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DIPLOMOVÁ PRÁCE

Labor Costs in Industrialized Countries
Is There a Convergence?

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I do hereby declare that this diploma thesis is work of my own and that I have used only the listed bibliography.

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ABSTRAKT

Diplomová práce pojednává o konvergenci mzdových nákladů mezi 21 vyspělých zemí v období 1961-2006. Naše pojetí konvergence se opírá o Samuelsonovu (1948) hypotézu vyrovnání cen faktorů produkce mezi ekonomikami (Factor Price Equalization Theorem). Dále se zabýváme nadnárodními společnostmi a jejich funkcí v snižování rozdílů ve vybavenosti produkčními faktory a rovněž i jejich vlivem na produktivitu a mzdové náklady v hostitelské zemi. V empirické části testujeme doposud poměrně zřídka zkoumanou hypotézu konvergence mzdových nákladů. Naše výsledky potvrzují, a to poměrně významně, hypotézu konvergence mzdových nákladů a to jak v případě jednotlivých zemí tak i pro panelová data. Dále odhadujeme, že země střední a východní Evropy mají před sebou období přibližně 10 (ČR, Maď) až 15 let (SK, Pol) k tomu, aby přešly od konkurenceschopnosti založené na nízkých nákladech a mzdách ke kvalitativně založené konkurenceschopnosti.

ABSTRACT

This diploma thesis focuses on labor cost convergence. We interpret convergence within the framework of Samuelson's (1948) Factor Price Equalization Theorem, in which free trade equalizes factors' reward. Further, we consider the role of multinational enterprises as they serve as mediators of factor price convergence by transferring factor endowment and by affecting productivity and wages in the host country. Finally, we empirically test convergence hypothesis by applying unit root tests for a group of 21 industrialized countries for 1961-2006. We have found that labor costs convergence is surprisingly well supported by the data both for individual countries and for panel data. Similarly, we estimate that counties in Central and Eastern Europe have 10 (CR, Hun) to 15 years (SK, Pol) to move from low-wage, low cost based competitiveness to quality-based competitiveness.

Keywords: Labor Costs, Convergence, Factor Price Equalization
JEL classification: F 11, F 43

Contents:

I. Introduction

Increasing international trade, reduction in trade barriers and continuing economic integration are likely to be stimulating for the convergence process of labor costs and wages. This is especially true for the European Union given its increasing mobility of firms and production factors as well as its far-reaching political and economical integration. Still, the effects of these processes on labor costs and on their convergence are rarely studied, in particular, as contrasted to the large body of literature on output convergence (e.g. Barro and Martin 1991, Mankiw et al. 1992, Evans 1996). We would like to bridge this gap and focus on how labor costs evolve in the long-run.

One of the reasons why it has been studied less frequently is the fact that economic theory does not concentrate on wage (labor costs) convergence in sense of providing a coherent theoretical framework. Nevertheless, there are two possibilities for studying labor costs convergence on theoretical basis. First, the approach we pursue, is to interpret labor cost convergence in terms of Factor Price Equalization Theorem (Samuelson 1948). The second possibility involves studying labor cost convergence as a part of real convergence based on conventional growth theory and on productivity differential. We have chosen the first approach as the European Union is a suitable area for the Factor Price Equalization Theorem based on its long history of economic and political integration, its similar factor endowments, and creation of free trade area including elimination of trade barriers (1968), common currency (1999) and ongoing effort to creating common market.

1.1 Motivation for studying labor cost

For international comparison of wages is useful to perceive labor costs from the position of multinational enterprise which is assessing countries according to their labor costs levels to make a decision where to locate production facility. Global companies compare labor cost carefully across countries in deciding on their investments. According to KPMG (2004) labor represents 56 to 72% of location-sensitive costs in manufacturing and 75-85% for non-manufacturing. Given such a high share of labor in the costs of production process, it is not a surprise that low wage countries enjoy strong inflow of foreign investments and stand at the center of offshoring or overseas sourcing business. There is widespread evidence that labor cost and unit labor cost are key determinants of foreign investment to low wage countries (e.g. Bevan and Estrin, 2004). In 2005, labor costs in the Central and Eastern Europe (CEE) are 1/2

(Slovenia) to 1/7 (Latvia) of those in EU-15 average. Abraham (2000) states labor costs are widely perceived as a key determinant of international competitiveness.

Furthermore, entrepreneurs are seeking to take advantage of labor arbitrage-a process of shifting from expensive to cheaper labor associated with the shift of location of production. Dunning (1993) identified labor costs as a key location determinant for efficiency seeking multinational companies. In other words, location of production is a part of corporate strategy. To exploit the cost advantage of low wage hubs such as NMS, it is critical whether such competitive advantage is time persistent, or how fast will the labor cost differential narrow. For instance, The Economist (2003/369) predicts that: „*A further threat to eastern Europe's offshoring business lies in the forthcoming entry into the EU of countries like the Czech Republic and Poland. That is sure to narrow wage differentials with the rest of Europe and eradicate much of the rationale for offshoring there*."

Costs are a major factor influencing the costs of goods produced by a country relative to those of its trading partners and consequently its international competitiveness (Dean and Sherwood 1993). Moreover, as claimed by Eurostat (2001): "labor costs considerably influence the choices of political, economic and social decision makers, as they account for some two-thirds of the production costs of goods and services. Moreover, knowledge of labor cost levels is an essential tool in the strategic planning of investment, production, employment policy or wage levels in collective bargaining. "

For decision makers are then labor costs important to ensure they are kept under control in as they are one of the key predictor of inflation (cost-push model) as the share of labor costs is approximately 2/3 of the total value added.[1] Similarly important are labor costs for unemployment. In addition to that, wage, a principal component of labor costs is the major determinant of workers welfare and standard of living, which also projects to aggregate demand etc.

1.2 Definition of Convergence

The convergence hypothesis has become an intriguing topic for research and is being applied to number of studies of including income, productivity, price level studies of convergence. Hence, there are also several approaches and definitions as well as methodologies for testing convergence. Intuitively, the general definition of convergence is that the difference between

[1] The labor share in costs for the private US business sector (excluding government enterprises) averaged 67 percent over the 20-year period from 1982 to 2001 (BLS 2006). This implies the very central position of labor costs on firm's profitability.

two variables decreases and ultimately becomes zero. Formally, two random variables y_t and x_t converge (in probability) if

$$\lim_{t\to\infty} P(|y_t - x_t| > \delta) = 0$$

where $\delta > 0$. As far as empirical testing concerns, the main dividing line is between cross-country and time-series approach. We prefer the time-series approach, which examines the long-run relationship in movements of labor costs between country i and country j. In other words, we ask how persistent is the differential between countries and sample average (EU-15). If the stochastic convergence is to take place, the differential between country i and country j cannot contain unit root[2].

Our analysis is divided into five chapters. In the second chapter, we describe Samuelson's (1948) seminal Factor Price Equalization Theorem, which proposes a framework in which flows of goods replace immobile factors of production and equalizes factors' reward. Third chapter considers the role of multinational enterprises and mobility of capital as a bridging elements between countries capable of transferring technology and knowledge capital. In the fourth chapter we consider the role of nominal and real convergence and difficulties connected with making reasonable international comparison. Finally, in the fifth chapter we empirically test labor cost convergence applying both individual time series tests and panel data approach. This will be done for EU-15 as well as for countries of Central and Eastern Europe.

[2] The term unit root refers to a solution of difference equation that needs to be within a unit circle for solution to be stable, i.e. to ensure convergence (see Enders 1995: Chapter I). We will discuss definition of convergence and methodology of time series test in section 5.1 and 5.6.

II. Factor Price Equalization

Obvious starting point for discussion of factor price convergence is Samuelson's (1948) seminal *factor-price-equalization-theorem* (FPE) that postulates necessary conditions under which flows of goods replace immobile factors of production and equalize factors' reward. After presenting principal features of the FPE model we will discuss consequences when some of the rather stringent assumptions are relaxed and point to more recent approaches of New Trade Theory. Then we focus on the mobility of production factors and, toward the end, we review the FPE literature.

2.1 Factor Price Equalization Theorem

Hardly any discussion of international trade dares not to begin with the fundamental law of comparative advantage that claims that trade pattern is based on relative and not on absolute efficiency in production. Such an advantage may be technological as in Ricardo's model or based on factor-endowment. The factor endowment models are based on work of Heckscher (1933) and Ohlin (1933). These authors stress importance of factor endowments in determining patterns of trade and have facilitated debate on trade and its impacts on the earnings of the factors of production. Ohlin argues that trade would bring factor prices closer together but not necessarily equalize them.

Samuelson (1948) builds on their work and formalizes sufficient conditions under which factor prices will eventually become equal. The synthesis of these models is called *Heckscher-Ohlin-Samuelson* model (HOS). HOS is a general equilibrium model and as will become clear, it implies trade in goods and mobility of production factors as perfectly substitutable. In what follows, we present the simplest version in 2-2-2 case-two countries, two factors of production (capital and labor), two products as presented in Samuelson (1948) and Hong (1996).

2.1.1 Assumptions and Implications

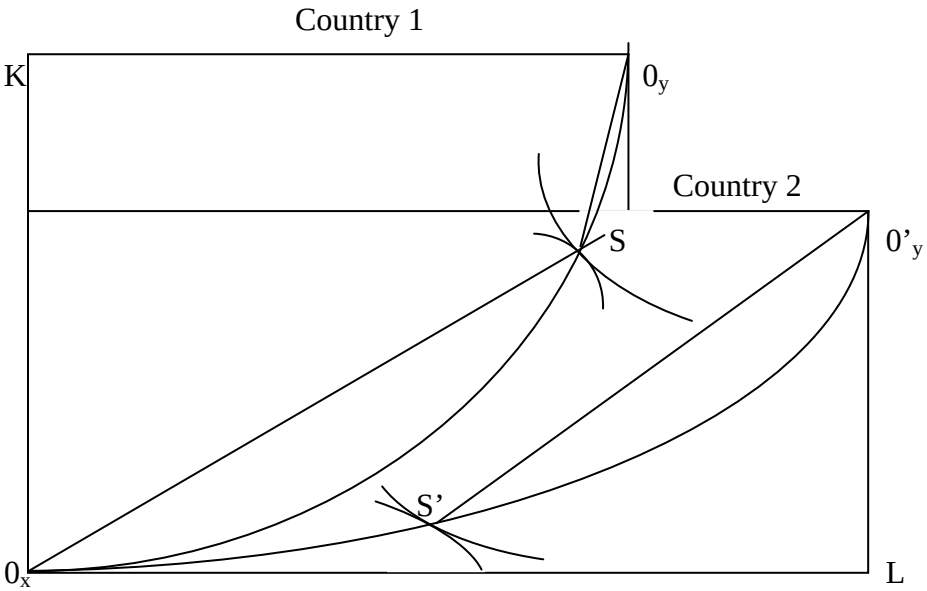
1. Production function is linear and homogenous with constant returns to scale; technology is identical for both countries. Marginal productivity of factors is positive and diminishing. Unlike the comparative advantage models of Ricardo the assumption of identical technologies ensures that access to technology is not the basis of comparative advantage.

2. Factors of production are homogenous and therefore factor endowment is determined solely by quantity.
3. Factors are in fixed supply, mobile between industries within a country at no cost and internationally immobile.
4. Perfect competition in the goods[3] and factor markets, no transport costs or barriers to trade. Hence, commodity prices are equalized across the countries.
5. Goods can be divided along the factor intensity. That means that products differ in their factor requirements (capital, labor intensive). Moreover, it is assumed that there are no factor-intensity reversals[4] and that the number of goods is at least as high as the number of productive factors.
6. The factor endowments among countries are sufficiently similar. This implies that both countries produce both goods under free trade.[5]
7. Finally, consumers have identical preferences; their demand is homothetic ensuring that the proportion in which goods are consumed is determined by prices and not by income. In other words, if the commodity prices are equalized, then for given proportion of world income a country has, country's aggregate consumption equals exactly its proportion of world income.

Assumptions 1 to 7 ensure that international trade leads to factor price equalization. Figure 2.1 describes the mechanism in 2-2-2 case. It shows two box diagrams of factor endowments with dimensions labor (L) and capital (K). Further, it shows for each country a contract curve- a set of points with efficient production of both goods Y and X[6] for two countries. For Country 1 it is 0_x0_y line, for Country 2 $0_x0'_y$ line. In autarky, a country can produce anywhere on its contract curve. Country 1 produces at point S and Country 2 at point S'.

[3] In original version, services are disregarded; however, as long as same services are tradable to the same extent in both countries and countries do not specialize the results remain unchanged.
[4] Factor intensity reversal means that given product there exists no wage/rental ratio such that product is capital intensive for higher return ratios and relatively labor intensive for lower factor return ratios.
[5] Put it differently, endowments have to lay within the same diversification cone- a set of all factor endowments consistent with production of two goods and cost-minimizing production methods. See Deardoff and Courant (1990) for more on this issue.
[6] Contract curve consists of tangential points of isoquants of production of goods X, Y and hence it is a set of points with marginal rates of technical substitution of K and L equal for both goods i.e. there is no possibility to relocate factors of production in order to increase production of one good keeping the amount of second good constant.

Figure 2.1: Factor price equalization



Production in Country 1 employs more capital-intensive methods of production for both goods. More capital per unit of labor is used in every sector in Country 1. This can be seen from the slope of lines $S0_x$, $S'0_x$ and $S0_y$, $S'0'_y$ respectively, and therefore relative price of labor will be higher in Country 1 than in Country 2 and the price of capital will be relatively higher in Country 2 than in Country 1. If countries open up to the free trade, then according to Heckscher-Ohlin theorem Country 1, where capital is relatively cheap, exports the capital intensive good Y and Country 2 (with relatively cheap labor) exports labor intensive good X. Country 1 moves along its contract curve toward 0_x, while Country 2 expands production of X and moves toward $0'_y$. This is accompanied by increasing price of capital and labor in Country 1 and 2 respectively. At the free trade equilibrium, flow of goods equalizes prices of goods X and Y.

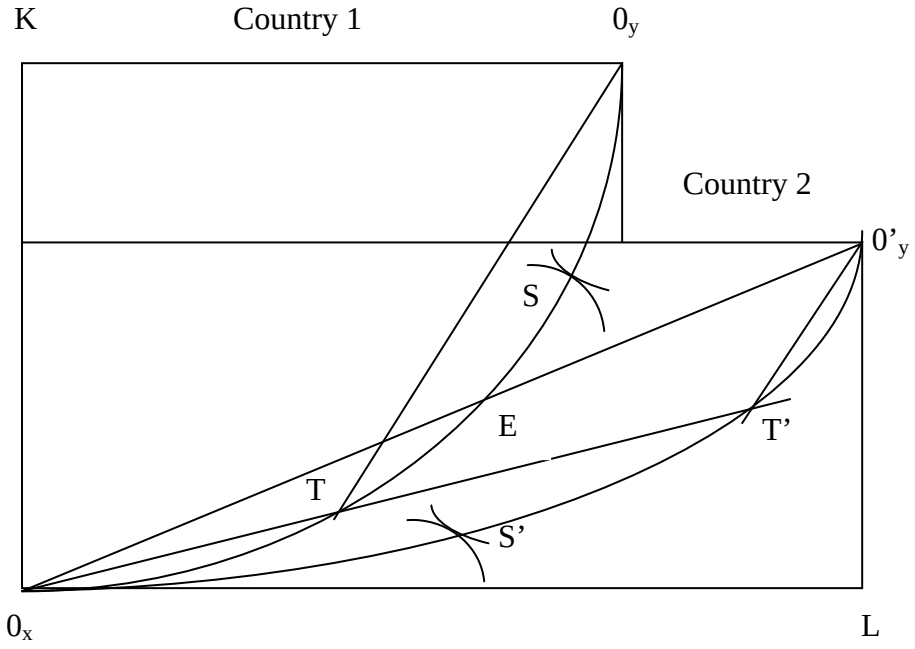
Figure 2.2 depicts possible trade equilibrium T and T'. These points lie on the same line and $T'0'_y$ and $T0_y$ are parallel (isoquants of production not shown). At these points factor intensities (K/L) in industries equal across countries. Assumption of identical production functions with constant returns to scale implies equalized marginal products, and hence equalization of real factor rewards.

This was formalized into Stolper-Samuelson Theorem (Samuelson 1948), which declares that if relative price of good increases (good Y for Country 1), then the real returns to intensively used factor increase (capital for Country 1), while factor price of the other declines (labor). For Country 2 the shift in regime from autarky to free trade means export of labor intensive good X and therefore the price of labor goes up. Overall, price of labor (and also rental price

of capital) converges. Trade is hence a perfect substitute for factor mobility. As long as there are trading equilibrium such as T and T', the factor price will be equal both relatively and absolutely; marginal productivities of capital and real wages across countries are equalized. Equalized factor prices are then compatible with factor and commodity market clearing; FPE is Pareto optimal.

There are several points worth mentioning. First, at the trade equilibrium, as said above, industries have same factor intensities. Therefore, in the Figure 2.2 points T and T' line on the same line going from the origin 0_x and lines $T'0'_y$, $T0_y$ are parallel. However, identical factor intensities cannot be reached for any arbitrary combination of production and therefore the FPE is not always fulfilled. Let us assume that world demand for good X has increased.

Figure 2.2: Free Trade Equilibrium



Both countries raise their production of good X (move upward their contract curves towards 0_y and $0'_y$). Factors of production shift from industry Y to industry X. For sufficiently large increase in demand, Country 2 will reach $0'_y$ and become fully specialized in the production of X. At the same time, Country 1 produces at E. If the demand increases even further, increase in demand and relative price of X Country 1 is somewhere between points E and 0_y and factor intensities differ since Country 2 cannot shift any factor from industry Y to X. Since Country 1 is relatively labor scarce, the relative price of labor will go up beyond point E and the FPE will no longer hold.

