rate and price changes.

The hypothesis under study will be analyzed using a multivariate time series approach: cointegration analysis and vector error correction modeling. The following data from the Ukrainian Ministry of Statistics will be used: labor productivity in different sectors of the economy as a proxy for total factor productivity (TFP), price indexes as proxies for prices, and wages for an eight year period on a quarterly basis (from 1996 to 2003).

The paper has the following structure. In Chapter 2 literature is reviewed; in Chapter 3 the theoretical framework is presented; Chapter 4 describes the methodology and data; estimation results are given in Chapter 5. Chapter 6 concludes and discusses possible policy implications.

Chapter 2

LITERATURE REVIEW

This section presents an overview of the literature in the field of study. The first part of the literature review shows how the B-S framework can be used to study relative prices and *real exchange rate* (RER) behaviour. In the second part, a detailed analysis of the key papers is conducted to expose their methodological strengths and weaknesses and inform the approach to be used in this study.

Part I

Balassa (1964) and Samuelson (1964) developed a theoretical concept, which attempts to explain movements in a country's *relative prices* and real exchange rate from the supply side. According to this concept, difference in productivity growth in domestic and foreign country affects RER via wage equalization between sectors and relative prices changes. Most often this theory is referred to as the Balassa-Samuelson (B-S) theory. In its simplest form, the B-S effect can be explained as the impact on a small country's consumer price level of an increase in productivity in the traded goods sector. The increase in productivity will not reduce prices in the traded goods sector (assuming perfect competition) because prices of traded goods are determined in international markets. Therefore, real wages in the tradable sector will rise as a result of increased productivity. Given that there is no corresponding increase in productivity in the non-tradable sector, then, because of wage equalization (assuming perfect labour mobility across sectors in the long run) the price of non-traded goods must rise to accommodate the higher wages. The increase in prices in the non-traded goods sector implies a rise in the country's overall price level (correspondent to the weight of the non-traded goods sector in GDP), and ultimately, an appreciation in the RER

In fact, for the B-S theory to hold the following assumptions need to be made: (1) perfect competition (factors markets and final goods markets need to be competitive to allow for factor prices to be taken as given, and to allow for profit maximization condition); (2) constant returns to scale (to equalize factor intensities $\delta=\gamma=1/2$); (3) capital is perfectly mobile internationally (to equalize capital prices throughout the world); (4) labor is internationally immobile but mobile between the tradable and non-tradable sectors (to allow for wage equalization among the sectors); and finally (5) the theory is viewed as a theory for a small open economy to allow for the "law of one price" to hold for tradable goods.

The B-S framework incorporates several relationships, each of which can be tested. They are:

a) the relationship between changes in the relative productivity of non-tradables and the relative prices of non-tradables (or in other words the long-run inflation pattern in a single country);

b) the relationship between *dual productivity changes* (i.e. ratio of relative productivity changes between the countries and developments of the RER;

c) on the basis of the extended B-S framework the fundSamental equilibrium RER can be tested. The extended B-S framework allows for adding other fundamental variables into the model, such as government expenditures and capital flows.

Broadly speaking, to study relationships (a), (b) and (c) different methodological approaches are used. Though this paper focuses on studying only first relationship, we will describe shortly all three of them below, since they are closely related.

To study **relationship (a)**, long-run inflation patterns, – the *internal transmission mechanism* is used. The internal transmission mechanism is a relationship that links the productivity differential to the relative price of non-tradable goods in terms of tradable goods in the country under study. Schematically it can be presented in the following way:

$$\frac{prod(T)}{prod(NT)} \Rightarrow \frac{pr(NT)}{pr(T)}, \tag{15}$$

where *T* – tradable goods sector; *NT* – nontradable goods sector; *prod* – total factor productivity; *pr* – price level.

There are many examples in the literature of the use of the relationship (a) to investigate long run inflation patterns. In particular, there are numerous studies on transition economies[1]. Some authors attempt to model the RER using internal transmission mechanism [relation (15)], for instance, Coricelli and Jazbec (2001), or Halpern and Wyplosz (2001). However, such a modelling may lead to false conclusions since the relative price of non-tradable goods in terms of tradable goods influences only the internal allocation of resources and poorly depicts the external position of the country; which is true for industrialized countries especially.

Therefore, RER should be studied using only the **relationship (b)**. Relationship (b) allows for studying the RER as a function of dual productivity. Potentially, there are two ways to do it. First, the relationship between dual productivity differentials and the real exchange rate (RER) can be tested as:

$$\frac{prod(T)}{prod(NT)} \div \frac{prod(T^*)}{prod(NT^*)} \Rightarrow RER, \tag{16}$$

where an asterisk denotes trading partners' variables. In this case, the intermediate link is skipped, namely the connection between dual productivity and dual relative prices. Therefore, it is assumed in relation (16) that the relationship between dual productivity differentials and relative prices is a priori verified. However, there is a risk of finding a spurious relationship with this approach. In order to avoid it, a second approach has been adopted, in which the relationship between productivity

[1] See Backe et al. (2002), Sinn-Reutter (2001), Rother (2000), Simon-Kovacs (1998), Mihaljek (2003), Egert et al. (2002), Egert (2002).

developments and prices in the non-traded goods sector relative to the traded goods sector, and the relationship between these relative prices and the real exchange rate are tested separately. This relationship can be represented as:

$$\frac{prod(T)}{prod(NT)} \div \frac{prod(T^*)}{prod(NT^*)} \Rightarrow \frac{pr(T)}{pr(NT)} \div \frac{pr(T^*)}{pr(NT^*)} \Rightarrow RER \qquad (17)$$

The first approach (relation 16) is employed by Golinelli and Orsi (2001) to model inflation in EU accession countries. The second approach (relation 17) is tested by Egert (2002).

Both of the above mentioned approaches (a) and (b) are known as the simple B-S framework. However, the simple B-S framework can be extended – **relationship (c)** -- by adding other fundamental variables when trying to evaluate the influence of productivity differentials on relative price increases and RER behaviour. Usually these variables are government expenditures, (which fall heavily on non-traded goods and therefore change the relative price of nontradables) and capital inflows, (which are likely to increase the demand for nontradables, again resulting in an increase in the relative price of nontradables). Other fundamental variables which influence RER may be also included. The extended B-S framework is used to estimate the fundamental equilibrium real exchange rate[2].

Part II

This paper focuses on the study of long-run inflation patterns [relationship (a)].The key papers testing for long-run inflation patterns are those of Egert (2002), Egert (2003), Rother (2000) and Mihaljek and Klau (2003). In Egert (2002), the study was conducted for a group of transition countries (namely: Czech Republic, Hungary, Poland, Slovakia, and Slovenia), while Egert (2003) studies only Estonia. Rother

[2] A methodological overview of the fundamental equilibrium real exchange rate can be found in: Dobrinsky (2001), Filipozzi (2000), Randveer and Rell (2002), Halpern and Wyplosz (1997), De Broeck and Slot (2001) and Fischer (2002).