Set of factor endowments for which identical factor intensities can be reached (and in which FPE does hold) is called cone of diversification. This is a set of points for which

1. Both goods are produced in both countries.
2. Economies employ all of their resources (domestic demand=domestic supply, factor markets clear).
3. Firms minimize costs (optimizing employed factor intensities) for each sector.
4. Goods market clears (world demand=world supply).

For these endowment points under no factor mobility trade is able to replicate a situation which is identical to free movements of factors and hence in which factor rewards are equalized.7 However, the cone of diversification (FPE set) is restricted and it depends on the relative factor endowments between trading partners. Were the relative factor endowment "too" different, factor price equalization when moving from autarky to free trade does not occur. The level of difference is conditioned both on endowment (initial factor prices, isocost line) and on technology (isoquants of production). By the concept of cones of diversification Samuelson (1948) has formally shown that convergence of labor costs is likely to be expected for countries that are similar in factor endowment.

Second, Figure 2.2 suggests that the greater the difference in initial factor endowments, the greater the probability of complete specialization among countries. If Country 2 were even more labor abundant, then its contract curve $0_x0'_y$ would shift eastward. The area with equilibrium trading points under incomplete specialization and constant capital would then decline. The diagonal line $0_x0'_y$ can then eventually blend in with the TT' line and Country 2 would fully specialize in labor-intensive production. No points of trading equilibrium under incomplete specialization are then possible; factor price equalization does not take place.

Third, even if the FPE does not occur, trade still decreases differences in factor prices. Country 1 as relatively capital abundant exports capital-intensive goods and the price of capital goes up. The same is true for Country 2 where price of labor increases until the complete specialization in the labor-intensive good X at point $0'_y$ is reached. In this sense, product trade is an indirect competition between the same factors in different countries. Samuelson (1971) presents a slightly different model, a dynamic Specific-Factors Model, in which each sector uses a productive factor not used in the other while both make use of a factor that is freely mobile between sectors. For example, agriculture uses land,

[7] These points are also called integrated equilibrium. See Appendix for a description of cone of diversification.

manufacturing capital and both industries employ within-sector mobile labor. In such setting transition from autarky to free trade will induce partial factor price equalization in the sense of a reduction in factor price differences among countries rather than complete equalization. Such a tendency we shall call factor price convergence (FPC). This has been known to Mundell (1957) who postulated that perfect mobility of commodities causes equalization of commodity prices.

2.2 FPE reconsidered

Presented model provides a strong prediction about the evolution of factor rewards given free trade is allowed. As the model is logically consistent and yields remarkable results, we have to consider look on its relevancy especially in terms of assumptions.

Some of the biggest shortcomings include the assumptions of constant returns to scale and perfect competition in international trade. Until now, we assumed that trade is explained by comparative advantage either in technological differences or in factor endowments. Following this reasoning trade should be greater the greater the differences between countries. However, empirical evidence speaks more in favor of the opposite (see Greenaway and Winters 1994, Chapter 3). The stylized facts show that the majority of trade takes place between countries similar in technology and factor endowments. EU, USA and Japan account for a higher proportion of world trade than their proportion of world income (Keller et al. 2003). Likewise, the intra-industry trade, a country simultaneously exporting and importing products of the same industry, accounts for phenomena that comparative advantage fails to explain.

Finally, yet importantly, multinational firms are taking considerable share of international trade. They enjoy firm specific advantages and increasing economies of scale, which are central explanation of specialization. Altogether, it seems natural to enhance the analysis of factor price equalization under imperfect competition and the economies of scale and consider the role of multinational enterprises.

2.2.1 FPE in New Trade Theory

Increasing returns to scale and imperfect competition in international trade are a phenomenon largely proposed in New Trade Theory. For us is the key concern how, if at all, will the results of FPE be modified in models with increasing returns to scale and imperfect competition. These aspects were principally developed by Helpman and Krugman (1985). They pay attention to the fact that that: *"...economies of scale provide an incentive for specialization and trade over and above such reasons as international differences in factor endowments."*

(ibid: 131). This fact complicates our analysis in a sense that trade equilibrium without FPE can arise; uniqueness of FPE solution is usually not preserved.

There are several approaches how to include increasing returns to scale into FPE. One of them regards increasing returns as being external to the firms in given industry. This allows us to keep the assumption of perfect competition in product market. Under such circumstances, the FPE set is defined and therefore can be shown that factor prices can be (not must be) equalized. On the contrary to the previous case, there are several patterns of specialization and trade permissible, factor content of trade is not uniquely determined. Intuitively, we can imagine an example when labor costs in Country 1 are lower than in Country 2. According to Stolper-Samuelson Theorem, Country 1 should produce, if not all, then at least some of labor intensive good X. Nevertheless, due to decreasing average costs of production in the production of X, Country 2 can produce all of X with external economies despite cost disadvantage in labor supply.

The other approach in modeling wage equalization in NTT concentrates on contestable markets, where given the threat of entry from potential competitors monopolistic firms are forced to charge average cost prices. Since there are still increasing returns to scale in some industries, the production in these industries will be through trade located in one country. It can be shown that as in previous case there are multiple equilibriums possible with no necessary equalized factor prices.

Until now, we implicitly assumed that all of produced goods are tradable. To include non-tradable commodities such as some of services, we assume that they are produced with the same factors as tradable ones. If trade equalizes factor prices, also prices both of tradable and non-tradable goods will be equalize. However, as Deardoff and Courant (1990) prove, the size of cone of diversification is adversely affected by the number of non-tradable commodities. Hence, the likelihood of FPE decreases as the number of non-tradable goods increases. This has important implication. If nowadays many of services are becoming tradable, the size of cone of diversification grows and the likelihood of FPE rises owing to the trade effect of services. Especially for the EU trade in services, if at least partly approved, would mean considerable impetus for FPE.

In the New Trade Theory models FPE analysis was generalized beyond two countries, two goods case. Helpman and Krugman (1985) deal with multiple countries and goods and conclude that it does not alter results as long as countries are not too different in their factor endowments and the number of goods at least equalizes the number of productive factors. If countries differ, the equilibrium arises with more than one cones of diversification. Then the

countries within the same cone tend to reach FPE, equalization of factor prices between the cones does not happen. Deardoff (2001) explores whether economic growth tends to induce countries to the decreasing number of cones, this is based on assumption that factor endowment is not constant, rather it evolves in time. His results prompt that in neoclassical growth model there is no evidence that economic growth should bring countries' factor endowments closer together. Multiple cones are necessary. This has two implications. Firstly, as economic growth is not, on average, likely to bring factors endowments closer together then one of the key assumptions of FPE remains unfulfilled. Then we may observe little convergence or even divergence even in the long run. Secondly, it makes sense to explore convergence in a broad sample as well as in sub-samples and this way search for groups of mutually converging countries which are not too different in their endowment.

2.2.2 International Mobility of Labor

International trade is certainly not the single source of labor cost convergence. Relaxing assumption of internationally immobile production factors, flows of either labor or capital is apt to exert influence on factors' reward. Robert Mundell (1957) formalized this idea: a perfect mobility of factors results in factor price equalization and, even when commodity movements cannot take place, in a tendency toward commodity price equalization. Additionally, international flows of productive factors at the same time lead to convergence of factor endowments; similarly international flows of technology lead to convergence of production technology. Altogether, mobility of factors make countries more similar and hence draw nearer to common cone of diversification.

Economists usually agree on the fact that impact of migration on the average standard of living is positive[8] and a majority of studies has found positive effect on economic welfare of the destination country (Kleinman 2003). At the same time, there are consequences on distribution of income, which depend among others on flexibility, openness to world trade, degree of regulation. Magnitude of economic gains expands with the degree of migrant labor complementarity. Assuming constant returns to scale, immigrants will affect economic growth in the long run only if they are different from the existing labor force in terms of their mix of skill, otherwise they just augments the population.

[8] A migrant by relocating from a place where she is less productive to a place where she is more productive increases production and hence she benefits standard of living of the community as well as of her own.

Most studies conclude that the overall economic impacts of immigration are positive, yet relatively modest (Smith and Edmonston 1997). However, even if the overall balance is positive, there can be some groups with labor force negatively affected. Fears arise that particularly low skilled migration may adversely affect position of their domestic counterparts. For USA, Card (1990) detected that there is only a weak relationship between native wages and the number of immigrants both for skilled and unskilled workers on state or city level. For UK, Dustmann et al. (2002) conclude that any strong evidence that immigration has any large adverse effect on employment or wages is missing. Also studies by Borjas (1994), Hanson and Slaughter (1999) and Friedberg and Hunt (1995) confirm that factor prices are rather insensitive to migration. Kleinman (ibid) therefore deduces that consistent with a large body of evidence for other countries the fears of large and negative employment and wage effects on the resident population are not easily justifiable.

Regardless how important labor migration theoretically seems to be, empirical evidence does not back it as a one of the key variables of FPE mechanics. Certainly, there are obstacles both formal and informal to perfect mobility of labor. On the other hand, second production factor, capital, is highly mobile, that way can substitute for labor mobility in adjustment towards FPE, and it may even be the case that mobility of capital influences labor cost more than mobility of labor.

2.2.3 International Mobility of Capital

Mobility of capital belongs to leading characteristics of globalization (UNCTAD 1998). Its movements should ensure efficient allocation of resources and eventually equalize risk-adjusted rates of return on capital globally. In addition to that, capital mobility contributes to higher rate of accumulation (augmenting capital-labor ratio); it transfers technology and operational procedures.

It is necessary to distinguish between various kinds of factor mobility that, in fact, can sway convergence to divergence and *vice versa*. Short-term financial flows comprise of volatile and liquid capital primarily based on acquisition of instruments traded on financial markets. Although capable to contribute to long-term productivity growth, it is usually assumed they are less vigorous in decreasing variation of labor costs. In some cases, they can be detrimental to trade balances, exchange rates and subsequently to the economy as a whole.

Foreign direct investment (FDI), on the other hand, are connected with flow of real resources aimed at yielding long-run profit on investment, they are presumably less volatile, and can

bolster convergence by facilitating technology transfers and spillovers and hence increasing productivity of labor. Their importance is clear, for example the World Bank (1996) considers FDI as a driving force behind economic convergence. Moreover, flows of capital affect differently both recipient and country of origin and therefore are especially relevant for potential convergence of labor cost. For those reasons we will devote complete next chapter to exploration of FDI and multinational enterprises and their effects on FPE.

2.3 Factor Price Equalization-Survey of Literature

Now, since we have discussed the FPE model, we are finally in a position to turn to the empirical examination of factor price equalization. We focus on Stolper-Samuelson Theorem and then on empirical evidence for or against factor price convergence (equalization).

2.3.1 Stolper-Samuelson Theorem

This theorem is a necessary condition for Samuelson's (1948) version of FPE. However, Samuelson's successors have extended FPE for increasing returns to scale and imperfect competition and permitted factor price equalization without it. Besides, rather than for equalization as a long-run equilibrium empirical studies look for factor price convergence as a process possibly leading to equalization.

Helpman and Krugman (1985) as well as Brown et al. (1993) question the Stolper-Samuelson Theorem and have shown both theoretically and empirically that reward of country's scarce factor tend to increase rather than decrease since gains from increasing returns to scale can accrue to all factors including the scarce one. For North America Free Trade Area Brown's study comes to the identical results for differentiated products and imperfect competition. Thompson (2003) in his survey of trade models (including various types of market competition, models with specific factors of production) concludes that beyond two factor model there is no presumption that for a country trade will force the reward of its scarce factor to decrease. Hence, empirical evidence suggests that for Samuelson's original model, support is rather limited.

2.3.2 Factor Price Convergence

To explore FPE, there are two major directions of research. The first set of studies focuses on FPE across group of countries. For OECD countries Mokhtari and Rassekh (1989) find significant evidence of factor price convergence in aggregated manufacturing data. Trade

openness was found as the strongest factor that contributed to decreasing wage variation. Jung and Dorodian (1995) use Johansen's cointegration framework for testing labor costs convergence in manufacturing for eight OECD countries and "they find support for convergence."

Davis (1992) examines convergence across industries in developed and developing countries and concludes that despite a trend to common mean due to international trade, convergence is to a large part reserved to rich countries. Similarly, literature does not show any long-run convergence trend between developed and developing countries (UNCTAD 1998). O'Rourke et al. (1996) concludes that convergence has been demonstrated both by convergence of relative factor-price as well as relative scarcity of labor and land between 1870-1913 for USA, Sweden, Australia, Germany, UK, France, Denmark. They assigned such development to increasing integration of world markets where trade served as a substitute for factor migration. For the successive periods evidence is considerably weaker.

The second set of studies tests FPE across regions of particular country. Results vary; the hypothesis of convergence finds little support as argued by Tomuira (2005) for Japan, Bernard et al. (2002) for United Kingdom, Bernard and Schott (2002) for the USA. These studies reject the hypothesis that *all* regions within the country face the same relative factor price. For the case of UK, three distinctive regional prices were found. Besides different cones of diversification, disparities in wages emanate from heterogeneous products or region-specific differences in total factor productivity due to of distinctive technologies and immobile factors of production. For USA, Bernard and Schott (2002) uncover that wage difference across regions increases with the difference in industry structure and likewise they discover at least three different cones of diversification for USA. The fact that there are persistent wage differences and with different industry mix authors explain by different exposition to international trade. On the other hand, Webber (2001) investigates wage convergence among 57 EU-regions between 1980-94 and his „finding supports the hypothesis that economically integrating economies face a progressively similar level of factor rewards."

To my knowledge, literature does not deal with the possible discrepancy of results in FPE studies among countries and within individual states. Potential explanation may be the distribution of region in different cones of diversification. For example, Prague and Northern Bohemia differ in factor endowments as well as in the production and therefore the FPE is unlikely. On multinational level such regional disparities balance mutually vis-à-vis similar regional structure and the overall picture turns to convergence.

2.4 Summary

Factor Price Equalization Theorem provides a clear answer for the evolution of factor rewards under international trade. If FPE holds, than the marginal productivities of capital and real wage are identical across countries. We have presented Samuelson's original construction and reconsidered it by the lenses of New Trade Theory. While in the former model equilibrium is unique with the identical set of factor prices over all the countries, in the latter case equilibrium with FPE is just one of the possible outcomes. It seems plausible that due to numerous existing cones of diversification, factor price equalization through the process of convergence arises among groups of sufficiently similar countries. This idea was also acknowledged in the survey of literature, where the tendency of real factor rewards to converged was confirmed mainly among countries employing similar technologies, having similar factor endowment with mutually low barriers to trade. Role of labor mobility does not seem to be an important determinant of labor cost convergence.

III. Mobility of Capital, Multinational Enterprises and Factor Price Equalization

Mobility of capital and multinational enterprises (MNE)[9] are worth considering in the process of factor price equalization. Besides international trade, they represent a bridging element between countries; they promote closer linkages among economies and have potential to transfer factor endowments (technology, expertise, know-how etc.). They serve as mediators of factor price convergence. Therefore, considering both foreign direct investments (FDI) and multinational enterprises enriches our analysis by two elements which steer economies (their cones of diversification) closer together and which subsequently contribute to the factor price convergence.

Multinational (transnational) enterprises, major originators of FDI, are becoming increasingly prominent in the world's economy. In 2000, world's ten largest MNE produced nearly one percent of world's GDP and one hundred largest MNE are responsible for more than four percent of world GDP (UNCTAD 2002 in Mündler 2006). In addition to, MNE grow rapidly and spread their activities on worldwide scale. It is not a surprise that FDI reflect more prominently the linkages between economies than international trade (e.g. Cuyvers et al. 2002).

Our discussion will proceed as follows. First, we briefly consider types of FDI and their roles in host country. Then, we focus on what the theory says about capital flows and their impacts on FPE. Survey of literature follows in order to quantify consequences of FDI on wages and productivity in recipient countries. Finally, the effects on home country are considered.

3.1 Foreign Direct Investments

Foreign direct investments can be generally interpreted in two ways. The first one considers FDI as a flow of capital from home to host countries. These flows transfer ownership in the host country and are included in the balance of payments as flows and stocks. The second approach regards FDI as regular operations (production, sales etc.) of MNE's new affiliate

[9]As multinational enterprises, we consider firms with own operations in more than one country. Contrary to them, national enterprises (NE) perform own operations in just single country. For this reason a Czech firm exporting abroad and employing local distributors there is not a MNE. As foreign direct investment, we think of activities performed by MNE to secure assets abroad. Flow of physical capital is not necessary-FDI may not be source of additional finance to the host country. Throughout the chapter, we focus primarily on the FDI. Short-run financial flows, speculative capital or portfolio investment certainly deserves attention as well but they are usually regarded as less conducive (sometimes even preventing) to convergence and we will not discuss them unless explicitly stated.

after the acquisition has taken place. Perhaps, this latter conception is more relevant for our subject as convergence is result of activities rather than result of sole investment flow. However, as Lipsey (2002) notes, this second aspect is substantially more difficult to control for, as the data are not always available.

From the point of view of host country, FDI are divisible according to their position in the production chain. We distinguish between vertical and horizontal investments. For horizontal FDI, production is located in parent company and in production plants abroad, all focusing on similar set of activities. Vertical FDI, in contrast, exploit international factor price differentials; operations are divided into the headquarter services and production. While the former manages firm's knowledge assets and support functions (skill intensive labor) in countries, where skilled labor is relatively cheaper, the latter focuses mainly on production of output (manual labor) in low cost countries. In other words, activities are located according to their factor intensity.

Empirical literature agrees that horizontal FDI are the most abundant of all FDI and that most of them take place between developed countries. For example, Markusen (1995) calculates that more than 80 per cent of FDI is directed to industrialized countries. Market size, distance and trade costs explain these flows satisfactorily well. Factor price differences (wage differences) did not turn out to be an important determinant of horizontal FDI (Brainard 1997, Gaston and Nelson 2002). Therefore, models of horizontal FDI usually employ assumption of equalized factor prices (see Claro 2005).

For vertical FDI wage differential is essential. Helpman (1984) in his seminal model of multinational enterprises shows origination of vertical FDI. Since there are cross-country differences in factor endowments, there are also cross-country differences in factor prices (no FPE). Labor cost differential enables MNE to take advantage of geographical division of production, which is at the outset catalyzed through FDI. In equilibrium, capital mobility has equalized real factor rewards as well as enlarged factor endowment set.

Regardless of particular type of investment, FDI take three main functions in the host country. First, MNE as originators of FDI possess so-called knowledge capital (e.g. Dunning 1977). This is a firm specific advantage such as technology, management skills, scale economies etc. enabling MNE to successfully compete abroad. Authors confirm and emphasize the role of knowledge rather than capital as key component of investment flows (e.g. Markusen 2002).

Second, some parts of knowledge capital may spill over to domestically owned enterprises making them more competitive and also providing tighter linking of the host country to the world economy. As it has come clear from the second chapter, convergence of employed

technologies is one of presumptions for presence in the same cone of diversification and hence for convergence of factors rewards.

Third, FDI may provide an additional source of capital allowing investment beyond the level of domestic savings and expansion of host country production. Inflow of capital leads to switch of production methods and to convergence of factor endowments and factor intensities.

3.2 Factor Price Equalization and Mobility of Capital

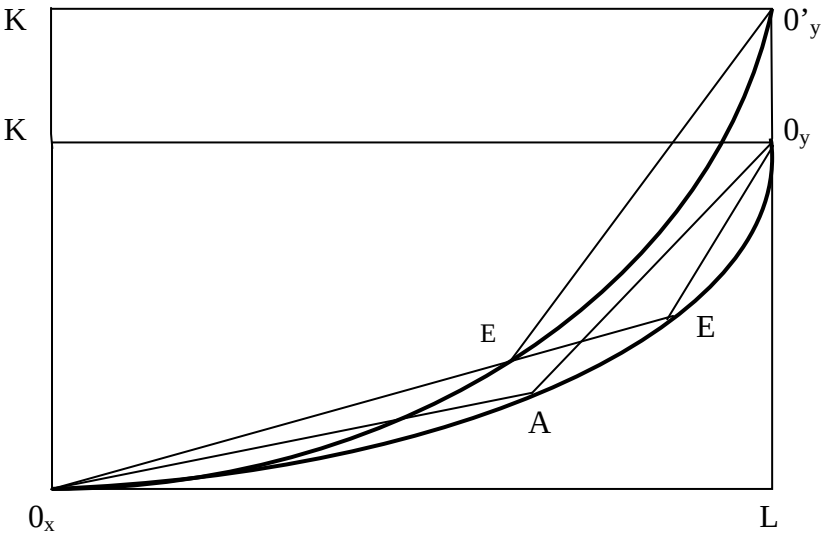
As we know from previous chapter, Heckscher-Ohlin-Samuelson (HOS) model assumes that factors are internationally immobile; yet, trade still equalizes commodity and factor prices. In the following, we focus on the complementary situation, namely whether capital mobility alone is in "2-2-2 HOS world" capable of achieving factor price equalization even if international trade is prohibited.[10] This question was for a first time formally answered by Mundell (1957) in his article on capital mobility and factor price equalization. In the following, I present treatment by Hong (1996, Chapter 15).

Let us assume that free trade has ensured FPE, holding capital and labor internationally immobile. Such equilibrium is depicted by point E in the Figure 3.1. Further, we assume that Country 2 imports capital-intensive good Y and exports labor-intensive good X. In such a case, removing barriers to capital movement does not induce any flows since returns to factors are already equalized. If now relatively less capital-abundant Country 2 imposes a prohibitive tariff on capital intensive good Y, the price of Y rises relative to the price of X[11]. There is no trade at all in 2-2-2 models. Subsequently, Stolper-Samuelson effect takes place: factors move from labor-intensive industry that produces good X to capital- intensive industry producing Y. As a result, there is an excessive supply of labor and excessive demand for capital. Production of good Y grows and that of X declines, country moves down along its contract curve to autarky point A.

[10] The HOS 2-2-2 world refers to the model presented in the preceding chapter including all the employed assumptions. The only modification is prohibition of international trade here. See section 2.1.1 in the previous chapter for the comprehensive description of the assumptions in original model.

[11] Model assumes that Country 1 does not respond by levying a counter tariff, the tariff increase is unilateral. If ere is a response, capital flows cannot equalize factor rewards since the interest payment to Country 1 will be subject to these trade impediments.

Figure 3.1: Capital Flows-Country 2



In autarky, relative factor intensity K/L has fallen in comparison to free trade equilibrium, i.e. marginal product of capital increases and the marginal product of labor decreases. As there are no impediments to factor movement, Country 2 enjoys inflow of capital and factor endowment set is enlarged by the additional amount of capital that equalizes marginal products in both countries. Factor endowment set expands to $0_xL0'_yK$. For graphical tractability, although results are valid generally, it is comfortable to assume that Country 2 is small relative to Country 1 so that marginal product there remains unchanged and thus also factor proportions and commodity prices. In equilibrium then, factor proportions in HOS must be the same and hence the new equilibrium, E', lies on intersection of $E0_x$ and line parallel to 0_yE. Factor flows from Country 1 to Country 2 have equalized both factor rewards and commodity prices even without free trade. It is not a coincidence that, *ceteris paribus*, Country 2 consumes the same mix of goods as under free trade (commodity prices and factor rewards remain unchanged); however, now Country 2 needs to increase production in order to finance payments of interest to Country 1. It can be shown that these results are applicable for any positive value of tariff as well as that they are independent from size of trading partners.

In the line of presented argument, we can imagine that labor scarce Country 1 introduces a tariff on labor-intensive good X. As a result, price of X increases and owing to Stolper-Samuelson argument marginal product of labor grows and that of capital falls. If there is a perfect mobility of labor, labor force migrates to Country 1 until marginal products are equalized and factor rewards are the same. This result is even more robust than the one of capital mobility. Since, if workers as owners of productive factor settle in Country 1 and consume their incomes there, results of FPE is valid regardless whether Country 2 responds

by levying a counter tariff on good Y. Mundell (ibid) formulates these findings in the way that trade impediments give rise to movement of production factors with the identical results as unrestricted trade with factors internationally immobile. In "2-2-2 HOS world", factor price equalization is sufficient to ensure commodity price equalization and vice versa.

Since we have discovered that capital flows alone (given the assumptions of Heckscher-Ohlin-Samuelson model) are capable of achieving factor price equalization, international trade is not a necessary condition anymore. It is valuable to explore what other, less restrictive, models prompt about capital flows and labor reward.

Brown et al. (2002) summarize theoretical implications of capital mobility and survey relevant models on capital mobility and factor rewards. Their study includes variations of two-sector Heckscher-Ohlin-Samuelson model, Specific Factor Model or model with multiple cones of diversification. Table 3.1 reports their findings. All but one model shows a non-negative relationship between wages and capital inflow. Let me briefly comment on some of the models.

In the case of small country with two cones of diversification, capital inflow leaves wages intact. This is caused by the fact that within the same cone, FPE holds and given the HOS assumption, there are not any incentives for capital to move. Between the cones, FDI from capital-abundant country to labor-abundant country situated in different cones will be favorable to factor price convergence. Wages will grow and returns to capital fall while the opposite happen in home (capital-abundant) country. In other words, FDI raises capital stock in a host country. For sufficiently large inflow, country grows to different, higher, cone with higher output and higher wages.

Table 3.1: Effects of FDI on Host Country Wages

Model (sectors x factors)		**Small Country**	**2-Country Model**
One sector (1 x 2)		+	+
HOS (2 x 2) specialized		+	+
Specific Factors (2 x 3)		+	+
HOS (3+ x 2) two-cone, diversified		0	+
Feenstra-Hanson (infinite x 3) two cone, diversified	Skilled labor	+	+
	Unskilled labor	+	-

Source: Brown et al. (2002: 51), small country is defined as a country that takes prices as given

The decrease in wages of unskilled workers in Feenstra and Hanson (1996) is connected with the change in labor demand as the least skilled jobs from high wage countries are transferred to the low-wage countries. Subsequently, these jobs become the most skill intensive there and as result the relative demand for skilled labor increases causing wages of skilled workers to rise and those of unskilled to fall in the host country. FDI expands production of skill-intensive products in low wage country.

With the exception of two above-mentioned cases, Table 3.1 shows that the majority of surveyed theoretical models are supportive for the idea that wages grow with the inflow of capital. Brown et al. (2002: 9) therefore concludes that: "...labor earning a higher wage as a result of an inflow of FDI is a normal case, in the absence of knowledge that circumstances are otherwise". This is an encouraging result for low-wage countries to catch up with the high-wage countries as they enjoy large influx of foreign investments.

3.3 FDI and Wages-Survey of Literature

Having reviewed what the theory suggests about capital flows and wages, now let us proceed with a survey of literature. Before proceeding further, a word of warning is necessary. Despite the current surge in research on MNE, there are not many definite answers, yet some stylized facts are emerging. One of them is the fact that compared to national firms, MNE pay higher wage rates both in developing and developed countries (e.g. Lipsey and Sjöholm 2004, Lipsey 2002, Doms and Jensen 1998). This seems to be a well-established fact, yet a curious reader immediately goes further and asks

1. Do MNE pay higher wages than in NE for *ceteris paribus* identical workers?
2. Do higher wages in MNE spill over to NE?
3. If yes, are spillovers enough robust to transform to growth of average wage level

Ad question 1. To answer this question comprehensively, the problem of the data availability becomes even more troublesome. In order to make a meaningful comparison, one ideally needs detailed information both for MNE and for NE on detailed (employee) level about skills, education, experience etc. To my knowledge, three studies have well accomplished such task.

The first study was made by Aitken et al. (1996) for Mexico, USA and Venezuela. They find that MNE's wage premium in all three countries averages around 30 percent for both skilled and unskilled labor. Controlling for presence in high wage industries, plant size location and some basic worker's characteristics does not fully explain size of the premium. Therefore, it is

to assume that there is some part of the MNE wage premium assignable exclusively to foreign ownership. Results of Brown et al. (2002) point to the case MNE pay higher wages even when controlling for worker characteristics such as education, experience etc.

Lipsey and Sjöholm (2001) investigate MNE's wage premium on Indonesian industry level data. They start with the finding that controlling for education and ownership foreign-owned firms pay 33 percent and 70 percent more for blue and white collar jobs respectively more than NE. Further, taking into account other underlying characteristics (industry, location, plant size, other inputs) they arrive at the conclusion that around one third of the premium is assignable solely to foreign ownership. This means that approximately 11% for unskilled and 27% of skilled wage premium can be attributed to MNE as such.

Empirical evidence seems to suggest that MNE do reward labor more generously than NE, even above market wage. Of course, results have to be confirmed by successive studies; nevertheless, the results are in this respect promising. Let us now consider for a moment why it may for MNE be rational pay higher wages.

Why do MNE pay higher wages?

The theory of efficiency wages (Katz 1986 , Stiglitz and Shapiro 1984) offers an appealing explanation that higher wage is a cause of higher productivity, rather then vice versa. Based on firm-workers relation, firms pay higher than market wages in order to reduce shirking, to reduce turnover and cost of retraining and to attract the most productive workers. However, these reasons apply similarly for NE and therefore cannot serve as a sole explanation. There are some additional reasons to justify higher wages in MNE other things being equal. First, since Dunning (1977) existence of MNE is explained by possession of firm specific assets that enable them to successfully compete with NE. In order to prevent spillovers to their competitors, MNE motivate employees not to leave enterprises by higher wages. Secondly, MNE may incline to behave in a socially responsible manner owing to public pressure in home countries. This means avoiding "sweatshops" and exploiting low-paid workers. Responding to these activities, MNE may pay higher wages than NE for identical workers. Thirdly, Lipsey and Sjöholm (2001) suggest that MNE may have less knowledge of local labor market or workers may require a wage premium for working in foreign firms.

These reasons provide some relevant explanations for wages exceeding the market wage for otherwise equal workers.

Ad question 2. One of the important points in examining convergence of factor rewards is to pose a question whether MNE's wages, which are higher than those of NE, spill over to local enterprises. Positive wage spillovers would force NE to pay higher wages and hence there would be a negative externality arising to them.

For Portugal Martins (2004) estimates spillover effects from foreign presence to wages paid by domestic firms as significant and positive. Foreign-presence has increased, on average, domestic wages between 2% and 3%. Lipsey et al (2004) found positive and significant spillovers to NE in Indonesian manufacturing enterprises. They assign part of the wage increase to the increase in demand for labor. Aitken et al. (ibid) find that higher levels of foreign ownership were associated with positive wage effect of foreign activities in NE on plant as well as on the industry level. In their study they have found that a 10 percent increase in the share of foreign investment in industry employment raises wages by 2,5 percent in Mexico and Venezuela.

For UK electronics industry, Driffield and Girma (2002) locate statistically insignificant spillover effect on wage. Girma et al (2001) using firm-level panel data for UK manufacturing for 1991–96, find on average no overall spillover effect of multinationals on the wage level in domestic firms.

Seeming discrepancy in results notwistanding, Lipsey (2002:30) concludes that:"...there are enough positive wage spillovers, even in panel data studies, to preclude any conclusion that they are typically negative." Nevertheless, more consideration would be appropriate to control for different policies in host countries on state as well as on industrial and firm's level.

To my knowledge, there is no study on Central European Countries regarding wage spillovers. From the available literature, we learnt that for developing or less industrialized countries wage spillovers occurred and were positive and significant. The potential for the spillovers in NMS is likely to be sizeable. This proposition arises from the fact NMS are with exception of Poland rather small countries with relatively open economies in the proximity to core EU countries. They successfully attract MNE and are capable of applying the new technologies-the technological gap is not large.

Ad question 3. For the impact on average wage level, we consider whether higher wages paid by MNE together with potential wage spillovers are enough robust enough to increase the average wage level either on the level of industry or entire economy. Such an increase can be a result of labor market competition. Were the market competition for workers sharp, then increasing labor demand upon the arrival of MNE (labor demand curve shifts upward) would

cause an increase of equilibrium wage for all the enterprises and hence an increase in average wage.

First, let us look at those few studies on average wage level. Gopinath and Chen (2003) consider effects of FDI on wage level as measured by labor's share on GNP for 1970-1992. Their results seem encouraging for labor cost convergence and are consistent with the theory presented in this chapter. Controlling for other factor's endowment (capital, land, population), authors have found that developing countries face an increase in wage of average worker as the capital flows in. This prompts the idea that on average capital inflows raise capital-labor ratio and therefore as capital becomes relatively less scarce, its rewards tend to fall, while those of labor rise. The elasticity of wages with respect to inward FDI (=elasticity of wages with respect to capital endowment) was estimated at 0.13 for developing countries. For developed (high-wage) countries wage elasticity with respect to net FDI is negative (-0.04) which goes well along the presented theory: as capital flows out; it becomes scarcer relative to labor and thus its reward increases while wages fall.

For Indonesia, Lipsey and Hölstrom (2004) have identified that following foreign takeover the wages for both white and blue-collar workers rose absolutely and relatively to their industry, while domestic takeover led to wage decrease. Figlio and Blonigen (2000) deduce that new foreign investment in South Carolina have so large effect on aggregate wage levels that it could not have been only the result of the high employee wages in the foreign owned firms. Rather, wage spillovers to domestically owned firms had to have been operating. Similarly, Aitken et al. (1996) concludes that for Venezuela and Mexico there was a significant effect of foreign ownership in raising average industry wage levels. Besides that, Rama (2003) also finds out that an increase in FDI is associated with positive impact on wages. On average, 1% growth of FDI/GDP ratio leads approximately to 1% increase in wages.

Overall, and despite rather limited range of research, there seems to exist emerging evidence that FDI support an upward shift in average wages. For example, Lipsey (2004: 34) declares that he would summarize the sparse evidence on overall wage levels as pointing to positive effects of FDI activity. This is an encouraging result for wage convergence, yet we have to consider another important aspect of wage growth. Namely, the hypothesis whether the skill-biased-technological change[12] is operating. In other words, if FDI activities are focused

[12] To the fact that technological development requires labor that is more skilled is referred to as skill biased technological change. It could be argued that observing increasing share of affiliates participating on high value added activities such as R&D and falling share of production workers on total employment, as pointed by Berman, et al. (1998), document that the relative labor demand shifts in favor of skilled labor and adversely affects low-skilled labor.

mainly on skilled labor as measured by terms of recipient country, we can observe wage spillovers or higher demand for labor in industries with relatively higher value added. Subsequently, consequences of capital inflow across industries and type of labor would differ. For example, speed of FDI-induced wage convergence can vary across industries.

Gopinath and Chen (ibid) estimate wage elasticities for skilled (non-agriculture) and unskilled (agriculture) labor. Their estimates of wage elasticity with respect to inward FDI for developing (low wage) countries were 0.067 and 0.12 for unskilled and skilled labor, respectively. Ceteris paribus, the effect on skilled labor seems to exceed the one on unskilled almost twice. These results give some evidence to the claim that inward FDI reward skilled labor more generously than unskilled; a skill premium of inward capital flows was detected. Findings of Rama (ibid) reinforce these results. On panel data for both developed and developing countries he finds that one percentage point increase in FDI/GDP causes up to five-percentage points increase in return to additional year of schooling and hence FDI's rewards to wage increases with the level of education.