(2000) and Mihaljek and Klau (2003) also study the (a) relationship. However, the above mentioned four papers are not the only studies in the field. In recent years, there is a booming growth of papers testing B-S framework in transition economies. The main ones are brought down to the table 3.1: Comparative table of the selected empirical studies of the B-S effect in transition countries, table 3.1 is exported with some additional changes from Mihaljek and Klau (2003). As can be seen from the table the size of the B-S effect varies from study to study. The lowest estimates were obtained by De Broeck and Slok (2001) – 0.2 – 0.6 percentage points for a group of transition economies; the highest estimates are in the work of Halpern and Wyplosz (2001). The study of Arratibel finds B-S effect to be insignificant. However, Arratibel uses "new Keynesian approach" to estimate B-S effect, instead of the standard model derived by Balassa and Samuelson.

Below is a detailed analysis highlighting the weak and strong points of the key papers is presented. Egert (2003) studies the connection between productivity differentials and the relative price of nontradables in the long run in Estonia. He also uses a sectoral decomposition of the real exchange rate to explain movements in the RER with the changes in the relative prices of nontradables at home and abroad.

According to the author's estimations, the B-S effect contributes to CPI by a yearly average 2-3 %. Egert also finds strong evidence of the presence of the B-S effect in Estonia. The B-S hypothesis is tested using a benchmark of four major trading partners (Germany, Finland, Sweden, and UK). In the study, the author uses highly disaggregated data. A 15-sectoral breakdown for GDP and 5-digit level CPI data with over 260 items is used for the period 1993:Q1 to 2002:Q1.

Table 3.1. Comparative table of the selected empirical studies of the B-S effect in transition countries.

Study done by	Country, sample	Dependent variable	Sectoral decomposition		Other explanatory variables	Estimation method	Estimate of the B-S effect, percentage points
			Tradables	Non-tradables			
Kovacs and Simon (1998)	Hungary, 1991-96	REER*	Manufacturing	Services (excluding public administration)	--	Statistical analysis	2.9
Rother (2000)	Slovenia, 1993-98 quarterly	P^N/P^T (as PPI/labor costs)	Manufacturing	Rest (excluding agriculture)	Monetary base, budget deficit/GDP, gvt consumption/GDP	OLS	1.0 – 4.0
Cipriani (2001)	10 accession candidates, 1995-99 quarterly	P^N/P^T (from CPI)	Industry and mining	Rest (excluding agriculture)	--	OLS	0.5 – 0.7
De Broeck and Slok (2001)	25 transition countries, 1993-98	REER	Industry and construction	Services	Agricultural productivity, broad money, openness, budget balance, terms of trade, commodity prices	Pooled mean group estimation	0.2 – 0.6
Halpern and Wyplosz (2001)	8 accession candidates, Russia, 1991-98	P^N/P^T (services/non-food manufactured goods from CPI)	Industry	Services	GDP per capita, inflation acceleration term, lagged relative price	GLS	3.0
Coricelli and Jazbec (2001)	19 transition economies, 1990-98	P^N/P^T (sectoral GDP deflators)	Industry and construction	Rest	Share of non-tradable consumption, government consumption, "structural misalignment"	Panel, Fixed effects	0.9 – 1.2
Egert (2002)	6 transition economies, 1991-2001 quarterly	P^N/P^T (CPI/PPI); RER (D-mark)	Industry	Not considered (productivity set to zero)	--	VAR and panel cointegration	0.9 (pooled estimates); 0-3.5 (country estimates)
Fischer (2002)	10 accession candidates, 1993-99	REER	Industry	Services	Agricultural productivity, gvt cons/GDP, world real interest rate, terms of trade, commodity prices	SUR fixed effects	0.7 – 2.2 (partially attributed to the investment demand channel)
Arratibel et al (2002)	10 accession candidates, 1990-2001	P^N/P^T (CPI decomposition of NT/T goods and services)	Manufacturing	Not considered	Exchange rate regime, budget deficit, GDP per capita, wage growth, unemployment, oil price, terms of trade, etc	GMM	insignificant
Egert (2003)	Estonia, 1993-2002 quarterly	P^N/P^T (a number of measures employed: sectoral GDP deflators, disaggregated CPI, and PPI)	Several groups combining different sectors are used	Rest	--	VAR	0.5 – 2
Mihaljek and Klau (2003)	6 accession candidates, 1992-2001 quarterly	P^N/P^T (from CPI)	Manufacturing, mining, hotels, transportation and communications	Rest (excluding agriculture and public services)	--	OLS	0.3 – 1.6

* REER – Real equilibrium exchange rate

The author develops his own classification of tradables and non-tradables on the basis of each sector's behavioural characterisitcs. Sectors' behaviour is analysed in terms of the following criteria: openness to competition, presence of the trade arbitrage. Tradables include: agriculture, hunting, forestry, fishing, and manufacturing. Non-tradables comprise construction, trade, hotels, financial intermediation, real estate, renting, transport, and public services.

Egert employs cointegration analysis to confirm the relationships between the variables. The long run relationships are estimated using the Hodrick-Prescott technique. The results of the study indicate that in spite of the huge productivity advances in Estonia, the impact of the B-S effect on overall inflation was rather limited between 1993 and 2003. The main reason for this is the very low share of services in the CPI basket. The analysis also revealed that regulated prices diminish the B-S effect and that the classification of open and closed sectors may influence results. The results of the study seem to be quite sound, furthermore, very disaggregated, high quality data was used in the study

Egert (2002) studies a group of EU accession countries (Czech, Hungary, Poland, Slovakia, and Slovenia). Using time series and panel cointegration techniques (the sample size is 1991:Q1 – 2001:Q2), the author shows that the B-S effect cannot fully explain the movements inreal exchange rates. Egert also finds that productivity growth does not fully translate into price increases, which is explained by the calculations of CPI (regulated prices dampen the B-S effect, meaning that the regulations imposed on prices do not allow them to adjust freely to relative productivity changes).

The author makes two simplifying assumptions (due to the absence of the necessary data) in the study. First, non-tradables sector productivity growth is assumed to be zero across countries; second, non-tradable sector prices are proxied with the CPI and traded sector prices with PPI. In terms of B-S theory these assumptions may introduce some distortions in the results, since the productivity growth in non-traded sector may be different across countries. Additionally, the CPI reflects changes not only in non-traded goods prices, but also in traded goods prices, which is also true for a PPI, meaning that these indexes may not serve as good proxies.