These interesting results underline the importance of capital flows in supporting factor price convergence within a group of developed countries as well as between developing and developed countries. As we surveyed available literature, the role of FDI in factor price movement is becoming clearer. Presented evidence provides justification to the claims that MNE pay more to their employees than indigenous firms do and that higher wages spread to NE in some cases. On aggregate level, the presence of multinational enterprises in host country usually raises the average level of wages. Nevertheless, the impact is not unambiguous; it differs with skills. To be precise, FDI rewards skilled labor more than unskilled.

3.4 Foreign Direct Investment and Productivity

As reader may well anticipate, to complete the mosaic of MNE and their impact on wage convergence, we should now turn attention to productivity and its spillovers. As the stylized facts tell, MNE not only pay higher wages than NE, they are also more productive (e.g. Sjöholm (1999); Ramstetter (1999); Girma et al. (2001)). Part of the productivity differential is satisfactorily explained by the size of the enterprise, factor intensities, purchased inputs. However, there is still some residual productivity assignable to foreign ownership. Higher

productivity of MNE is a necessary condition for considerations whether higher productivity spills over domestically owned firms. If productivity spills over to NE especially by the means of new technology or operational methods, industries in home and host country are drawn nearer to the same cone of diversification, which is crucial for FPE, as we know from previous chapter.

Before proceeding further, we must remind that the relationship between labor productivity and wage is not as clear as one might expect. Assume that technology raises labor productivity. From labor demand theory, we know that workers in competitive industry are paid revenue marginal product of labor, $\boldsymbol{w = MP_L * P}$, (1).

To restore the equilibrium, firms in competitive industry change production. Ceteris paribus, there are generally three ways how to achieve this. First, an enterprise, as labor is more productive than before, produces more goods with quantity of labor input constant. As a result, price $\boldsymbol{P}$ falls with the supply growing relatively more than demand and ultimately the equilibrium (1) is restored. Second, the increased labor productivity decreases unit labor cost ($\frac{\boldsymbol{wage}}{\boldsymbol{MP_L}}$) and enterprise switches to relatively more labor-intensive production methods, produced quantity unchanged. With more labor employed, marginal product of labor decreases up to quantity that restores equilibrium. Finally, if entrepreneurs intend to expand production beyond quantities manageable by employment of existing factors, they have to increase wage in order to increase labor supply.[13] and again equalize (1). For these reasons, it is difficult to make *a priori* judgment on the sign and magnitude of technological change and wage. Correspondingly, a combination of all three effects can take place.

3.4.1 FDI and Productivity-Survey of Literature

Turning to empirical literature, we would like to go beyond what the stylized facts suggest and try to answer some of those more detailed questions that emerge along the well-established observations on MNE and productivity. Table 3.3 indicates the directions of our next steps.

[13] Since these trade models are general equilibrium models, there is assumption of market clearing set of prices; any unemployment is voluntary.

Table 3.2: Productivity and MNE

Stylized fact	Considerations
Compared to NE, MNE possess superior technology.	1. Does the higher productivity and technology spill over to national enterprises? 2. Why does the evidence for productivity spillovers differ so widely across countries? 3. Is the overall productivity level increased by the presence of MNE?
Controlling for other characteristics, MNE are more productive than NE.	

Source: stylized facts from Lipsey and Sjöholm (2004), Lipsey (2002), Doms and Jensen (1998), Ramstetter (1999), Girma et al. (2001).

Ad question 1. Evidence on productivity spillovers is not very persuasive which is in contrary to what one would expect when productivity spillovers serve as one of leading arguments for favorable treatment of FDI by the state authorities (tax holidays, financial incentives etc).

For Venezuela, a rise in foreign ownership reduced the output produced by domestically owned firms and decreased their total factor productivity in one to three years period (Aitken and Harrison (1991) in Lipsey (2002)). Kathuria (2000) defines positive spillovers such that the dispersion of productivity in particular industry between domestically owned firms and MNE decreases in time. On panel data for India, she did not find any supporting evidence for positive spillovers; rather the gap has increased which points to negative effect for productivity. These observations indicate the possibility of MNE's negative influence on the production activities of national firms.

For developing and transition countries, negative productivity spillovers are common, including the Czech Republic, Poland, Hungary and the rest of CEE region (Damijan et al. 2001, Djankow and Hoekman 2000). Benacek et al. (2000) finds that the presence of foreign firms has increased productivity levels in Central Europe, but only to a limited degree.

Görg and Greenway (2001) found limited positive spillovers and in their survey of literature conclude that most works fail to find positive relationship, with some reporting even negative spillovers. Similarly as for the wage spillovers, the panel data report negative relationship whereas cross section data point to positive relationship. However, it is worth noting that cross section studies are likely to be biased and detect positive spillovers where there are

none.[14] Since 2001, there are also panel studies indicating positive productivity spillovers (Haskel et al. 2002 for UK manufacturing plants, Keller et. al. (2003) for US manufacturing). In their most recent survey of the matter, Görg and Greenway (2004) bring together the vast majority of studies and conclude that positive spillovers were found mainly in the developed countries.

Results are thus far from being unambiguous. On one side, they indicate negative productivity spillovers in less developed countries and NMS. On the other hand, there is evidence for positive spillovers in developed countries.

Ad question 2. Variance in productivity spillovers can be clarified by country's and NE's characteristics as well as by competition among MNE affiliates and NE and by distinction in FDI. First, spillovers are not self-evident externality of MNE presence; rather they seem to be influenced by capacities of NE as well as by conditions of studied industry. For example, Kokko (1994) has found that the greater the technology gaps between MNE and NE, the less evidence for productivity spillovers. Blömstrom and Wolff (1994) reaffirmed that productivity growth was higher in industries in which NE were initially closer to MNE. Both Kathuria (2000) and Wang and Blömstrom (1999) condition speed of spillovers by competitive business environment and by NE's effort in learning (investments in R&D) and imitating advanced technologies. Alternatively, it may as well be the case that NE lack sufficient capacity to absorb or apply these externalities, for example due to quality of human capital. Clearly, countries differ in their ability to take advantage of presence of MNE and their technology. As for Venezuela, a relatively closed and trade-protected country with presumably high number of small firms, the negative productivity spillovers were found. An arrival of MNE can then lead some of the least efficient firms to exit or to operate on small less efficient levels.

Second, Baily and Solow (2001) refer to pro-competitive effects of affiliate operations. The MNE have lower marginal costs due to firm-specific advantage. The foreign entrants may then take domestic firms' market shares as they stimulate product-market competition, and thereby force domestic firms up their average cost curves, which are then left to produce at lower, less economical level. This effect seems to prevail over the opposite scenario where

[14] Cross section studies do not allow for investigation of time development of labor productivity as well as they fail to control for time invariant differences in productivities across sectors that are correlated with MNE's presence without being caused by it. For example, electronics sector is inherently more productive than agriculture, yet the FDI were not the cause for it. However, if MNE are present in this industry, then the relationship between productivity and MNE activities would be positive (see Görg and Greenway 2004).

competition forces stimulate indigenous firms down their average cost curve. Moreover, NE in developed countries are already used to competition with MNE-after all, the successful NE become MNE-and have learnt how to take advantage of strong competitors and perhaps induce them to move down their average cost curve.

Third, there are two kinds of spillovers. Horizontal spillovers virtually increase the competitiveness of NE through a provision of better technology. Therefore, it is in the interest of profit maximizing firm to minimize the horizontal spillovers. Should it happen despite the effort to prevent so, this kind of knowledge transfers can be regarded as market failure. Contrary to horizontal spillovers, vertical spillovers may go well with the interests of MNE. They may voluntarily help to increase the efficiency of domestic suppliers through technical assistance or simply demand high quality intermediate products from the local suppliers. In other words, spillovers may take place through contacts between domestic suppliers of intermediate goods and MNE (so called backward linkages). The literature on this topic is rather scarce. Smarzynska-Javorcik (2005) finds on Lithuania panel data positive productivity spillovers through backward linkages. Blalock and Gertler (2003) come across the same for Indonesian plant-level data.

Ad question 3. Unfortunately, the literature on the role of FDI and aggregate productivity is very scarce. This is caused not only by lack of available data but also by inherent difficulties in measuring productivity beyond the measure of value-added.[15] To my knowledge, De Mello (1999) conducted a panel data study of aggregate country effects in developed and developing countries leaving industrial division behind. He found that FDI in developed countries raise total factor productivity and in developing, it raised fixed investment. Baldwin et al. (1999) is one of the studies exploring productivity growth and FDI. For industry aggregates in nine OECD countries, they report that higher FDI penetration levels led to higher growth in industry labor productivity than otherwise.

Irrespective of the mixed stories for productivity spillovers, the stylized facts tell us that foreign owned firms are highly productive; their productivity exceeds the one of national enterprises. As far as productivity spillovers concern, empirical evidence is differs between developing and developed countries. Positive spillovers are conditioned by technological gap

[15] See Lipsey (2002: 50) for detailed discussion of productivity measuring.

and capacities of national enterprises. Overall, FDI appear to increase labor productivity also in the aggregate.

3.5 Home Country and MNE

Finally, yet importantly, we have to take into account how capital mobility affects home country. Theoretically, FDI can mean outflow of capital making country scarcer in terms of capital causing adjustments in marginal productivities and tendency to factor price equalization as we have demonstrated in Heckscher-Ohlin-Samuelson model. For home country FDI also mean a sharing of technologies and knowledge. The question to ask is how, if at all, capital outflows will act upon wages and labor demand. Fear is growing that increased competition from low-wage countries such as transition economies or NMS will lead to a relocation of economic activity and lower domestic wages.

Rather than directly examining wage effects of FDI, literature concentrates on job relocation from home to host country. The relationship between labor demand in parent firm labor and their foreign affiliates is not clear. Some studies point to a substitution effect between parent and subsidiary labor demand (Cuyvers et al. (2004); Braconier and Ekholm (2001); Konings and Murphy (2001)). Some are inconclusive and some highlight a complementary relationship especially in the long run (Hansson (2001); Bruno and Falzoni (2000), Konings (2004)). All the results are intuitively plausible: either as a transfer of labor-intensive operations to low wage countries, or as a concentration of capital-intensive operation in home country and their complementarity to production abroad. The labor demand substitutability, for example, increases with the similarity of operations performed in home country (affiliate) and low wage country. Braconier and Eckhölm (2001) note that for those of EU 15 countries that are engaged in labor-intensive operations (Spain, Portugal, Greece, Italy); the decrease in employment due to expansion in CEE has been significantly higher than in the rest of EU 15. Bundler and Becker (2006) find similar results for German manufacturing industry. With every percentage increase in German wages, German MNE relocate 2,000 manufacturing jobs to Central and Eastern Europe (CEE) and 4,000 jobs overall.

This is a relevant point for convergence. If labor-intensive operations are relocated to low wage countries as NMS, FDI receiving industries should experience pressure for growth of labor rewards while the opposite will apply for their EU 15 counterparts. Then we can observe convergence in wages for particular skill group and/or between industries across countries.

As a complementary scenario, we can think about a setting when a high-wage country based MNE may relocate their more labor-intensive production to their affiliates in low wage countries, while concentrating their more capital-intensive or skill-intensive operations at home. Blomström, Fors, and Lipsey (1997) find some indication for it, in a sense that larger production in developing countries by a U.S. firm was associated with lower labor intensity at home. Lipsey (2002) concludes that multinational operations have led to a shift by parent firms in the United States toward more capital- intensive and skill- intensive domestic production. Thus, overall the production in low-wage countries seems to raise the parent firm's demand for skilled workers at home relative to the demand for unskilled workers.
As in the previous case, we may observe a divergence between rewards to high-skilled labor in home and host countries if labor demand in low wage countries for unskilled labor rises relatively faster than demand for skilled labor.

3.6 Summary

In this chapter, we have focused on the role of capital mobility in convergence of factor prices. FDI as a bridging element between economies have the capability to influence host country not only as a source of physical capital but rather as a source of knowledge capital. On theoretical basis, capital flows are conducive to FPE, since it has been proved by Mundell (1957) that flows of capital are sufficient to equalize factor rewards even if trade is prohibited. Moreover, both theory and empirical studies have confirmed positive relation between capital inflow and wages in host country as well as between foreign presence and wage spillovers to NE. As far as productivity concerns, the evidence is mixed. The support for positive productivity spillovers is rather limited, while there is some empirical justification for horizontal spillovers. There is an interesting contrast in positive wage spillovers and insignificant or even negative vertical spillovers in productivity. An intuition suggests that NE are forced to compete on labor market with MNE for labor force and the increased wage make them less productive. For home country, the idea that FDI transfers production activities from high wage to low wage countries has been reaffirmed.

IV. Labor Cost Convergence, Exchange Rate and Transition Countries

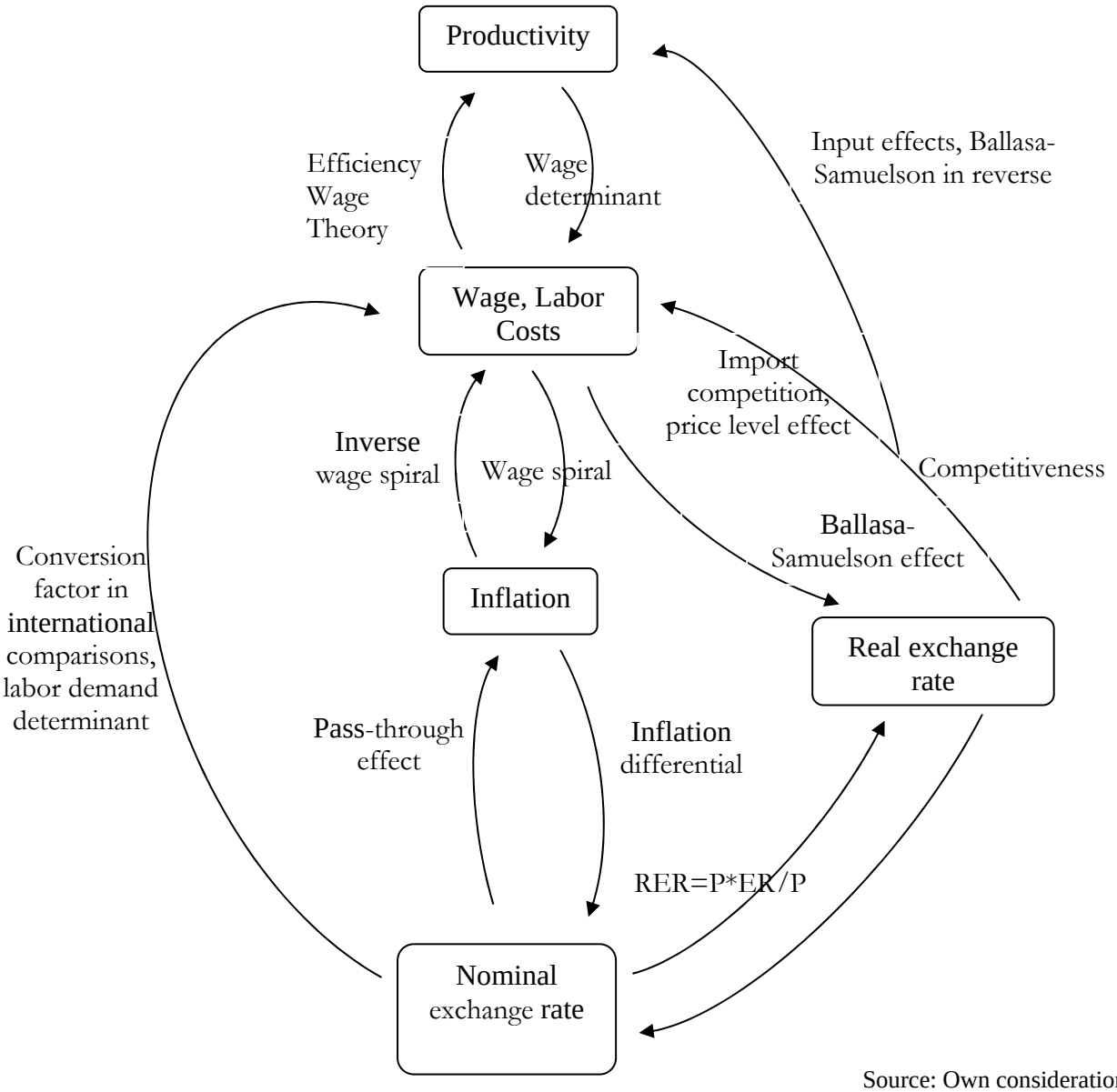
Having discussed international trade, multinational enterprises and foreign investments as convergence stimulating forces, in what follows, we focus on the third aspect; namely on the role of exchange rate, its contribution to labor cost convergence and on the specific position of transition countries in convergence. This has three motivations. First, to estimate convergence quantitatively we need to convert data from national to common, *numeraire*, currency. This step, even though it may seem simple at the first sight, can substantially affect results (Turner et al. 1993); the choice of appropriate conversion procedure is crucial. Second, examining wage convergence includes considering both nominal (nominal exchange rate, price level) and real convergence (productivity, GDP growth) and these processes are connected and inseparable. Third, wage convergence is even more appealing from the view of transition countries especially with respect to Balassa-Samuelson effect, real exchange rate appreciation and inflation differential.

The chapter proceeds as follows. First, we will briefly mention the interdependence and cross-connections in international comparison of wages and labor costs. Then, discussion of nominal and real exchange rate will take place. In the third part, we look at transition economies and real exchange rate. Towards the end, we discuss in more detail the possibilities for international comparison and the choice of appropriate conversion factors.