Mihaljek and Klau (2003) in their study of the group of countries (Croatia, the Czech Republic, Hungary, Poland, Slovakia and Slovenia and the Euro area) attempt to overcome the simplifications that Egert (2002) makes. They employ more reliable estimates of traded and non-traded goods prices. In particular, they follow the De Gregorio et al. (1994) classification, which defines a sector as a "tradable" if more than 10 % of total production of this good is exported. The authors use a 15-sectoral breakdown to classify tradables and non-tradables.

Mihaljek and Klau depart from the panel data estimation technique on the grounds that this technique gives reliable results only if economies in the panel are highly homogeneous. Instead the authors extend the time span in the sample, which enables the B-S effect to be estimated for individual countries. Nevertheless, datasets are still very short for some countries, for example, for Croatia and Slovakia data runs from 1995:Q1 to 2001:Q3.

Initially aiming at explaining differences in inflation between the six countries and the Euro area, Mihaljek and Klau come up with the following results. Productivity differentials explain on average only 0.2 – 2.0 % of annual inflation differences vis-à-vis the euro area. Productivity differentials explain a small portion of domestic inflation in central European economies.

The estimated long run elasticity of inflation with respect to productivity differentials suggest that the B-S effect is likely to be smaller in the future. Taking this into consideration, Mihaljek and Klau conclude that the importance of the B-S effect on determining the ability of CEE countries to satisfy the Maastricht inflation criterion will diminish over time and will not be significant by the time CEE countries enter the EU.

There exists a possibility of obtaining spurious results using econometric techniques that Mihaljek and Klau employ. They apply OLS to the macroeconomic time series. However, as Plosser and Nelson (1982) state, almost 95% of macroeconomic time-series are non-stationary in levels, thus applying OLS to non-stationary series may lead to spurious regression, with misleading estimators and test statistic. The use of non-stationary variables not necessarily results in invalid estimators. An important exception arises when two or more I(1) variables are cointegrated.

Rother (2000) uses the simple B-S framework to study long-term inflation patterns in Slovenia. The period of analysis is 1993 to 1998 on a quarterly basis. Notwithstanding problems with the availability of data, the division of goods into tradables and non-tradables was rather simplistic. Manufactured goods were considered as traded, and the rest as non-traded.

The contribution of the B-S effect to domestic inflation was estimated on the basis of internal transmission mechanism (described above). According to the author's estimations, the average absolute impact on inflation of sectoral productivity differentials amounted to 2.6 % annually. The author also found evidence that overtime increased productivity-influenced inflation. He concluded that it may become increasingly difficult to reduce inflation to EU levels if the level of productivity differentials remains the same.

Some caution in interpreting results is warranted by Rother, since the relatively short observation period and the lack of some data leave some uncertainty regarding the robustness of results.

Among the simplifying assumptions common for most of the existing literature in the field are the following. First, factor intensities in non-traded and traded sectors are the same. Second, average labour productivity is used as a proxy for total factor productivity (TFP). The consequence of proxying TFP with average labour productivity is that productivity growth is exaggerated. This bias is usually greater for traded goods than non-traded goods, since traded goods are more capital intensive.

Though in recent years one can observe a booming growth in papers investigating the B-S effect from different angles (RER behaviour, inflationary pressure on prices, comparing inflation levels among countries and so on), still the vast majority of studies cover accession countries to the European Union. Ukraine is presented in two studies only (De Broeck and Slok, 2001 and Coricelli and Jazbec, 2001). These two papers aim at explaining the behaviour of the RER in terms of either productivity differentials (De Broeck and Slok) or structural changes and reforms (Coricelli and Jazbec). However, no studies have been conducted for Ukraine to investigate the relationship between productivity differentials and inflation patterns. This paper aims to fill that gap.

Chapter 3

THEORETICAL FRAMEWORK

In recent times the B-S model has been used extensively for assessing structural inflation patterns. If the following assumptions are satisfied then the price of tradable goods in terms of non-tradable goods is determined entirely by production technology, that is, demand preferences do not matter at all. Crucial assumptions to be fulfilled are: (1) factor markets and final goods markets are competitive, (2) production takes place under constant returns to scale, (3) capital is perfectly mobile internationally, and (4) labor is mobile between the tradable and non-tradable sectors. Below we show formally how relative prices are related to relative productivity, closely following derivation of B-S effect from Nelson Mark (2001).

The relationship between the change in the productivity differential and the change in relative prices can be derived using a Cobb-Douglas production function for the tradable and non-tradable sectors.

$$Y_T = A_T L_T^{(1-\gamma)} K_T^{\gamma}, \tag{1}$$

$$Y_N = A_N L_N^{(1-\delta)} K_N^{\delta}, \tag{2}$$

where subscript T – stands for tradable goods, and N – stands for non-tradable goods; Y – production of a good, A – total factor productivity, L – labor, K – capital.

According to the theory, this relationship holds in the long run. In this respect the balance of trade is assumed to be zero, which must be true in the long run. We also assume that we are working with a small open economy, meaning that the price of tradables is taken as given. Let the tradable good be the numeraire ($P_T = 1$).

Competitive firms take factor and output prices as given and choose K and L to maximize profits. The inter-sectoral mobility of labor and capital equalizes factor prices paid in the tradable and non-tradable sectors. Hence, a firm's profit maximization problem is:

$$\Pi_T = A_T L_T^{(1-\gamma)} K_T^{\gamma} - WL_T - RK_T \, , \tag{3}$$

$$\Pi_N = P_N A_N L_N^{(1-\delta)} K_N^{\delta} - WL_N - RK_N \, , \tag{4}$$

where W – wage rate, R – rental rate of capital, Π – profit.

Let $k = (K/L)$. It follows from the first-order conditions that:

$$A_T (1-\gamma)(k_T)^{\gamma} = W \, , \tag{5}$$

$$P_N A_N (1-\delta)(k_N)^{\delta} = W \, , \tag{6}$$

$$A_T \gamma (k_T)^{(\gamma-1)} = R \, , \tag{7}$$

$$P_N A_N \delta (k_N)^{(\delta-1)} = R \, , \tag{8}$$

Since this model is developed for the small-country, and given international mobility of capital, it follows then that R is exogenously given by the world rental rate on capital. Equations (5) – (8) represent the system of four equations with four unknowns (P_N, W, k_N, k_T).

To solve this system, first express k_T from (7):

$$k_T = \left(\frac{\gamma A_T}{R} \right)^{\frac{1}{1-\gamma}} , \tag{9}$$

Next, we get the wage rate by substituting (9) into (5):

$$W = (1-\gamma) A_T^{\frac{1}{1-\gamma}} \left(\frac{\gamma}{R} \right)^{\frac{\gamma}{1-\gamma}} , \tag{10}$$

By plugging (10) into (6) we obtain:

$$k_N = \left(\frac{(1-\gamma)}{(1-\delta)} \frac{A_T^{\frac{1}{(1-\gamma)}} \left(\frac{\gamma}{R} \right)^{\frac{\gamma}{1-\gamma}}}{P_N A_N} \right)^{\frac{1}{\delta}}, \tag{11}$$

To obtain the solution for the relative price of the non-tradable good in terms of tradable good we substitute (11) into (8):

$$P_N = \frac{A_T^{\frac{(1-\delta)}{(1-\gamma)}}}{A_N} C R^{\frac{(\delta-\gamma)}{(1-\gamma)}}, \tag{12}$$

where C is a positive constant.