4.1 Wage in International Comparison

Before reflecting on specific aspects of exchange rate and convergence, let us present a diagram, which depicts the interplay and dynamics between the key variables for international comparisons of wage. It should illuminate, in admittedly simplified way, principal relations we should take into account when considering labor cost (wage) convergence.

Figure 4.1: Wage and Its Determinants



Source: Own consideration

At least two interesting observations emerge. First, there are no one-way relationships; variables are not mutually independent. Considering variables in international framework adds on complexity as variables are influenced by domestic and foreign environment. This is demonstrated by for example the (inverse) wage spiral[16] and by pass-through effect.[17]

[16] Wage-price spiral proposes that as workers attempt to maintain or increase real wages in excess of productivity growth and firms strive to keep or raise their profit markups (battle of markups, Kandil 2003) then, when aggregate demand increases, inflationary pressures arise. This idea has been fairly well established in traditional cross-country studies, but as it comes to scrutiny in newer studies and new analytical tools (cointegration analysis, ECM), the support has been rather weak (e.g. Gordon 1998). On the other hand, Mehra (2000) among others point to reverse causality between inflation and wages. Specifically, if inflation is kept low and firms are not able to pass along increased wage costs to higher prices. However, if increasing price level (e.g. due to expansionary monetary policy) permits to raise the prices of their products, because of excess of aggregate demand caused by expansionary monetary policy, workers then demand higher wages.

Second, we are interested in nominal as well as real convergence. Nominal convergence is essential, as we pay attention to nominal exchange rate and price level, real convergence is important since productivity determines wages.[18] These two types of convergence cannot be separated. The common economic wisdom points to the fact that countries with lower income per capita also have lower price and wage level. Income growth is followed by price level growth and exchange rate appreciation, which further affects country's position in international competition, exports and again the income growth. Kowalski (2003) claims that no trade-off between nominal and real convergence is expected in the long run. Nominal and real convergence can be both mutually reinforcing as well as mutually opposing as documented by Egert (1999) and by Grauwe and Schnabl (2005).

For the purpose of labor costs convergence, we have to consider the links (interactions) between nominal and real convergence. This requires looking for links between wage and its real economy determinants (especially productivity) as well as looking for nominal convergence (nominal exchange rate and price level). Let us now take a closer look at the above-presented diagram.

4.2 Nominal Exchange Rate

The role of nominal exchange rate in wage convergence is twofold. First, nominal exchange rate influences labor demand. This occurs as changing exchange rate affects profits of the firms on the side of both revenues and costs, both at local and international market. For example, in an export-oriented industry with dominance of domestic inputs currency depreciation increases revenues from abroad as well as labor demand given that labor demand is a function of output's real price. Further, nominal exchange rate directly influence import prices and indirectly price level as such which projects to wage claims on the labor supply side. Second, exchange rate serves as a conversion factor in inter-country comparisons. Any changes thus directly influence the empirical assessment.

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[17] The pass-through effect deals with the pass-through from foreign price level to exchange rate to domestic economy through the exchange rate. This projects into price measures such as CPI inflation, inflation expectations and the responsiveness of consumer, producer prices to exchange rate changes. There are many factors contributing to scope of the effect (openness, business cycle, exchange rate misalignment etc., see Devereux 1999).

[18] We understand real convergence as convergence of economic levels to given benchmark (measured by gross domestic product per capita in purchasing power parity or by productivity per employee). On the other hand, nominal convergence entails convergence of nominal variables (price level, wage level, inflation, exchange rate band etc.) as connected with Maastricht criteria.

Nominal exchange rate determinants can be seen from definition (1) where the exchange rate in logarithmic form is defined as

$$E = RER + P - P^* \quad (1)$$

E is a nominal exchange rate expressed as number of domestic currency unit per benchmark country, RER is real (price level adjusted) exchange rate, P is domestic price level, P^* is price level abroad. Equation (1) implies that the higher inflation differential $P - P^*$ and/or real exchange rate depreciation, the higher the rate of nominal depreciation. As long-run exchange rate determinants, empirical literature has confirmed (Lane 1999, Obstfeld et al. 1995) long-run inflation differential and long-run real exchange rate.

Inflation differential is a determinant of nominal exchange rate according to the theory of dynamic purchasing power parity (PPP) which states that nominal exchange rate in the long run moves in the opposite direction to development of domestic price level in order to keep real exchange constant. This relation ensures the stability of real exchange rate, but not necessarily the validity of absolute PPP. Despite the general reconciliation that there are even long-run departures from PPP,[19] Obstfeld et al. (1995: 122) acknowledges this theory as "...tolerably good description of dollar exchange rates." Further, they find that in the long run in OECD countries inflation differentials transfer into nominal exchange rate depreciation almost in one to one relation; differential explains the bulk of nominal exchange rate variation. For sample of OECD countries Lane (1999) finds that the "inflation" variables (openness, government debt) and income growth rate (Balassa-Samuelson effect) prevail to terms of trade as determinants of nominal exchange rate.[20]

A specific case for nominal exchange rate is the transition countries. Their specificity is due to exchange rate having a unique role in the initial phases of transition. According to Halpern and Wyplosz (1997), transition can be characterized by initial sharp nominal and real depreciation followed by period of gradual appreciation. This is caused by three factors:

1. Price liberalization has shifted inflation expectation upward.
2. Demand for foreign assets has grown immensely due to trade liberalization and foreign currency liberalization.
3. Initial nominal exchange rate was set quite low (strong initial nominal depreciation) to provide a cushion for start of transformation.

[19] There is a wide body of literature studying potential causes for these deviations, see Engel and Rogers (2001) for a survey of these causes. To name some of them Balassa-Samuelson effect, existence of non-tradable goods, barriers to arbitrage for tradable goods, changes in terms of trade etc. are believed to play a role.

[20] See Simone and Razzak (1999) for discussion of other long-run determinants (interest rate).

Following this phase, currencies usually go through a phase of real appreciation as real exchange rate approaches its equilibrium rate to correct initial exchange rate position.

4.3 Real Exchange Rate

The other determinant of nominal exchange rate is the real exchange rate (RER) which is also widely acknowledged as an indicator of international competitiveness and hence an important topic in macroeconomic policy. Real exchange rate is price level adjusted nominal exchange rate as it is seen from (1). It is closely connected with the absolute version of purchasing power parity theory postulating that real exchange rate equals one. Movements in real exchange rate can be regarded as changes in competitiveness and hence it is important to distinguish between two scenarios. If real appreciation occurs because of improved competitiveness (e.g. due to increase in productivity), it is a positive event, which draws real exchange rate closer to its equilibrium rate. On the other hand, if real appreciation is a result of an increase of costs (increase of domestic price level not compensated by an increase in productivity, or by an increase in non-price competitiveness); the new real exchange rate makes, *ceteris paribus*, economy less competitive in a sense of being able to sell their products at international markets.

4.3.1 RER and wages

Besides being a determinant of nominal exchange rate, theory describes three ways how real exchange rate affects wages (e.g. Robertson 2003, Goldberg and Tracy 2001). First, real exchange rate appreciation makes imports of capital, inputs and technology cheaper and hence make worker more productive, which enables, *ceteris paribus*, an increase of wages (input effect). Second, lower costs of imported inputs increase demand for them and to the extent that imported and local inputs (labor) are complements (substitutes) also stimulate (mitigate) the demand for domestic, non-imported inputs. Third, real exchange rate appreciation discounts relative prices of foreign goods and hence prices of imports decrease and exported goods are less price-competitive. Not only domestic producers are exposed to fiercer competition from abroad, but also to the extent that imports are substitutes to domestic products, this effect contributes to downward pressure on domestic prices and on wages. Hence, real appreciation, if nominal wages remain stable (downward stickiness of wages), contributes to an increase in real wage (price level effect).

These effects will vary across countries and industries subject to the extent of their international orientation and penetration of foreign competitors to particular market as well as importance of imported inputs. The higher the presence of importing firms, the more is the competitiveness of local producers affected by real exchange rate. Similarly, the higher the export shares in sales, the higher responsiveness to exchange rate. Converse applies to the share of imported inputs. Likewise, elasticities of product demand, labor supply and labor demand vary across industries and do modify the effects.

Revenga (1992) for panel of U.S. manufacturing industries estimates that dollar's real appreciation in 1980-85 is connected with 2 percent wage decrease. Goldberg and Tracy (1999) on panel of disaggregated sample of US industry data found real exchange rate appreciation to be associated with declines in hourly earnings. Goldberg and Tracy (2001) find that 10 percent dollar depreciation causes a 0.8 percent increase in wages for the whole sample. The impact for wage in more open manufacturing industries was almost fourfold the effect in relatively closed manufacturing industries. Moreover, real exchange rate wage sensitivity is inversely related to the level of education. Campa and Goldberg (1999) confirm the intuitive results: *ceteris paribus*, real depreciation increases wages more in export-oriented industries than in more sheltered industries.

4.4 Transition Economies and Real Exchange Rate

Transition economies are characterized by real appreciation (De Broek 2001, Coricelli and Jazbec 2001, Egert and Revil 2005). There are four potential mechanisms driving real exchange rate appreciation in transition countries in the long run. Besides Balassa-Samuelson effect, literature considers real appreciation due to structural factors associated with ongoing changes and strong initial undervaluation (Halpern and Wyplosz (1997)) or to the competition pressures and cost increases (Cincibuch and Vavra (2001). Likewise, transition-undervalued wages (Krajnyak and Zettelmeyer 1998) may play some role.

There is a space for convergence by the means of exchange rate. Gaspar (2001) declares that for Central and Eastern European countries actual exchange rate was strongly undervalued compared with the equilibrium rate. Moreover, this gap has exceeded the gap for Spain, Portugal and Greece 5 years before their EU membership. Plausibly, this difference is assignable to the transition history of CEE economies.

4.4.1 Balassa-Samuelson Effect and Transition Countries

The scope for Balassa-Samuelson effect is especially large in transition countries which were underperforming in planned economic system in terms of effective allocation of resources and which enjoy influx of FDI and arrival of multinational enterprises to the tradable sector in particular. Hence, a rapid productivity growth can be expected.

A core of BS effect is captured by dividing of goods on tradable and non-tradable goods (e.g. services). Further, it assumes that the Law of One Price holds for tradable goods; prices of tradable goods are internationally equalized due to international trade.[21] Productivity grows faster in the tradable sector than in non-tradable sector and hence wages in tradable sector increase (at no expense to competitiveness). Under the assumption of perfect mobility of labor within a country but zero labor mobility across countries, labor reward grows in non-tradable sector and catches up (equalizes) with wages in tradable sector. As a result, higher wages are then reflected in an increase of relative price of non-tradables.

Eventually, this mechanism leads to growth of the overall price level in the economy and to the real exchange appreciation. In BS model, price level grows with the growth of real income resulting from the productivity expansion in the tradable sector. Therefore, countries with higher income have higher price level than countries with lower income, which is one of the key predictions of BS model. As we know, comparing countries with higher and lower income, we find that prices of non-tradables tend to increase with the GDP. Therefore, the model explains why exchange rates systematically differ from its PPP rates (disparity between internal and external purchasing power) and that the deviations are associated with productivity differentials.

4.4.2 Real Appreciation and Excessive Wage Growth

Real appreciation is, as demonstrated by Cincibuch and Vavra (2001), assignable to the upward cost pressures associated with worse competitiveness given the downward inflexibility of wages and prices. On the case of the Czech Republic, they demonstrate that real exchange rate appreciation (producer prices) is to a large part a result of increased wage

[21] Model assumes no barriers to trade, perfect factor and product market competition, no product differentiation, zero transport cost, perfect information. Formal treatment is presented in Holub and Čihák (2003) or Asea and Corden (1994). Sometimes Balassa-Samuelson Theory is called Harrod-Balassa-Samuelson Theory as Harrod is perceived as predecessor of this model. Balassa-Samuelson model originates, in fact, from two independently published articles written by B. Balassa (1964) and P.A. Samuelson (1964). Balassa (1964) describes the effect using Hecksher-Ohlin 2-2-1 model (a two-country, two commodity, one production factor) with which we have worked with in the second and third chapter.

costs. As the Law of One Price does not hold, domestic producers are allowed to charge higher prices. Hence, real wage growth exceeding productivity growth leads to an increase in manufacturing unit labor costs[22] and for this reason to worse price competitiveness position, which other things equal transfers into falling net earnings and increase of labor share in value added. This picture is documented by observing that ULC-based exchange rate appreciated considerably more than the exchange rates based on producer prices.

Wage inflation above productivity growth seems to be a relevant also for other countries, which converge to the EU core members. Juselius and Ordonez (2005) on case of Spain support the view that high competitiveness especially in the tradable sector (manufacturing) is crucial for convergence and hence wage inflation should not exceed productivity growth.

4.4.3 Undervalued Wages & Transition

Krajnyak and Zettelmeyer (1998) as well as Halpern and Wyplosz (1997) conduct an interesting examination of wages and labor cost in the CEE region with respect to workers' endowment (physical, human capital), their productivity and country conditions attempting to estimate real equilibrium exchange rate through wages in transition economies. They use relative euro-converted wage as a proxy for the real equilibrium exchange rate. Both studies identically argue that even though the gap between actual and equilibrium wages is closing during transition, wages still remain substantially undervalued (35-75 % of the equilibrium wage in 1995) in comparison with what they would otherwise be paid in non-transition countries. This result would then seem encouraging for wage convergence since it supports the idea that transition countries do reward identical workers differently (relatively less) than developed countries do. Then, there would be a transition-related wage growth "premium" beyond mere productivity growth. As a result, the wage growth would be accelerated. Deutsche Bank (2005) using similar methodology confirms ongoing real undervaluation for the Czech Republic (depending on the estimates 8-20%), Poland (15-40%), Slovakia (approximately 20%). However, *forint* seemed to be overvalued by more than 10% in 2004.

[22] Unit labor cost (ULC) is a ratio of labor cost to output; hence, it measures how much labor is necessary for production of unit of output. The ratio of foreign and domestic ULC gives a unit labor cost based exchange rate (see Turner, van Dack 1993 for more).

4.4.4 Structural Factors of Real Appreciation

Halpern and Wyplosz (1997) stress structural factors in real appreciation. During the transformation, productivity growth is pushed by sectors neglected and underperforming (or non-existent) in the command economy (for example financial services). These sectors may offset productivity losses in industries suffering from transformation slump (loss of export markets, imperfect legal institution, law enforcement etc.). Jazbec (2002) argues that relative prices and labor market in central planned economy were distorted in such a way that real exchange rate has to inevitably appreciate once the structural reforms started.

Regardless of the source of real appreciation, transition countries seem to be prominent candidates for it. We shall now examine whether real appreciation and Balassa-Samuelson effect are empirically established facts for the transition countries.

4.4.5 Balassa-Samuelson Effect, Real Appreciation-Empirical Assessment

Balassa-Samuelson model has been tested frequently, most recently, due to foreseen accession to the euro-zone and challenges between real convergence and the Maastricht inflation criterion. Let us now look at empirical validity of BS as well as at real appreciation.

Holub and Cihak (2001), for example, point to the fact that the long-run trend of real effective exchange rate appreciation (2-5 percentage points) is higher than the size of Balassa-Samuelson effect which is estimated at 1-2 percentage points for CEE countries. Gaspar (2001) finds, given the differences in growth of labor productivity between EU 15 and CEE countries, the equilibrium real exchange rate appreciation between 2-3 percentage points per annum.

Egert (2002) estimates BS effect for Central European countries. For the Czech Republic, productivity differential explains around 10% of real appreciation, for Poland around 30%. Strong relationship has been found in Slovenia and Hungary both with values over 50% assignable to BS effect and hence with strong dependence of real appreciation and productivity growth. In the Czech Republic, productivity does not seem to play a major role in real exchange rate appreciation. Arratibel et al. (2001) estimates BS effect in CEE region within the 1-3% range, roughly a half of inflation differential to Euro area countries.

Egert and Revil (2005) examined systematic appreciation for all CEE countries between 1991 and 2001 concluding its heterogeneity. Czech Republic and Slovakia have appreciated in real terms 4 to 5% annually (steady exchange rate peg, positive inflation differential). Poland

seems to be similar case appreciation assignable to exchange rate flexibility and free flow of capital. Appreciation has been lower in countries, which actively managed their currencies (Hungary 2.5-4%, Slovenia 1.5-2%).

To conclude, Balassa-Samuelson effect as well as real appreciation (up to 5% per annum in some countries) are well-established facts in transition countries. Yet, BS effect though being a major appreciation effect (especially in Poland and Hungary) is not the only one, there seems to be other factors (structural aspects, wage growth) actively contributing to ongoing real appreciation in particular in the Czech Republic and Slovakia.

4.5 Transition Economies and Real and Nominal Convergence

As it was hypothesized above nominal and real convergence are two sides of the same coin. As such, they should proceed in close relation. For example, in the Czech Republic the income per capita in 2005 in Eurostat's Purchasing Power Standard (PPS) reached 74% of the EU-25 level, while the comparative price level-CPL $\left(CPL = \frac{P}{EP^*}\right)$ reached 56% and the labor costs per employee stood at 41% of the EU-25 level.

To take a closer look on this, we run two regressions. Besides, the regression of comparative price level on GDP per capita in PPS we add regression of labor cost level (as approximated by average labor compensation per employee in economy, expressed in euro) on GDP in PPS per employee, both for the year 2005. The second regression serves two purposes. First, labor costs are important price level determinant so we can use them as a validation of the first regression. Second, as we regress labor cost per employee in euro (hence true costs of labor) on GDP in PPS per employee, which in fact approximates labor productivity per employee, we also assess how is labor rewarded with respect to other sample countries. Table 4.2 reports residuals (second and fourth column) and explanatory power given as a ratio of actual price (wage) level to the predicted level by the regression.