Taking logs together with the constant returns to scale condition gives us following equation (lower case letters stand for logs):

$$p_N = (a_N - a_T) + c, \tag{13}$$

Equation (13) represents the so called *internal transmission mechanism* of the B-S effect between the productivity differential and the relative price of non-tradable goods. Over time the evolution of the log relative price of non-tradables depends only on the technology. In Appendix A the connection between relative prices and RER – called the Sectoral Real Exchange Rate Decomposition – is elaborated.

In practice, equation (13) is tested as follows:

$$(p_N - p_T) = f(a_T - a_N). \tag{14}$$

There are at least two reasons why the relative price of non-tradables in terms of tradables should increase with a country's income. First, even if a_T and a_N increase at the same rate (say, because of unbiased technological growth), p_N will still rise over time. An argument is that tradables are manufactured goods whose production is relatively capital intensive, whereas non-tradable goods are mainly services, which are relatively labor intensive, thus $a_N < a_T$. Second, p_N will increase over time if technological growth is biased toward the capital intensive sector (tradables sector). In this case, a_T grows faster than a_N . If either of these scenarios are correct, it follows that fast growing economies will experience a rising relative price of non-tradables.

Chapter 4

METHODOLOGY

This chapter describes the tested equation, employed variables, proxies used for these variables, classification of sectors into tradable and nontradable sectors, data description, and the estimation technique.

Tested equation

It was shown in chapter 2 on the "Theoretical Framework" that we are to test the functional relationship between the relative productivity of tradable and nontradable sectors and the relative prices of tradables and nontradables, which here is called the internal transmission mechanism. The relationship is formalized (in logs) as

$$(p_N - p_T) = f(a_T - a_N). \qquad (17)$$

This relationship was explained in chapter 2. Equation (17) can be empirically specified as

$$\ln\left(\frac{price\_index_t^N}{price\_index_t^T}\right) = \beta_0 + \beta_2\left(\ln(LP_t^T) - \ln(LP_t^N)\right), \qquad (18)$$

where the LHS stands for the relative price of non-tradables in terms of tradables; on the RHS we have two terms: the constant and the total factor productivity of tradables relative to non-tradables goods sectors.

Employed Variables and Proxies

As can be seen from equation (18) the following variables are used:

(1) prices of tradable goods;

(2) prices of non-tradables;

(3) total factor productivity for tradables; and

(4) total factor productivity for non-tradable goods.

Since data on these variables are extremely hard to find, proxies are used. Construction of the variables is complicated by the fact that we need to classify either prices or productivity into tradables or non-tradables. In this respect, we first consider how the prices of the goods of both tradable and non-tradable sectors were proxied, and then cover the productivity measure.

In fact, we will be working with two series: (1) relative productivity of tradables in terms of non-tradables [LP_i ; where i indexes type of classification]; (2) and relative prices of non-tradables in terms of tradables [PR_j ; where j indexes type of prices classification].

Price Series Formation

Most common proxies used for prices are price indexes or GDP deflators. Maliszewska (1998) uses CPI as a measure of the non-tradable prices, and PPI as a measure of tradable goods prices. A more accurate approach is to employ the CPI with subcomponents enabling a breakdown into traded and non-traded goods and services; this approach has been used by Mihaljek and Klau (2003) and Egert (2003). An alternative way to proxy prices is to use implicit sectoral GDP deflators (Egert 2003, Canzoneri et al 1999). Having at our disposal CPI for food, non-food products, and services, and also PPI, in our work we try several types of proxies for tradables and non-tradables prices, which are summarized in the table 4.1: Proxies for prices.

Table 4.1. Proxies for prices

Type	Prices of tradable goods sector	Prices of non-tradable goods sector
1.	$CPI_{non\text{-}food}$	$CPI_{services}$
2.	PPI	CPI

Although not usually stated explicitly in most papers on the subject, it is necessary to note that only cumulative price indexes can be used in the analysis, since we are interested in prices' long-run behavior, which can be only captured with the price indexes formed relative to some base period (cumulative indexes).

Relative prices are formed as in the next table.

Table 4.2. Relative prices.

Code	Type	Relative prices representation
PR_1	1.	$CPI_{services}$ / $CPI_{non\text{-}food}$
PR_2	2.	PPI/ CPI

Total Factor Productivity Series Formation

Canzoneri et al (1999) show that it is possible to use average labor productivity as a proxy of TFP, under some assumptions. In general, it is very difficult to compute a measure for TFP; that is why the overwhelming majority of papers employ average labor productivity as a proxy. For the purposes of our analysis we compute average labor productivity as the gross value added divided by the number of employed in the sector.

Classification of economic sectors into tradables and non-tradables

One of the most difficult and important questions in the empirical investigation is how to distinguish the tradables and non-tradables sectors. Most of the papers related to the field of study employ data which enables following disaggregation into economic sectors: agriculture (including forestry and fishing); industry (including mining, manufacturing and energy sector); construction; services such as trade, transportation, telecommunications, and public services including health education, public administration. At this level of disaggregation, industry is considered to be a sector producing tradable goods, though some authors single out only manufacturing as a tradables component from the industrial sector. Agriculture and construction are ambiguous sectors for which the classification depends on the particular country. In some cases agriculture and construction are included into tradables. Nonetheless, agriculture is more often excluded from both tradables and non-tradables as it often heavily depends on subsidies and government intervention in the price formation process, which is also true in Ukraine. Construction is usually considered as a non-tradable sector. The remaining sectors are usually considered as nontradables. Table 4.3 shows that there is no unequivocal way to classify economic sectors into tradable and non-tradable goods sectors.

Table 4.3. Classification of Tradable and Non-tradable Sectors.

Study	Tradable sector	Non-tradable sector
Coricelli and Jazbec (2001)	Industry and construction	Rest, excluding agriculture
De Broeck and Slok (2001)	Industry and construction	Rest, excluding agriculture
Egert et al (2002)	Industry and agriculture	Rest
Fillipozi (2000)	Industry	
Fischer (2002)	Industry	
Halpern and Wyplosz (2001)	Manufacturing	Services; excl. agriculture, construction
Lommatzsch and Tober (2002a)	Industry	Construction, Trade, Finance
Randveer and Rell (2002)	Agriculture, manufacturing, hotels, transportation	Rest
Rother (2000)	Manufacturing	Rest
Sinn and Reutter (2001)	Manufacturing and agriculture	Construction, energy, services
Backe et al (2002)	Manufacturing	Rest
Egert (2001)	Industry	Rest
Golinelli and Orsi (2001)	Industry	Rest
Kovacs (2001)	Manufacturing	Services, excl. agriculture, public services
Mihaljek and Klau (2002)	Mining, manufacturing, hotels, transport, communications	Rest, excl. agriculture and public services

Source: Egert, B. (2003) " Nominal and Real Convergence in Estonia: The Balassa-Samuelson (Dis)connection", *Bank of Estonia research paper no. 3*.

In this study, we use data broken down into sixteen sectors (the list of sectors is given in the data description section later in this chapter), which are classified into tradables and non-tradables goods sectors. The selection criteria for the tradable sector are: (1) it has to be open to competition (e.g. through privatization); and (2) trade arbitrage – the main mechanism insuring that PPP holds in the sector as assumed in the model – should be possible. The obvious candidate for the tradable sector is industry. The non-tradable sector includes mainly services: wholesale, retail trade, motor vehicle repair; hotels and restaurants; transport, storage, telecommunications; real estate, renting & business activities; education; health and social work; other community, social & personal services. Construction is considered to be tradable, since it is open to competition and trade arbitrage; furthermore it is capital intensive, implying a very low share of labour costs in its total costs. Financial services are sold at home and abroad by international banks, which makes them tradable also.

Several measures of tradables and non-tradables were calculated, since the classification into tradables and non-tradables brings a number of difficult judgments. The following table summarizes calculated productivity measures.

Table 4.4. Classification into tradables and non-tradables.

Type	Code for relative productivity series	Tradables sector	Non-tradables sector
I	LP_1	Industry (includes mining, manufacturing, and energy sector)	Rest excluding agriculture
II	LP_2	Industry, and construction	Rest excluding agriculture
III	LP_3	Industry, construction, and financial services	Rest excluding agriculture
IV	LP_4	Weighted* share of industry	Weighted* average of the rest excluding agriculture
V	LP_5	Weighted* average of industry, and construction	Weighted* average of the rest excluding agriculture
VI	LP_6	Weighted* average of industry, construction, and financial services	Weighted* average of the rest excluding agriculture

* Weights used to aggregate into individual industries into traded and non-traded sectors are industries shares in total value added (corrected for agriculture).

Using these six types of tradables—non-tradables classification we will try to check to what extent the estimation of the B-S effect depends on the type of classification we used.

Data description

The time period covered for Ukraine includes 1996:Q1 – 2003:Q4, which constitutes 32 quarterly observations. This sample size is small but sufficient to provide a reliable estimation, since only two variables are used in the model: relative prices (prices of tradables in terms of non-tradables) and relative productivity (ratio of productivity of the tradables sector to the productivity of the non-tradables sector).

To compute productivity data on productivity, we used gross value added decomposed in 19 sectors as a measure of output before year 2000 and 16 sectors after 2000. For the period 1996:Q1 – 2000:Q4 only the output measure based on industrial division is available (this was the national accounting system inherited from the Soviet Union). Starting from 2001:Q1 sectoral decomposition of output is available on the basis of international standards in national accounting. In the tables 4.5 and 4.6 below the industrial and sectoral decomposition used is given.

The same concerns the employment series (used in labor productivity calculations): up until 2000:Q4 a "by industry" classification is used, and the new sectoral decomposition starting from the 2001:Q1. For the prices series CPI (for food, non-food products and services) and PPI are used as stated in the methodological part. The data source is the statistics of Ukrainian Ministry of Statistics.

Table 4.5. Industrial division of gross value added (old Ukrainian standards).

№	Industries
	Industries that produce goods
1	Industry
2	Agriculture
3	Fishing
4	Forestry
5	Construction
6	Other industries, producing goods
	Industries that produce services
7	Transport
8	Trade
9	Informational services
10	Real estate services
11	Financial services
12	Geodesy, and land-surveying
13	Housing
14	Municipal services
15	Health, and social services
16	Education
17	Cultural sector services
18	Science sector services
19	Other industries that provide services

Table 4.6. Sectoral decomposition of gross value added (international standards)

№	Sectors
1	Agriculture and forestry
2	Fishing
3	Industry total
4	Mining and quarrying
5	Manufacturing
6	Electricity, gas, water supply
7	Construction
8	Wholesale, retail trade, repair motor vehicles
9	Hotels and restaurants
10	Transport, storage, telecommunications
11	Financial intermediation
12	Real estate, renting & business activities
13	Public admin., defence, compuls. social security
14	Education
15	Health and social work
16	Other community, social & personal services

Estimation technique

There are several assumptions to be verified prior to econometric analysis. The theoretical model explicitly assumes labor mobility within an economy, and a relationship between productivity and real wages. These assumptions will be verified by inspecting the series of wages and productivity in both the tradable and non-tradable sectors.

To estimate the relationship between relative productivity and relative prices, a multivariate time series approach will be used. The algorithm of estimation is described in the chart B1 (Appendix B). The series will be checked for stationarity using an ADF test. If the series are stationary, then we can estimate equation (18) with OLS. Otherwise, regressing non-stationary variables may lead to a spurious regression, in which estimators and t-statistics are misleading. To estimate equation (18) in case of non-stationary variables, the VAR technique will be applied. Initially, it will be checked if the series cointegrate, with the help of the Johansen cointegration test and Engle Granger procedure. The cointegration tests will allow us to estimate a cointegrating vector [CV], which characterizes the long run relationship between the series (relative productivity and relative prices). Finally, a Vector Error Correction Model [VECM] will be built. The VECM has the following form:

$$\Delta y_t = \gamma_1 + \sum_{j=0}^{k} \delta_j \Delta y_{t-j} + \sum_{j=0}^{k} \beta_j \Delta x_{t-j} + \alpha_1 (y_{t-1} - \beta x_{t-1} + \varphi) + \varepsilon_t$$

$$\Delta x_t = \gamma_2 + \sum_{j=o}^{k} \delta_j \Delta x_{t-j} + \sum_{j=0}^{k} \beta_j \Delta y_{t-j} + \alpha_2 (y_{t-1} - \beta x_{t-1} + \varphi) + \varepsilon_t ,$$

where y – relative prices of non-tradables in terms of tradables;

x – relative productivity;

α_i – speed of adjustment coefficient, $i = 1,2$;

β – parameter showing long run relationship between series,

φ – constant,

β_j, δ_j, γ_i – estimated parameters, $i=1,2,\ j=0,k$.