Table 4.2: Price and Labor Cost Level-Real and Nominal Convergence, 2005

	CPL (in pp)	Actual/Pred.	Labor Cost (in pp)	Actual/Pred.
CR	-16.94	0.77	-22.22	0.65
SL	-7.12	0.91	-11.14	0.87
SK	-4.95	0.92	-30.66	0.50
Est	0.31	1.00	-14.51	0.71
Lat	1.51	1.03	-9.49	0.70
Lit	-3.30	0.94	-14.17	0.65
Hun	-3.13	0.95	-24.73	0.66
Pol	4.79	1.09	-17.54	0.66

Note: CPL and Labor Cost refer to residuals from the regressions, they are in percentage points of EU-25=100. Second and fourth column show the ratio of actual price (wage) level to the level predicted by regression. Results and regression scatter plot for labor costs are in the Appendix.

It is an established fact that the price levels in several countries of CEE are below what they should be given its progress in real convergence (Holub and Cihak 2001, Zdarek 2006). This is case of CR as well as (in lower extent) for SK, SL, Hun, Lit; the opposite is valid for Pol, Lat and Est. We also see that regression explains a large share of actual price level (third column). In last two columns of Table 4.2, we look at the relation between real convergence and wage level. The regression indicates that for a 1% point increase of relative income in PPS with respect to EU-25, increases *euro* denominated labor costs by 1.65% relative to the EU-25 average. More important are the residuals in the fourth and fifth column. Here we see that labor costs as an indicator of nominal convergence are substantially below what one should expect for given progress of real convergence for *all* of the CEE countries.[23] The gap is larger than for price level and the explanatory power of estimated relationship decreased (rather dramatically) compared to price level regression. The drop is particularly strong for SK, CR, Hun, Pol. This can indicate that either labor costs cannot be used to sufficiently well approximate price level (and nominal convergence) or there may be a considerably large gap between real convergence (convergence in productivity) and labor costs.

If the latter would be relevant, then the potential for convergence for countries could be magnified. Overall, there should be three processes operating. First, convergence due to

[23] We also run the same regression for variables converted by nominal exchange rate only. The principal result, i.e. the negative residuum for Central and Eastern European countries with the exception of Slovenia remains valid. The gap has, however, decreased to 4 (CR) to 11 (SK) percentage points of EU-25 average. Results can be provided upon request.

closing the productivity gap (real convergence) should take place. Second, this process should be reinforced by nominal convergence (wage and inverse wage spiral from the diagram 5.1). Third, labor costs convergence may be supported by accelerating growth of labor costs leading to gradual decrease of the negative labor costs residuum. This goes in line with the section 4.4.3 where we mentioned that wages in transition countries seem undervalued. Hence, we call recall that a transition-related labor costs growth premium may accelerate labor costs convergence.

However, accordingly, we should ask whether these economies would close this gap or whether this deviation reflects some endogenous characteristic of transition economies. If the gap closes, this effect will be complementary to price level growth induced by real convergence and hence this would imply stronger growth of labor costs level than by other euro candidates. Nonetheless, if the deviation persists over time, it can provide the Czech economy and industry certain space for cost based advantage (lower domestic wage level than would correspond to income level) and hence for more competitive position of the Czech economy.

Nevertheless, the dominant transmission channel is also important. If the exchange rate channel prevails, nominal exchange rate appreciation directly shows in price-competitiveness and in common currency denominated wages. If the price channel dominates, then wage and hence price level increase will have implication for competitive position to the extent that Balassa-Samuelson effect operates. This is governed by the growth of prices in the non-tradable goods and it depends how it projects to the prices of tradable goods and how price level growth projects to nominal exchange rate. The question is then whether these alternative channels are identical (equivalent) with respect to inspections of common currency wage convergence. If the gap closes, then it will contribute to relatively faster growth of euro-converted wages.

Table 4.3: Channels of price level convergence (2001-5, annual averages)

	Nominal ER	HICP	REER
Czech Republic	3.6	2.3	6.4
Hungary	0.9	6.5	7.5
Poland	-0.1	3.9	-0.6
Slovakia	2.0	6.9	3.8
Slovenia	-2.9	6.1	1.0
Latvia	-4.3	3.8	-2.3
Lithuania	1.4	1.0	1.4
Estonia	0	3.6	2.8

Note: REER-real effective exchange rate, based on unit labor costs, trade weighted, HICP-harmonized index of consumer prices. Lithuania and Estonia have currency board. Source: VSEM (2006), Zdarek (2006).

Table 4.3 illustrates the different channels through which nominal convergence takes place in the EU-8 countries. We see that the Czech Republic and Lithuania are the only countries where the exchange rate channel dominates over the inflation channel. The converse is relevant for all other EU-8 countries. Heterogeneous is the course of real effective exchange rate, where Poland and Latvia seem to oppose the idea of real appreciation in transition countries.[24]

4.6 International Comparison and Conversion Factors

Previous discussion has brought us to the debate about the function of conversion factors in international comparisons. In order to compare wage, labor costs across countries need to be converted to common units. Here we face several difficult choices (constant or current prices, nominal or real values, price deflators (producer, consumer price index) etc). A chapter of its own would be the comparability of data across countries and time as well as statistical methodology. Let us sidestep these and look at the plausible alternatives for comparing labor costs across countries. It is fair to say in advance that there is no single best solution. Rather, it depends on purpose of comparison and the degree of inaccuracy one is willing to accept.

[24] A combination of low inflation and nominally appreciating country makes *koruna* together with *yen* one of favorite currencies for carry trade, a low interest rate based speculation. Given the relatively "comfortable" price level convergence by the means of nominal exchange rate, this is an additional argument against entering the EMU "soon" at the expense of future positive inflation differential due to irrevocably fixed exchange rate.

Nominal Exchange Rate

Using nominal exchange rate has its pros and cons as any other approach. Primarily, nominal exchange rate is subject to short-term fluctuations (volatile capital movements, random walk hypothesis etc). Moreover, mainly trade in tradable goods influences exchange rate, hence exchange rate does not directly represent the relative prices of non-tradable goods and services[25] and is subject to exchange rate policies as well. Disadvantage of nominal exchange rate especially for NMS, as we showed in the previous parts, is that its movements frequently result from transformation period (undervalued currencies, fluctuations) rather than from movements in fundamental variables. The advantage is its availability over long time horizons. Moreover, nominal exchange rate reflects the cost (dis)advantage for enterprises and the on the spot value of product. Nominal exchange rate converted labor costs allow a direct comparison across countries. They can be easily interpreted as they describe the labor costs and market value of produced output faced by employer and hence allow market-based comparison of locations, branches and related cost (revenues) arbitrage etc. Such assessment would be best suited for a multinational firm seeking to take advantage of cost differentials.

Purchasing Power Parity

The advantage of using purchasing power parities in international comparisons is in the fact that these measures reflect differences in national price levels that are not taken into account by exchange rates. PPP-based study would be interesting from workers' point of view as it assesses the purchasing power of locally paid wages. A corollary to Balassa-Samuelson effect, as Balassa (1964) postulated it, is that if productivity differences in tradables exceed the productivity differences in non-tradable goods across countries, then the currency with higher productivity in tradables will also appear overvalued in terms of purchasing power parity.

Empirical evidence has confirmed that richer countries, when the exchange rate is used as a conversion factor, are richer than they actually are if the PPP is employed in inter-country comparisons. This is caused by the fact that non-tradables in poorer countries are relatively less costly than non-tradables in rich countries and hence PPP of poorer countries is above what the nominal exchange rate would suggest. Samuelson (1994) called this tendency for real income comparisons based on PPP to be systematically biased Penn-effect. Related to wage convergence, for nominal exchange rate converted wages, convergence may appear as

[25] It represents relative prices of non-tradable goods to the extent that these prices show up in the prices of tradable goods.

too sluggish with considerable differences in wage levels across poor and rich countries. Using PPP, on the other hand, will downplay differences especially in productivity measures and wage convergence will be under way at significantly faster pace. [26]

The problem of using PPP concept for convergence is, as Mahony (2001) warns, that the successive rounds of International Comparisons Program (ICP) that produces estimates of PPP are not intertemporally consistent.[27] Limited time comparability originates from changes in the weights of ”aggregate” PPP, changes in the individual purchasing parities for sample products and from differences in commodity samples (due to relative prices, quality adjustments). In addition, as expenditure PPP are usually calculated, they regard only the final output, not intermediate products. Expenditure based PPP also incorporates subsidies, taxes, regulated prices, social contributions. Furthermore, the ICP or Eurostat projects take place with the three years periodicity and the data, hence, need to be extrapolated to allow year-to-year comparison, which can be a source of additional inaccuracies. There are also objections that can be raised to cross-sections comparability of purchasing power standards (see van Ark et al. 2005).[28]

Unit Labor Costs

There are several reasons why it is preferable to consider predominantly labor costs and not unit labor costs in our analysis. One of them is that for multinational firms are labor costs arguably more important than unit labor costs when deciding on (re)location of their production capacities. This is based on the idea that knowledge capital (how-know, technology etc.) is internationally mobile factor and hence productivity is transferable, if qualified labor force (or the one that can become qualified at relatively low cost) is available in the destination country. Illustrating example of this is provided by Marin (2004) in a firm-

[26] These inaccuracies decrease the smaller are the income differences within the group. Deviations are measured by the ERDI coefficient defined as ration of nominal to PPP based exchange rate.

[27] However, the index-number problem (non-transitivity of international price ratios) has been diminished; both Eurostat and OECD employ so-called multilateral schemes to make prices levels ratios transitive (see Mahony 2001 for more detail).

[28] Van Ark (1995) alternatively proposes to use Unit value rations (UVR) which are defined as sales values of products divided by quantities. Contrary to PPP, this measure does not include other sources of income (subsidies etc), rather it shows true producer prices (not only final sale price, excluding intermediate products) which makes them better suitable for analysis of wage convergence in the sectors which do not operate with final on sectoral level such as manufacturing. Although being theoretically superior to PPP and nominal exchange rate conversion, the availability of UVR limits its role in international comparisons and this is especially relevant for NMS. Alike, the product match (matching identical UVR across countries) in terms of quality, availability restraints the wider use (see van Ark 1995).

level study of German and Austrian multinational companies,[29] which have invested in Central and Eastern Europe. The study reveals that CEE productivity per employee (GDP per employee) and labor costs per employee (defined as full cost of labor) were approximately 23% of German average in 2001. However, on firm level German affiliates in the Central and Eastern Europe pay on average 17 percent of their German parent wages but are able to increase their productivity to 60 percent of the parents' productivity level as soon as the end of last century. For this reason by considering relative unit labor costs on the state level (close to 1); one could have erroneously deemed CEE as not worth of exploiting labor cost differential. Yet, given what affiliates actually can achieve with their know-how, expertise, training etc., this region is much more attractive. In this sense from firm's point of view labor costs rather than unit labor costs is important since it indicates the real price of labor. The actual productivity is a matter of firm's own ability as well as availability of appropriate labor force and labor market situation. Hence, from this point of view is more informative a general wage level and its evolution from which firms derive the remuneration they will offer. The increasing importance of labor costs as contrasted to unit labor costs is also acknowledged by DIHK (2006) and by Beyfuß and Eggert (2000).

As noted by Schröder (2005) high labor productivity can be also a result of high employment of capital. For comparing levels of unit labor costs can be then misleading since high increases of labor productivity can be result of substitution between labor and capital, which can ultimately lead to competitiveness improvement (lower ULC) due to lower employment.[30] Moreover, if we would use unit labor costs we have, as argued above face the challenge of converting productivity (as real flows) by using purchasing-power standards. These standards are not, however, suited for comparison in time as it was argued above. Hence, we would need to choose a benchmark year and use fixed PPS and results would be influenced by the arbitrary choice of base year. In addition to that, the constant prices based estimation become

[29] Study includes 660 German and Austrian firms with 2200 investment projects in transition countries during the period 1990 to 2001. The author claims that his survey data represent 100 percent of Austrian and 80 percent of German direct investment in Eastern Europe.

[30] The relationship between labor costs and productivity is not as straightforward as it may seem. On one hand, productivity explains almost all of the cross-country labor costs variation (R2 over 0.8) as can been seen in section 4.5. However, we also have experimented with estimating a long-term relationship between labor productivity and labor costs for individual time series. Since both time series are non-stationary we have applied Johansen's (1995) cointegration test for labor productivity per employee and labor costs per employee on sample between 1961-2006. Perhaps surprising we have found that 9 (Aus, Bel, Ca, Fr, Ger, Ir, It, Sp, Swe) out of 20 time series pairs were not cointegrated on 10% level of significance. Hence at least for these countries there are some other variables that need to be included for explaining labor costs growth.

less accurate the further the current period is from the base year, which in case of 45 years data span can cause a substantial distortion.

4.6 Summary

This chapter was intended to highlight essential features connected with comparison of labor costs among countries. Especially, we demonstrated the complexity and interlinks between wage and exchange rate and their determinants. Given the importance of real exchange rate and Balassa-Samuelson effect, we paid attention to these variables in connection with the transition countries. On the side of transition countries, real exchange rate appreciation may work against convergence of labor costs. On the other hand, nominal and real convergence (Maastricht criteria-stable inflation and exchange rate, productivity catch-up) will be generally supportive for labor costs convergence. We have also identified for all CEE but Slovenia negative residuum in labor costs-labor productivity relationship. Closing this gap would offer additional source of labor cost convergence.

We outlined potential difficulties associated with comparisons using nominal exchange rate, PPP and unit labor cost. Considering the matter carefully, we have concluded that the relatively simplest comparison based on labor costs converted by nominal exchange rate is at the same time for us the most appropriate given the alternatives of purchasing power parity and unit labor costs.

V. Labor Cost Convergence-Empirical Assessment

In this chapter, we concentrate on testing labor costs convergence hypothesis. We will test for unit root in time series of relative labor costs per worker using convergence tests for both individual countries and panel data. First, we introduce the convergence concept and provide methodology for the Augmented Dickey Fuller (ADF) test as a univariate unit root test and a founding stone for empirical testing. In the second section, we briefly discuss available data. Empirical part presents and discusses results of ADF test then panel-data convergence analysis is performed. In the last section, labor costs convergence in Central and Eastern European countries is considered.

5.1 Definition of Convergence

The convergence hypothesis can be divided on the absolute and conditional (relative) version. Let us assume that countries have same technology at disposal. The absolute convergence hypothesis implies that labor costs in initially low wage countries grow faster than their counterparts in high wage countries and that labor cost levels in low wage countries catch up with those in high wage countries at the same time. Ultimately, steady-state wage levels are identical, labor cost differential between two countries (or country and group average) is stationary around zero and deviations from this state are only temporary. In other words, there exists a balanced growth path where fluctuations are only temporary and where relative labor costs return to its original path. The relative convergence, on the other hand, indicates that countries have different steady states and in the long run, only the growth rates are the same and thus relative labor cost differential converges to some non-zero value. We intuitively understand steady-state labor costs as a long-run equilibrium where capital per unit of effective labor is constant. Given the same underlying structural characteristics, labor costs in two economies grow to the same absolute level and grow at the same rate if they are at the same steady state. The second possibility is that economies are at parallel growth paths (see below).

According to Karras and Evans's (1998) definition of stochastic convergence, we formulate convergence for labor costs within a group of N countries such that

$$\lim_{i\to\infty} E_t(lc_{n,t+i} - \overline{lc}_{t+i}) = \mu_n \text{ for } n = 1,...,N \qquad (1)$$

where E_t denotes expectations conditional on available information in time t, $lc_{n,t}$ is labor costs expressed in levels (logarithms) in country n in time t, $\overline{lc}_{n,t}$ is a mean of benchmark

group labor costs (EU-15 in our case)[31] in time t in logarithm. Definition (1) implies that in the long-run deviations of labor cost in country n from cross-section average are to be expected to converge to constant μ_n. The parameter μ_n shows whether the convergence is absolute ($\mu_n = 0$) for all n, or whether $\mu_n \neq 0$ and convergence is relative with economies being on their own parallel growth paths.

5.1.1 Cross-Country and Time Series Approach

There are both cross-country and time series tests of convergence. The former approach was pioneered by Barro and Sala-i-Martin (1991) and Mankiw, Romer and Weil (1992). They study income convergence based on regressing average income accumulation rate in the examined period on the initial level of income and other exogenous variables. Negative relation between average growth and initial income points to the β-convergence. However, cross-country method has been challenged by successive research (Quah 1993, Bernard and Durlauf 1996, Evans 1997). The main critique is based on three main arguments:

1. Negative correlation between output growth and initial output is consistent with a stable variance in cross-country output (Quah 1993).[32]
2. Cross-country tests have low power to reject non-convergence hypothesis. Moreover, they are ill designed to analyze data where some countries are converging and others do not (Bernard and Durlauf 1996).
3. Cross-country method in order to be valid puts highly restrictive assumptions on the data: economies must have same first-order autoregressive representation, economies affect each other completely symmetrically and the vector of explanatory variables controls for all permanent cross-country differences. If these assumptions are violated, then cross-country approach may generate inconsistent estimates (Evans 1997).

Hence, the current research almost exclusively draws on time series tests (Freeman and Yerger 2001, Cunado et al. 2005, Weber 2001). We will follow this path for both individual time series and panel data. However, on occasion, we look not only at time series tests of convergence but also assess how the dispersion in labor costs levels across countries in time evolves and estimate σ-convergence. We use the coefficient of variation as a measure of σ-

[31] We have decided to use EU-15 as a benchmark rather than individual country, e.g. Germany, to avoid distortionary effects that result from shocks reserved to individual countries (e.g. unification). Moreover, labor costs of EU-core counties (Bel, Neth, Lux, Fr, Ger) are persistently above the average, hence we would not dare to call German labor costs as sufficiently representative.