For the sake of robust results, there is a need for a properly specified VEC model. A number of diagnostic tests have to be carried out. To ensure that the absolute values for the roots of the autoregressive polynomial of the VECM are below unity, we will use the AR Roots Graph which reports the inverse roots of the characteristic AR polynomial; see Lütkepohl (1991). The estimated VECM is stable (stationary) if all roots have a modulus less than one and lie inside the unit circle. If the VAR is not stable, certain results (such as impulse response standard errors) are not valid. One of the criteria for choosing the lag length in the VECM is the existence of cointegration under a given lag length. A lag exclusion test was also employed to ensure the significance of the included lags. The lag length of the VECM should ensure the absence of serial correlation in the residuals and normality of the residuals.

Chapter 5

RESULTS

In this part we report on tests of the main assumptions made to derive the domestic Balassa-Samuelson effect, and present data analysis and estimations results.

Assumptions Testing

There are several linkages to be verified prior to econometric analysis. The assumption of labour mobility is hard to verify empirically. To see whether the wage equalization holds, we need to (1) look at the link between real wages and productivity in the tradables sector, since the model assumes that productivity changes are directly incorporated into real wages; and (2) find the extent to which nominal wages equalise across the tradables and non-tradables sectors. We will test these assumptions for all types of classifications of tradables and non-tradables. To test the link between real wage and productivity developments in the tradables sector, we use the methodology suggested by Egert (2003). We compute the real wage in the tradable sector as the wage of tradable goods sector divided by the PPI; and the productivity measure as an index of the real productivity of tradables (real productivity is also computed using PPI). As can be seen from Appendix C the productivity measure moves very closely in line with the PPI deflated real wage series for all eight types of tradables constructed. This supports the existence of a relationship between real wage and productivity developments in the tradables sector. More over, we can see that the closest relation is observed in the type III classification, which may suggest using type III classification for testing the B-S effect in Ukraine. The next step is to find the extent to which nominal wages equalise across the tradables and non-tradables sectors. Again, from Appendix D we can observe that the wage equalization process works well enough, since the wages across the sectors are very close. This tendency is especially clearly conveyed for the 1996:Q1 – 1999:Q1 period, when the Ukrainian economy was still experiencing a decline in GDP. However wages in tradables are slightly higher than in non-tradables after the 1999:Q1 (this is usually always the case for any country). This can be explained by the fact that the Ukrainian economy began to grow at this time, and wages in the tradables sector (as a growth leading sector) started to rise relative to non-tradables. It is worth noting also, that for all types of tradables constructed on a weighted average basis (TypeIV – TypeVI) the series behaviour is pretty much the same, which means that indeed wages tend to equalize across sectors and even industries, and the connection between real wages and real productivity in tradables exists.

To obtain a first impression of the B-S effect, the sectoral data on productivity and prices are plotted in Appendix E and Appendix F respectively. As Appendix E shows productivity in the traded goods sector has grown faster than in the non-traded goods sector over the whole sample period. The average growth rate for labour productivity in tradables amounted to the 9.3 %, but only 5.9 % in the non-tradables sector for types of the classification computed on the weighted average basis (Type IV – Type VI), and 7.2% and 6.0% for the types of classification computed on the simple average basis (Type I – Type III). According to the theoretical model, faster productivity growth in tradable industries should have implied faster growth of non-traded goods prices. From Appendix F we can see that this has been really the case for Ukraine: non-tradables prices grew faster relative to tradables prices.

The essence of the productivity hypothesis suggests that relative prices of non-tradables should tend to rise as relative productivity in the tradables sector has increased. Charts in Appendix G reflect the behaviour of the relative productivity and relative prices series. From this figure we can observe that the growth rates of relative productivity are on average much higher than the growth rates of relative prices. Thus, on average relative productivity increased by 22%, while relative prices increased only by 3%. This suggests that relative productivity increases do not fully translate into relative price increases.

It should be also noted here that since labor productivity series of tradables and non-tradables were computed using "old" industry classification for the period 1669:Q1 – 2000:Q4, and using "new" classification for the period 2001:Q1 – 2003:Q4 and merged afterwards into one string, we need to check our series for a possible structural break. The Chow structural break test was employed for these purposes. We applied Chow test to equation (18). The test results reject alternative hypothesis of the structural break. The results are brought down into the table in Appendix H. This allows us to include the labor productivity series into VECM without dummies.

Estimation Results

As described in the section on Estimation Technique, we first check the series for unit root using an ADF test. The results of the test are presented in the Appendix I. We check relative prices [PR_j] and relative productivity [LP_i] for stationarity. In fact, the series are expected to be non-stationary in levels. As noted in Nelson and Plosser (1982), 95% of macroeconomic series contain a unit root in levels. The lag length in the ADF test was chosen in a way to minimize the Akaike Information Criteria. For all the series, the intercept and trend were included in the test equation, based on the analysis of a graphical representation of the series. The unit root test reveals that the series are integrated of order one – I(1).

Since, it is not entirely correct to apply simple OLS for non-stationary series; we proceed to ascertain whether the relative productivity series cointegrate with the relative prices series. In case of cointegration, we will be able to estimate the B-S effect using a VECM approach. The Johansen cointegration test is employed for the analysis. The results are summarized in table J.1 (Appendix J). The cointegration test is done under following specification. We assume a linear deterministic trend in the data. An intercept is included into the cointegration equation (following Canzoneri, 1999). As can be seen from the table in appendix J, relative productivity series do not cointegrate with the second type of relative prices series, in which PPI is used as a proxy for the tradables prices. One of the explanations for this fact might be that the PPI is too broad an index, since it includes prices of all the industries in the country, which are both tradable and non-tradable goods industries. Apart from that, the relative productivity series establishes quite robust cointegration relationships with the relative prices of type 1. In the type-1 classification of relative prices, more narrowly defined proxies for the prices of tradables and non-tradables were used, namely, CPI for the non-food goods as a proxy for tradables prices and CPI for services as a proxy for non-tradables.

To describe the characteristics of the cointegration vector itself, we should note that theoretically the B-S effect exists when relative productivity increases fully translate into relative price increases, i.e. the expected cointegration vector should have the form of CV=(1;β)=(1;-1), or in other words, the β-coefficient should approach unity in the long run. Estimated CV's reveal that the B-S effect is weak in Ukraine (see appendix J). The highest β=0.4663 was obtained for the relation between PR_1 and LP_2, thus we may say that in general there exists a connection between relative prices and relative productivity in Ukraine, however, the connection is not strong enough to ensure the full scale B-S effect. For the other first three types of relative productivity, the β-coefficients are quite close, ranging from 0.4053 to 0.4663. This, in general, implies that the "frontier" sectors (such as financial services, construction, or transportation), which may be classified both as tradables or non-tradables, do not have a major impact on the final results. However, in the case of Ukraine, the construction sector should be better considered as a tradable goods sector, since it causes positive influence on the β-coefficient: the β-coefficient increases with the inclusion of construction into tradables (0.4071 against 0.4663). Theoretically, construction can be justified as a tradable, since this sector is open to competition and capital intensive, another explanation might be that construction might exhibit price behavior like a tradable without being a tradable due to perhaps level of unemployment and unskilled nature of much construction work; however this is an area for further research. Furthermore, applying the weighted average approach for the productivity series construction of tradables and non-tradables reveals an even weaker relation between relative productivity and relative prices; estimates of β-coefficient range from 0.2189 to 0.2335. Basically, this fact can be explained in the way that the weighted average approach allows us to smooth out the influence of each sector's size on tradables – nontradables productivity series formation. Thus, the results from the cointegration analysis suggest only weak evidence in favor of the B-S effect in Ukraine.

In the next step, the VEC models are considered. To choose the number of lagged terms in the model the lag exclusion test, residuals normality criteria, residuals autocorrelation criteria and existence of cointegration criteria was used. Since the labor productivity series behave similarly, the VEC models specification is almost identical for all types of classification of tradables and nontradables. Estimation results of the models are presented in appendix K. We present only first equation of the VECM out of two, since we are interested in modeling relative prices as a dependent variable of relative productivity but not vice versa.

The coefficients in the estimated VEC models can be interpreted in the following way. The first group of coefficients is the immediate change coefficients [δ_1, β_1] that stay together with the lagged differenced terms. These coefficients show how relative prices respond to short-run shocks in both relative productivity and relative prices. The second group of coefficients – the error correction part of the model – consists of the speed of adjustment coefficient [α_1], and the long run relationship coefficient [β]. The speed of adjustment coefficient shows in percentage points the extent to which relative prices return to their equilibrium level during the next period in case of deviation from their long run path, (the α_1-coefficient is negative and less than unity). The β-coefficient, in our case, shows in percentage points the elasticity of relative prices in terms of relative productivity, or in other words, the extent to which relative prices depend on relative productivity in the long run.

Thus, in model U_1, the immediate response of relative prices to a short run positive shock in relative prices in the previous period will be a 15.4% increase (δ_1=0.1540); relative prices will decrease by 7% in the short run as a response to a short run positive shock in relative productivity (β_1= -0.0703). As we can see in the short run relative prices behavior is mostly formed by past information about prices, though in the long run relative prices depend substantially on relative productivity, which can be seen from the error correction part. Since β = 0.4071 in model U_1, we may say that in the long run, a 1% increase in relative productivity results in a 0.41% increase in relative prices. Furthermore, the size of the speed of adjustment coefficient reveals that in case of deviation from their long run path, relative prices will return to their equilibrium level during the next period to a degree of 52.19% (α_1=0.5219), or in other words will close the gap to their equilibrium level during the next period by 52.19%.

In the same way, the rest of the models can be interpreted. One peculiar characteristic is that the values of the coefficients are quite close in the estimated models, especially models U_4, U_5, U_6, in which tradables and non-tradables are computed with the help of weighted average approach. This may suggest that the way we define tradable and non-tradable goods sectors is not extremely crucial in determining the B-S effect, as far as standard approaches are used in dividing sectors into tradables and non-tradables. In addition, the β-coefficient is almost half the size in the second group of models (models using a weighted average approach in calculating tradables and non-tradables) as in the first group of models (in which simple summation were applied to compute tradables and nontradables), which may be explained by the fact that differences in productivity are higher between tradables and nontradables using the weighted average approach compared to the simple summation approach, while the relative prices series used in both approaches are the same. This results in a lower β-coefficient, capturing for B-S effect, in the weighted average approach.

In the estimated VECM immediate change coefficients appear to be insignificant. Both lagged differenced term for relative productivity and relative prices are insignificant. Nevertheless, using ECM, it can be shown that if we exclude lagged term for relative prices, then the term for relative productivity becomes significant. For this purposes we constructed ECM, with the cointegration vector determined using Engle Granger procedure. In the Appendix L, the cointegration vector estimates using Johansen test and Engle Granger procedure are presented. Again, both approaches give almost identical results. Thus, using cointegration vector estimated by Engle Granger procedure we construct ECM. The ECM estimates are brought down into table in Appendix M. Comparing two models: VECM and ECM, we may say that most noticeable difference lies in immediate change coefficient for lagged differenced relative productivity term. In ECM, the influence of relative productivity on relative prices in the short run is much higher than the VECM estimates, while the speed of adjustment coefficient is twice lower in ECM.

We further present the impulse response and variance decomposition analysis of the estimated VEC models. Since the analysis is conceptually similar for all models, we present here only the results for model U_6. From Appendix N you may see that one standard deviation shock in relative productivity leads to an increase in relative prices, which then stabilize at a certain level. On the other hand, one standard deviation shock in relative prices leads to a decrease in the relative prices level. In total the system stabilizes at a certain stable level in the long run. Variance decomposition of relative prices (Appendix O) shows that the dynamics of relative prices lagged terms is more important than the dispersion of relative productivity in the short run (up to 12 periods), though the importance of relative productivity dynamics increases constantly and by the end of the 50^{th} period explains more than 80% in relative prices variation. Increasing the number of periods to infinity shows that approximately 90% of variation in relative prices is explained by relative productivity and only 10% by relative prices itself.

For the purposes of comparison, the obtained results are compared to estimations of B-S effect in other eastern European countries done by Mihaljek and Klau (2003). Estimates of the model U_6 were chosen for comparison, since this model specification most closely follows that used by Mihaljek and Klau.

From Table 5.1 below you can see that the B-S effect in Ukraine is among the lowest relative to the rest of the countries in the table. The strongest evidence of the B-S effect is found to be in Poland and Hungary – countries in which the β-coefficient is close to unity.

Table5.1: Comparative table of the size of the B-S effect

#	Country	β-coefficient
1.	Croatia	0.569
2.	Czech Republic	0.068
3.	Hungary	0.924
4.	Poland	1.196
5.	Slovakia	0.446
6.	Slovenia	0.211
7.	Ukraine*	0.219

- Estimations of β-coefficient for Croatia, Czech Republic, Hungary, Poland, Slovakia, and Slovenia were done by Mihaljek and Klau (2003); estimation of β-coefficient for Ukraine was taken from the model U_6.

Influence of productivity on the price level

In fact, the β-coefficient shows us the elasticity of relative prices with respect to relative productivity. However, we are also interested to see how the general price level in the economy is affected by the productivity changes, since it will allow us to estimate the pressure that productivity causes on prices. To compute the price level change resulting from productivity changes we proceed in the following way. The estimated β-coefficient is multiplied by the historical average of the domestic productivity differential growth to obtain the contribution (in percentage points) of the productivity differential to the increase in relative prices, and then this contribution is multiplied by the share of non-tradable goods and services in the CPI to obtain the general price increase resulting from the productivity change. The computations are shown in Table 5.2.