[32] In other words, this implies β-convergence but no σ-convergence (see below). It can be shown that σ-convergence implies β-convergence but not *vice versa*. (see Barro and Sala-i-Martin 1992).

convergence. If the dispersion decreases over time, we conclude that convergence is taking place. For group of countries with identical steady states the dispersion converges to some non-zero value given by variation of residuals as shown in Barro and Sala-i-Martin (1995). This measure of convergence is a borderline between pure cross-country β-convergence and time series tests of stationarity.

5.2 Survey of Literature

As we mentioned in the very beginning the literature on labor cost convergence is not particularly rich.[33] To name some of the few studies, Tovias (1982) considers coefficient of variation for six EU founding countries between 1950 and 1979 as a proxy for wage convergence. He finds that wages have been converging up to 1968 and showing a diverging trend afterwards. Brandl (1996) tests for unit-root in wages of unskilled American workers on sample over 100 years long and finds only limited evidence for convergence. Abraham (2001) discusses labor cost convergence in OECD economies by applying non-unit root tests of convergence, yet he finds that "convergence is slow and often partial" (ibid: 17). For European Union as a group of adequately similar countries studies successfully identify wage convergence (Gremmen 1985, van Nourik 1987). These papers in particular confirm the importance of trade and lack of trade barriers as major contributors in narrowing factor price differences. Somewhat surprisingly, labor mobility did not play a major role in convergence. Berger and Westermann (2002) find that between labor costs in six major industrialized countries (Fr, Ger, UK, USA, Neth, Bel) there is "only a limited evidence of cointegration."

Overall, the evidence seems mixed at best. Unfortunately, studies mentioned above differ from scope and focus of our empirical examination. Principally, they employ different method of estimation (Abraham (2001) non unit root estimates, Jung and Doroodian (1995) cointegration). To my knowledge, there has been no study that employs the ADF tests or panel data tests to labor costs convergence. Consequently, this makes interpretation of our results more difficult since there is no benchmark of previous studies to compare with.

[33] There are some more studies on labor costs convergence in the Section 2.3 in the chapter on Factor Price Equalization Theorem.

5.3 Augmented Dickey Fuller Test-Methodology

A natural starting point for time series tests is the Augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1981) which in fact tests for the presence of unit root in the time series.

Let us assume that time series of labor costs, lc_i, is described by AR (1) process such that

$$lc_{i,t} = \alpha + \rho lc_{i,t-1} + \varepsilon_t \qquad (2)$$

where α and ρ are parameters and ε_t independently and identically distributed errors. If $|\rho| < 1$, then lc_i is stationary.[34] If $\rho = 1$, then the times series contains a unit root and is non-stationary, $|\rho| > 1$ represents explosive process.

We apply definition (2) for testing stationarity of the labor costs differential between two countries in time. In other words, the difference between labor costs per worker between two countries (in logs) in time must be a stationary process (a process integrated of order zero, $I(0)$) for labor costs to converge. Specifically, the null hypothesis is

$$H_0 = (lc_{n,t+i} - \overline{lc}_{t+i}) = I(1) \text{ for } n = 1,..., N$$

where $I(1)$ denotes a unit root non-stationarity process and n is a country index. Applied to labor cost convergence, the most general form of the Augmented Dickey Fuller test involves equation in the following form:

$$\Delta lc_{i,t} = \mu_i + \beta_i t + \gamma_i lc_{i,t-1} + \sum_{p=1}^{P} \delta_i \Delta lc_{i,t-p} + \varepsilon_{i,t} \qquad (3)$$

where $\Delta lc_{i,t}$ is the first difference of labor cost level in country i in time t relative to the benchmark country, μ_i is constant, t is time trend. The term $\sum_{p=1}^{P} \Delta lc_{i,t=p}$ represents lags of dependent variable to allow for higher order process ($AR(P)$) and $\varepsilon_{i,t}$ are identically and independently distributed residuals. It is easy to show that $\gamma_i = \rho - 1$.

Given the formula in (3), we are exploring convergence of relative labor costs *vis-à-vis* the average of EU-15 countries with $\gamma_i < 0$ supporting convergence hypothesis. If we are able to reject null hypothesis that $\gamma_i = 0$ in favor of one-sided alternative that $\gamma_i < 0$, we conclude that time series is stationary and therefore it converges.

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[34] A stochastic process with finite mean and variance is called (covariance) stationary if its mean and autocovariances are time independent (covariances between two periods dependent only on the lag and not on the actual point of time when they are calculated). See Enders (1995: 69) for a formal definition.

There are three issues, we have to solve for estimating (3). First, the ADF test assumes that residuals are statistically independent and of constant variance; they must be white noise. Especially the autocorrelation of residuals has serious consequences; it makes the least square estimators inconsistent. Hence, in order to control for possibility that series has been generated by higher than autoregressive process of the first order,[35] we have to include the term $\sum_{p=1}^{P} \Delta lc_{i,t=p}$ in (3). The strategy for determining number of lags that we undertake is to remove serial correlation in residuals by minimizing Schwarz information criteria and then to look at correlogram of residuals and associated Ljung-Box Q-statistics which tests joint hypothesis of zero autocorrelation of residuals up to lag P.

Second, in formula (3) intercept and time trend are optional parameters attributable to different types of convergence. Absolute, or zero mean convergence (Bernard and Durlauf 1996), points to $\beta_{i_i} = 0 \cap \mu_i = 0$ and is parallel to $\mu_n = 0$ in (1). In case of zero correlation in residuals and $\gamma_i < 0$, this process is modeled as an AR (1) process. However, it seems in many cases that absolute convergence is too strong assumption for describing behavior of particular time series. If $\mu_i \neq 0 \cap \beta_i = 0$, then we talk about relative convergence (Li & Papell, 1999). In this case, labor costs differential converges to some non-zero value. Countries have different steady states, yet their labor costs grow at the same growth rate (parallel growth paths). The gap for relative convergence can be derived for time going to infinity as $-\mu_i / \gamma_i$. It measures the long-run mean difference between labor costs in country i and the sample average (see Evans 1998), if country i is converging to group's mean. In accordance with Freeman and Yeger (2000) we will call this ratio long-run relative.

Lastly, if $\mu_i \neq 0 \cap \beta_i \neq 0 \cap \gamma_i < 0$ (statistically significant), the process in (3) is described as trend stationary. Although the presence of a time trend allows for permanent labor costs differences between the inspected time series, it might be appropriate in a context in which convergence is an on-going process (Bernard & Durlauf, 1995). This most general ADF test is suitable for countries, which are undergoing a rapid growth and can be characterized by shifting mean rather than by mean reversion. Inclusion of the trend is also necessary for ensuring the ADF test consistency since, as West (1987) points out, the ADF test is inconsistent if the process is stationary around time trend and the term is not included in the

[35] Said and Dickey (1984) show that by including sufficient number of lags, the ADF test is asymptotically valid even when the time series has been generated by moving average process. Therefore, the purpose of including lags is actually twofold.

regression (3). On the other hand, superfluous inclusion of trend lowers the power of the test (ability to reject false null hypothesis) and hence we keep the trend in model specification only if appropriate test statistics (see below) permits us to do so.

In case that trend and constant are included in ADF test, $\gamma_i < 0$ is not a sufficient condition for convergence (Tomljanovich and Vogelsang 2002). Necessary condition is to check whether $\mu_i \beta_i < 0$. If $\mu_n < 0$, then $\beta_n > 0$ must hold, if convergence is to occur. This corresponds to catching-up or "convergence from below." Were this not the case, then country with steady state labor cost below the benchmark country ($\mu_n < 0$) accompanied by negative time trend ($\beta_n < 0$) would not catch-up with labor costs of the benchmark but diverge from it. Similar case with opposite conditions (if $\mu_n > 0$, then $\beta_n > 0$) applies to "convergence from above".[36]

Thirdly, ADF test regardless of how simple it may seem, entails extensive discussion about the strategy of fitting the most appropriate model for particular time series (Elder and Kennedy 2001, Enders 1995 etc). One strategy is to make *a-priori* assumption about the nature of convergence process. This has been done by for example Duncan and Fuentes (2006), who drop deterministic trend and estimate ADF equation with constant only for all time series. Yet, we consider this approach as too restrictive for us given the heterogeneity of sample countries. We have to keep in mind that our sample countries (EU-15, Australia, Canada, Japan, Norway, South Korea, USA) were (are) distinctive units. It would be no surprise to find variable patterns of converge such that some countries are likely to meander around average (insignificant constant), while others are likely to converge to the average yet keeping distance (significant constant) and others are likely to converge fairly rapidly (significant trend).[37] Hence, the assumption of heterogeneity of convergence does not allow us to take any simplifying assumption about the deterministic regressors μ_i and β_i. This is also because there is not any fundamental theory that would help us in determining particular ADF form for labor cost convergence and we have to rely solely on past observations. We will start estimating ADF test in the most general form (3) and employ strategy described by Enders (1995: 254-258). This involves testing of the null hypothesis $\gamma_i = 0$ against one-sided

[36] Usually, this procedure involves regressing relative labor cost on constant and time trend to check whether relative time series has grown more (less) than average to enable convergence as catching-up (or convergence from above).

[37] Augmented Dickey Fuller test does not allow estimating (2) for time trend without constant since the estimates are then inconsistent, Dickey and Fuller (1981) for more detail.

alternative $\gamma_i < 0$ in the most general (unrestricted) model and supplementary testing significance of constant and time trend by F-test and τ statistics.[38] Subsequently, if time trend has been dropped, model is retested for unit root in restricted model. This stepwise procedure, although a bit laborious, allows reflecting heterogeneity of our sample countries and fitting model, which most suitably describes labor costs for particular country.

5.4 Data

The time series of labor compensation per employee in total economy are taken from annual macroeconomic database of national accounts (Ameco)[39] published by the European Commission's Directorate General for Economic and Financial Affairs. Labor compensation, as it is used here, is defined as the total remuneration (including employer's social security contribution), in cash or in kind, payable by an employer to an employee in return for work done by the latter during the accounting period (a year in our case)[40]. We use this broad definition of labor costs to capture different labor taxation approaches and to point to the full price of labor. These non-wage cost items are fully incurred by the employer and therefore we consider labor cost as a better indicator of true cost of labor than wages alone.

We use ecu-euro[41] denominated time series. To work with real compensation per employee the nominal values were divided by the deflator of gross domestic product. By converting labor costs by current exchange rate we assess how much it costs "to buy" a unit of labor in time and space. Hence, we do not only follow conclusion of the previous chapter, which concludes that nominal exchange rate is better suitable for our purposes than PPP or ULC, but also accept the recommendation by Hinze (1998:149) that for international labor costs comparisons the appropriate conversion method is to apply actual exchange rates. Use of this

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[38] Critical values under $\gamma_i = 0$ differ from conventional t-values, McKimmon (1996) tabulates them and they differ with the inclusion of trend and constant. Moreover, there are separate F-test based ϕ_i statistics testing joint hypothesis on $\gamma_i = 0$ and insignificance of deterministic regressors. In addition to that, we also have used $\tau_{\alpha\tau}$ and $\tau_{\mu\tau}$ statistics for assessing significance of trend or constant given that $\gamma_i = 0$. These are seldom reported in the literature, Eviews 5.1, where all our calculations were done, does not report them, Dickey and Fuller (1979) tabulated them. These statistics together with strategy of Enders (1996) were employed to estimate the functional form of ADF test.

[39] http://ec.europa.eu/economy_finance/indicators/annual_macro_economic_database/ameco_en.htm, all our data are taken from a version which has been lastly updated on November 6, 2006.

[40] See http://forum.europa.eu.int/irc/dsis/nfaccount/info/data/esa95/en/een00149.htm

[41] The Euro/ECU series has been generated by applying the respective year exchange rates of national currency (annual average) to ECU/Euro for reference periods preceding 1999. This also has been done for period before 1979 when *ecu* was launched. From 1999 on, the series were converted from national currencies to Euro by using the irrevocably fixed exchange rate in the case of countries, which have adopted the euro. Data are based on European System of Accounts (ESA 95).

"international euros" enables comparison in time across units as the labor costs data were originally compiled in national currencies. Moreover, as we are concerned with factor costs and not with standards of living, nominal exchange rate is appropriate. On the other hand, we admit that, at times, the development of euro-denominated labor costs might be determined more by the exchange rate changes than by labor costs (wage) developments in a particular country. We believe that the problem of exchange rate volatility is partly mitigated by converting national currency denominated data by annual average exchange rate.

Ameco is arguably the best available source of comparable labor cost data surpassing databases such as OECD's STAN or Groningen Database due to available time span and country coverage. Moreover, as we use a single source of data rather than compilation from individual statistical offices, the consistency of the data is, to an extent, guaranteed. The potential disadvantage can be in the level of labor costs data aggregation. As the data are not available we have to disregard convergence on occupational level, aspects of local labor market conditions or wages on skill level or remuneration per hour etc. However, such data are not available at all on a cross-country consistent basis to make reasonable inference on convergence in sufficiently long time horizon. In our concept, average labor cost per employee is to be understood as an indicator of general labor cost level. The rationale for using average labor compensation per employee is similar to convergence studies employing domestic product per capita, per worker in terms of aggregation.

Our data set spans, on annual basis, over the horizon of 1960-2006 for EU 15 countries and other industrialized countries (Canada, United States, Japan, Norway and Australia). Shorter time series is available for South Korea (1970-2006), Germany after the unification is represented as joint series. Ameco time series for Central and Eastern European countries are available from 1995 onwards or even shorter. At best, we arrive at panel of 33 countries.

5.5 Empirical Analysis

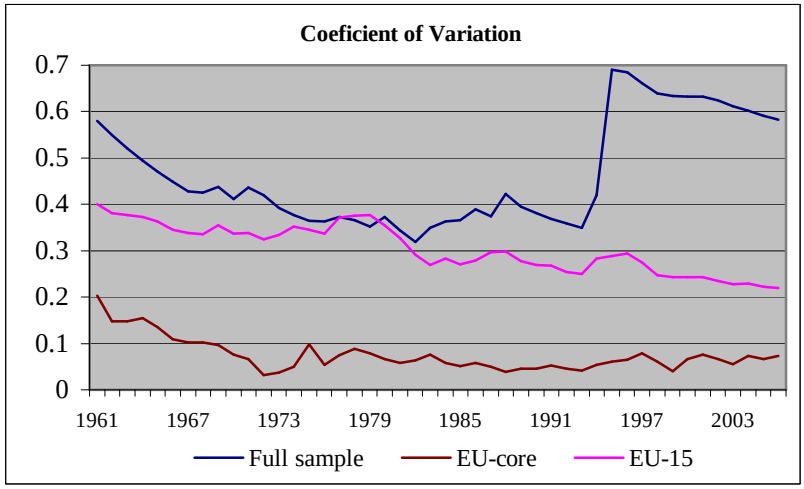
In the empirical part, we first look at σ convergence as a first indicator of convergence. Then we employ the Augmented Dickey Fuller test to study properties of labor costs time series. Finally, the panel data unit root tests are applied.

Before commenting on our results, we should make clear that implicit to studying convergence is to assume that the process generating labor cost data has been stable over the entire period to make reasonable statistical inference. However, there is not any a priori reason to assume that this has always been the case hence, we have to interpret our results cautiously.

5.5.1 Sigma Convergence

First, let us take a look on coefficient of variation, which measures σ convergence, i.e. dispersion in labor cost levels within the group.

Graph 5.1: Coefficient of Variation of Labor Costs Level



Source: Ameco (2006), own calculations, coefficient of variation is defined as standard deviation over group's mean.

We see that convergence is a relevant concept as far as we can judge by the coefficient of variation. Dispersion between EU-15 countries has been steadily decreasing, the coefficient declined by almost 50% between 1961 and 2006. Convergence process has been distracted between 1973-78 and 1992-96, however then always restored. The first deviation is assignable to the divergence within EU-15: Italy and United Kingdom experienced between 1973 and 78 a drop in relative labor costs by more 25 and 28 percentage points also due to sharply depreciating currencies (50% and 32% between 1973 and 78). To smaller extent, this applies to Ireland that fell from 0.75 to 0.62 of EU-15 average. On the other hand, Luxembourg and Netherlands raised their labor costs to over 1.4 of the average which has been associated with appreciating *franc* (16%) and *guilder* (19% between 1973 and 78). Distortion in the mid 1990's had similar cause; this time only with countries diverging to above (Bel, At, Lux).

Variation for EU-core countries (Bel, Neth, Ger, Fr, Lux) demonstrated decreasing trend up to 1973, and since then coefficient of variation remains quite constant. This is interesting observations since we can perhaps associate a falling coefficient of variation with full regional trade liberalization in European Economic Community in 1968, but subsequent integration does not seem to have influenced convergence among these core countries. In terms of levels,

relative labor costs for EU-core have occupied range of approximately 1.20 to 1.40 of the average. Illustrating is the fact that this range has been shifting down (with exception of mid 1990's) to roughly 1.10 to 1.30 of EU-15 average in 2006. Excluding Luxembourg, the range is halved to 1.08 to 1.18. Values of around 1.10 of EU-15 average can be considered as a likely lower threshold to which EU-core countries converge. Allowing for disruptions in mid 1990's these countries has been gradually approaching these values in almost three past decades. Overall, it makes the impression that these countries have steady state labor costs above the EU-15 average (suggests relative convergence) and that the dispersion is already at its minimum.

Deviation for the full sample[42] shows a one-off shock after 1994. This is intuitive as group grows in both number and heterogeneity. Still, the variation regains declining tendency in the late 1990's. Overall, variation in all three groups shows mean-reverting behavior (shocks are temporary) with decreasing trend.