Table 5.2: Estimates of the price level change due to productivity increases.

Model	β-coefficient	average productivity differential growth,%	contribution of productivity differential to relative price increase, %(4)=(3)*(2)	share of non-tradable goods in the CPI, %	price level change, percentage points (6)=(5)*(4)
1	*2*	*3*	*4*	*5*	*6*
U_1	0.4071	1.60	0.6514	16.97	11.1
U_2	0.4663	1.10	0.5137	16.97	8.72
U_3	0.4057	1.37	0.5661	16.97	9.61
U_4	0.2335	4.13	0.9647	16.97	16.37
U_5	0.2228	4.21	0.9388	16.97	15.93
U_6	0.2189	4.29	0.9397	16.97	15.94

The last column in the table shows us how the prices have changed on average when relative productivity increased by one percent for the last eight years in Ukraine. Notice that price level change (column 6 in Table 5.2) is given in percentage points, which should be interpreted in the following way. Out of one unit increase in price level only x % is explained by productivity changes, where x is the figure from column 6 of Table 5.2.

Summarizing the findings of this chapter, the assumptions made to derive the tested equation, namely the connection between productivity and real wages in the tradable goods sector, and wage equalization among sectors proved to be fulfilled. It was also discovered that CPI and PPI do not serve as a good proxies for the prices of tradables and non-tradables respectively. Rather CPI disaggregated into non-food CPI and services CPI can serve as proxies of tradables and non-tradables prices. Furthermore, several types of models (constructed using different approaches for computing the relative productivity of tradables in terms of non-tradables) show that the relative productivity changes do not fully translate into price increases, and in general, inflationary pressure of relative productivity on price level is about 9 to 16 percentage points.

C h a p t e r 6

CONCLUSIONS AND POLICY IMPLICATIONS

The purpose of this paper was to (a) to determine the strength of the relationship between relative productivity and relative prices; and (b) to estimate the additional pressure that productivity may cause on the price level in Ukraine. Based on disaggregated sectoral gross value added and CPI data the main findings of our investigation are:

(i) Cointegration analysis reveals that changes in productivity in the tradable goods sector relative to the non-tradable goods sector are indeed linked to the CPI-based relative price of non-tradable goods, which means that the B-S effect is at work in Ukraine; however, relative productivity increases do not fully translate into price increases. Theoretically, in the long-run relative productivity changes and relative price changes are expected to move in unison, or in other words the cointegrating relationship between the series should be one to one. However, in Ukraine the estimated cointegration relation (depending on the type of tradables/non-tradables classification) ranges from (1; 0.22) to (1; 0.48), which signifies the weakness of the B-S effect. Or in other words, only 20-50% of relative productivity increases are incorporated into relative price changes.

(ii) The quantitative analysis reveals that on average during the last eight years 9-16 percent of the change in the price level is explained by relative productivity changes.

(iii) Assumptions concerning labor mobility and a relationship between productivity changes and real wage changes in the tradable sector received empirical support. Labor appears to be mobile within the economy in the long run, since wages across tradable and non-tradable goods sectors tend to equalize; furthermore changes in real wages occur in line with the changes in productivity in the tradable goods sector.

(iv) Since the classification of economic sectors into tradable goods and non-tradable goods sectors brings a number of difficult judgments, we constructed a set of measures for relative productivity and relative prices. Namely, six different approaches to the classification of economic sectors into tradables and non-tradables were used. The B-S model was tested with each type of classification in total six models were estimated. In all six cases, the obtained results do not reject a positive relationship between relative productivity and relative prices, thus indicating the robustness of the obtained results. The classification into tradables and non-tradables is not crucial in determining the B-S effect, as far as standard approaches to the classification are used. Under standard approaches those commonly used in the literature are understood.

(v) Apart from that, two different approaches were used for proxying relative prices of non-tradable goods in terms of tradable goods. The prices of tradables and non-tradables were proxied as: (type 1) non-food CPI and services CPI respectively, and (type 2) by PPI and CPI respectively. The notable difference between PPI and non-food CPI as proxies for tradables prices should be emphasized. The two series differ in their structure; the PPI contains at least twice as many non-traded goods prices as the non-food CPI. As a consequence, cointegration analysis could not establish a long term relationship between relative productivity and the second type of prices proxy. However, the first type of proxy served well to support the tested hypothesis.

(vi) Error correction models allowed us to estimate speed of adjustment coefficient, which varies from 0.39 to 0.52 for the six estimated models. The size of the speed of adjustment coefficient reveals that in case of deviation from their long run path, relative prices will close the gap to their equilibrium level during the next period by 39-52%.

Finally, the conducted analysis can be considered for its policy implications. Estimation of the magnitude of the B-S effect in Ukraine leads to the tentative conclusion that the effect is not strong enough to drive inflation in the long run. This means that productivity growth – a supply-side factor – is not so influential in Ukraine to drive a steady price level increase. In fact, we may infer that in the 8% inflation last year only 0.83 percentage points was driven by relative productivity change. The results may also imply that there is little upward pressure on the real exchange rate from the supply side though this implication has to be verified. However, in the long run, the influence of the productivity on prices is likely to grow in Ukraine, since the share of services (non-traded goods) in the consumption basket will increase as the Ukrainian economy moves towards a developed one. On the other hand, the influence of the increasing share of non-traded goods in total consumption on the price level may be counterbalanced by the slowdown in productivity growth.

The main novelty of the study is that it focuses specifically on Ukraine. The study is the first one that solely investigates the B-S effect in the Ukrainian economy. Among the strengths of the study are the data used. The data allows disaggregation of economic sectors into 19 industries, which enables us to construct a set of measures for tradable/non-tradable goods sectors to verify the results. In addition, two types of proxies were used for prices of tradable and non-tradable goods prices.

Among the weaknesses of the analysis, the short data range may be mentioned. The range allows us to make estimations, but it is quite short to provide good asymptotic properties of estimations. In general, a short time series is a problem for all transition economies, nevertheless it has to be stressed here that the estimates obtained in this work are still reliable. Estimations of the β-coefficient using the Engle Granger procedure provide 15 observations per 1 degree of freedom, which is considered to be sufficient.

One of the extensions that this paper may have is to study the magnitude of the connection between relative prices and the RER. Through the sectoral decomposition of the RER it is straightforward to show that the RER depends on relative prices between domestic and foreign country in the long run. This area of research is important, since it touches not only upon the problem of modeling the behavior of the RER in Ukraine (a topic in which most foreign investors might be interested in), but also enables us to draw implications about whether the Ukrainian RER will appreciate steadily as a result of relative productivity changes. The described phenomenon was observed in Poland in the second half of 90's (Maliszewska, 1998). Whether the Ukrainian economy may be exposed to steady RER appreciation in the future is an open question.

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