These results make us optimistic in evaluating convergence prospects yet there are two major reasons why these indicators should be interpreted with caution. First, the figure expresses a measure of convergence for the sample as a whole. Hence, there might be subgroups (convergence clubs) in which dispersion decrease while other countries diverge. Second, if the data are not stationary, then even the coefficient of variation[43] as an indicator of convergence may be called into question (Brandl 1996). These observations make us careful in stating any too definite judgments about convergence; we will wait for more rigorous approach of ADF test to confirm or deny these encouraging results.

5.5.2 Results-Augmented Dickey Fuller Test

For the Augmented Dickey Fuller test, we employ time series for 21 countries utilizing the full length (1961-2006, 46 annual observations, Korea 34 observations) of the available dataset. Before reporting the results of the Augmented Dickey Fuller test, let us examine Figure 5.2, which describes major tendencies in labor costs relative to the average of EU-15 countries (all in logarithms). We see that countries can be fairly well divided into four categories:

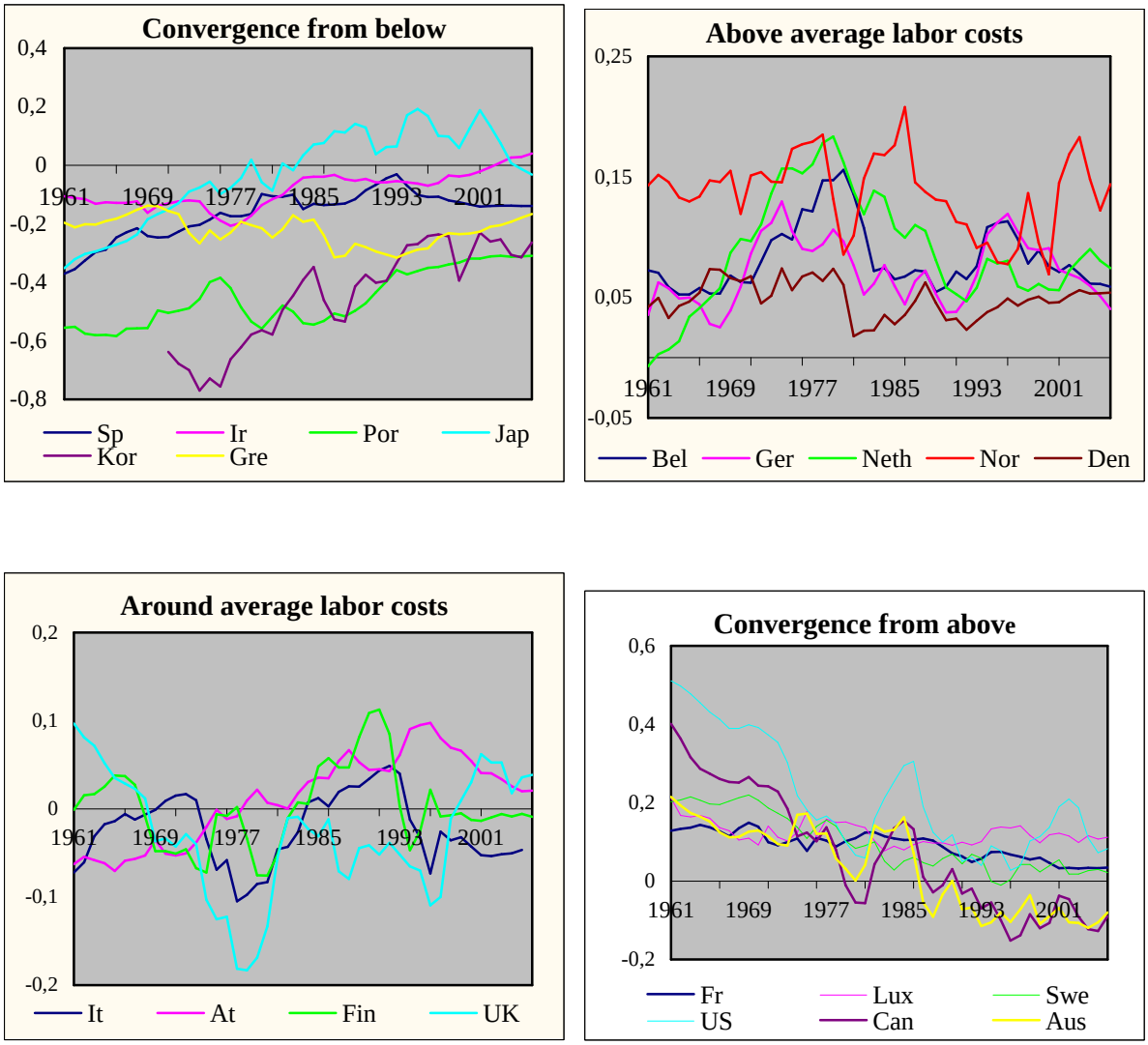
1. Countries converging from below (Portugal, Korea, Ireland, Japan, Spain, Greece)

[42] Up to 1994 EU-15+Nor, Aus, USA, Ca, Korea, Japan; from 1995 on Malta, Cyprus and the Central and Eastern European countries included-CR, Pol, SK, SL, Hu, Lit, Lat, Est, Ro, Bul.

[43] Coefficient of variation incorporates variability of the group's shifting mean hence it is better equipped to handle non-stationary data than standard deviation, for example.

2. Countries with above-average labor costs without apparent tendency for convergence (Germany, Belgium, the Netherlands, Norway, Denmark)
3. Countries with labor costs fluctuating around average (Finland, Italy, Austria, the United Kingdom)
4. Countries converging from above (Canada, Australia, the United States, Sweden, France, Luxembourg)

Graph 5.2: Convergence and Relative Labor Cost



Source: Ameco (2006), own calculations

Graphs provide us with rough estimates of convergence. Ireland, Portugal, Japan and Korea do seem to converge quite quickly in sense of catching-up, or Sweden and France show a quite steady trend in decreasing relative labor costs, they are converging from above. Italy fluctuates around the EU-15 average while Norway shows little propensity to come near the

average labor cost in the EU 15. This quick glance gives us first information on possible functional forms of ADF tests.

Table 5.1 reports a detailed statistics on the above described Augmented Dickey-Fuller test. Second column reports the estimates of ρ_i from equation (2) that ADF estimates by the means of parameter γ_i. In fact, estimates of coefficient ρ_i indicate convergence if they are between $(0;1)$. Coefficient ρ_i in our case can be interpreted as the share of initial labor cost differential that remains after one period. Hence, the lower it is, the faster is the convergence process. Third column informs us about significance of constant μ_i. As we have argued above, if $\mu_i \neq 0$, then there is a relative convergence and steady state to which labor cost converge in the long-run and in which EU-15 average and country are on the balanced growth paths. Estimates of β_i describe trend and are applicable to convergence from above $\beta_i < 0$ and below $\beta_i > 0$. In the fifth column are the estimates of the half-lives for the relative labor costs.[44] Last column reports on the long-run relative (LRR), a long-run equilibrium labor costs to which labor costs converge relative to EU average. It has been calculated as $\mathbf{exp}(-\mu_i / \gamma_i)$ to be directly comparable to EU-15 average, a values close to one indicates absolute convergence.

Starting with some general observations, several aspects are especially worth considering. First, there is a substantial variability how countries converge as was already suggested in Figure 5.1. Not in all cases particular functional form in (3) corresponds to visual inspection, nonetheless this should not be of major concern. Out of 21 time series, we have 13 significant and hence converging to EU-15 average. Out of these Australia, Canada and Luxembourg converge from above with significant time trend while Ireland, Korea and Portugal catch up from below.

[44] For AR(1) processes one can derive so called *half-lives* as $hl = \frac{\log(0.5)}{\log(1+\gamma_i)}$. This ratio indicates how long it takes for particular lc_i series to revert half-way back to its mean value given a unit shock. In our case, it indicates how long it takes (in years) for half of the differential between the initial level and steady state to disappear.

Table 5.2: Augmented Dickey Fuller Test, 1961-2006

	ρ_i	μ_i	β_i	**Half Live**	**LRR**
Australia	0.528***	0.09***	-0.0033***	1.09	0.966
Austria	0.959	-	-	16.56	-
Belgium	0.854	0.011	-	4.39	-
Canada	0.646**	0.09**	-0.0034***	1.59	0.94
Denmark	0.695**	0.015***	-	1.91	1.05
Finland	0.752**	0.003***	-	2.43	0.99
France	0.648	0.05*	-0.00087**	1.60	1.05
Germany	0.793*	0.014**	-	2.99	1.07
Greece	0.866	-	-	4.82	-
Ireland	0.851	-0.028	0.00073**	4.30	1.01
Italy	0.890*	-	-	5.95	0.98
Japan	0.907**	-	-	7.10	1.05
Korea	0.575	-0.36*	0.0064**	1.25	0.75
Lux.	0.533***	0.057***	-0.00023***	1.10	1.12
Nether.	0.916	0.008	-	7.90	-
Norway	0.659**	0.047***	-	1.66	1.14
Portugal	0.830	-0.041**	0.00095**	3.72	0.80
Spain	0.89**	-0.013**	-	5.95	0.88
Sweden	0.943**	-	-	11.81	0.97
UK	0.896**	-	-	6.31	0.99
US	0.954**	-	-	14.72	1.16

Note: *, **, *** indicate estimates significant at 10, 5 and 1 percent level of significance in the first column parameter gamma is evaluated using McKinnon (1996) critical values, the last column reports significance at usual t-values. For countries with trend (or without constant), the LRR was re-estimated in model with intercept to ensure comparability of the LRR estimates.

For these countries, we have performed auxiliary regression as described above to check whether necessary conditions hold. Unambiguously, these tests confirmed correctness of signs of constant and trend. [45]

As far as the absolute convergence (identical steady state labor costs) concerns, we can reject unit root for Italy, UK, USA and Sweden. In addition to that, relative convergence (long-run differential in levels accompanied by average-identical growth rate) seems to be the case for Denmark, Finland, Germany, Norway and Spain. We have found no country, which diverges in sense of increasing relative gap in time, which is indeed an encouraging result. On the other hand, there still seem to exist persistent gaps as suggested by significant constant terms (relative convergence). Overall, the spread for sample countries declined from 30-160% of the EU-15 average in 1960 to 50-130 (70-120% excluding Portugal and Luxembourg) in 2006. The gap has decreased by over 40%. Portugal remained the lower boundary throughout the whole period. From above the band was marked by Sweden, the Netherlands and most recently by Luxembourg.

Perhaps the largest variety is found in the speed of convergence process. This is estimated by coefficient ρ_i. The most rapid in terms of closing the gap is Australia (0.52) followed by Luxembourg and Canada. The slowest out of converging countries are USA (0.95), Sweden and Japan. Corresponding half-lives fluctuate for converging countries fluctuate between one year (Australia) and 14 years (USA). The mean half-live for EU-15 is around six years.

Last column informs about the long-run differential of countries for which we have indicated convergence. For this indicator to be reasonably interpreted particular time series must be stationary. Then for a stationary time series it is a prediction of ultimate steady state to which time series should convergence in the long-run (as time goes to infinity). We see that the spread between countries is only between 75-115%. Some of countries for which converge was found (Nor, Lux, Ger, Den) seem to retain a positive differential of 5 or more percent. For group of countries converging absolutely (Swe, UK, It) the differential was found close to one. This is reassuring finding in a way that these differentials are not fundamentally different

[45] Moreover, Fr, Por, Kor, Ire for which convergence by the means of ADF was not confirmed, we observe particularly significant trend behavior even under the null hypothesis for which the t-test statistics does not follow standard limiting distributions but the one of McKinnon (1996). In addition to that, if we would follow Enders' (1995: 256-258) prescription for ADF testing to its fullest, we would have to conclude that time series of Fr, Ir, Kor, Por are stationary. This comes from the fact that we were not able to reject hypothesis that $\beta_i = 0$ given $\gamma_i = 0$, i.e. test for presence of time trend. Then one should retest for a unit root ($\gamma_i = 0$) using standardized normal distribution to control for the possibility that trend is superfluous in regression (3) and for which the test statistics follow standardized normal distribution.

from relative labor costs levels reported in graphs above. Furthermore, Spain and Portugal given past development of labor costs should keep closing the gap up to values around 90% of EU-15 average. Overall, estimates of long-run relative seem to provide us with fairly well fitted reality check.

Our results are reassuring in terms of what we would expect. Initially low wage countries (Portugal, Spain, Ireland) demonstrate positive trend stationary behavior, while negative trend stationarity is characteristic for Luxembourg and France or Australia. Hence, it is logical that ADF test points to convergence of countries with initially "extreme" labor costs levels. Similarly, high labor cost countries such as Canada, USA or Australia have shown tendency for decreasing the relative labor cost gap. We also confirmed a persistent differential for Scandinavian countries and cost-advantage for Spain and Portugal. The gap is closing, yet there are differences.

Interesting and illustrative are cases of Germany, Belgium and the Netherlands as countries, which have been involved in the European integration ever since its outset. Not only have these countries experienced periods of strong fluctuations (early 1970´s-1980, early 1990's-mid 1990´s) when they actually diverged from the average, but their labor costs demonstrated persistent positive differentials after the fluctuations. Following these fluctuations, pro-convergence forces were operating, nevertheless there are continual deviations in relative labor costs remaining even after year 2000. These series show a relative convergence with long-run differential (measured by LRR) around 5 to 7%. This is in accordance with the results of σ convergence results. They may indicate what are the likely barriers to labor costs convergence possibly due to imperfect competition, labor productivity differentials, trade barriers, increasing economies to scale, factor endowment or specialization of production etc. All of these aspects are counterweight to similar factor endowments and presumably to common presence of EU-core countries in the same cone of diversification, which is pushing factor prices close to equalization.

There are several potential explanations why we were not able to reject false null hypothesis of non-stationarity for individual time series (the Netherlands, Belgium or Greece). First, unit root may be assignable to the strong fluctuations (early 1970´s-1980, early 1990's-mid 1990´s) as Figure 5.1 suggests. Subsequent declines in the 1980's and late 1990's were not enough "mean-reverting"; fluctuations due to some shocks had a permanent effect on series. This is not case of the United Kingdom (shock from early 1970 to the early 1980's), Finland (late 1980's) or Italy, where we observe persistent mean reversion.

Second, in cases of both rejection and non-rejection of null hypothesis, we tested particular time series by ADF and by a battery of statistical tests in order to approximate data-generating process. Hence, we are implicitly distinguishing between deterministic and stochastic trend (ADF with trend vs. ADF with constant). It is well known fact that these tests sometimes fail to distinguish the correct model, for example in cases of near unit root processes (Enders 1995). Hence, if we have failed in determining corresponding nature of the trend, our ADF tests are misspecified and estimated coefficients are, besides others, inconsistent. This might be the case of for example Portugal, Greece or Belgium that show high estimates of ρ_i coefficient.

Third, labor cost time series are not as volatile as for example financial time series and the fluctuations seems at least for some countries (UK, At, Neth) to be rather long-lasting (half-lives between 6 and 16 years). As a result, the ADF test performed at 45 annual observations may fail to reject the null since it is too short and series has not yet fully recovered from fluctuations.

Fourth, the fact that we have not indicated convergence for Belgium and the Netherlands can be also partly explained by the inability of rejecting the null. This is justifiable by the low power of ADF test-probability of rejecting a false null hypothesis in small samples (Freeman and Yerger 2001, Cunado and de Grazia 2005). On the other hand, even for countries for which the null hypothesis of unit root has not been rejected, the coefficient ρ_i is of correct sign. In order to increase power of conventional ADF test, as pointed out by Levin and Lin (1992), it is wise to take advantage of panel characteristics of multi-country time series. For these reasons is the panel unit root testing an obvious setting for verifying results of univariate ADF tests.

5.6 Panel Data Analysis

In the last decade, panel data are being introduced into unit root testing and convergence (Madala and Wu (1999), Breitung (2000), Levin, Lin, Chu (2002)). In general, all these tests are based on developing single series test in a way that they combine information from the individual time series together with panel generated cross-section series. This is especially valuable in case of short time series as we have for transition countries.

5.6.1 Panel Tests-Methodology

As a starting point, we take the individual Augmented Dickey Fuller tests from equation (3). The discussion as in the section 5.3 applies here as well. Employed tests work with the null hypothesis of unit root. If we are not able to reject the null hypothesis that $\gamma_i = 0$, then we conclude that all the relative labor costs in the countries have not converged. The alternative is that relative labor costs in at least one country have converged to the cross-section average.

We use three tests that assume cross-sectional independent panel: Breitung (2000), Levin, Lin, Chu (2002) and Madala, Wu (1999) (Breitung, LLC and MW thereafter) and one test that relax the assumption of cross-section independence, the CIPS test.

Let us start with the first three tests. While Breitung and LLC tests assume common unit root process for all series (all AR(1) processes have common autocorrelation coefficient, γ), the later, MW, allows for individual unit root and autoregressive coefficients can differ across countries. In particular, the MW tests $\gamma_i = 0$ for $i = 1,..,N$ as the null hypothesis while Breitung assumes $\gamma = 0$. Hence, the MW test allows the presence of individual unit root and Breitung and LLC assume a common unit root process for all the time series.

All three tests allow for trends, constants and higher-order autocorrelation patterns to be determined for individual time series and they assume a cross-sectionally independent panel.[46]

MW test combines individual ADF tests and combines observed levels of significance (p-values). The test statistics, $\lambda = -\sum_{n=1}^{N} \ln \pi_i$, follows χ^2 distribution with $2N$ degrees of freedom, where π_i. is the p-value of the ADF test for the i^{th} time series.

As multivariate generalization of ADF test, Breitung test is based on estimating standard ADF equation as in (3), specifying the optimal number of lags and by detrending time series of interest. Breitung-modified $t-$statistics then follows standard normal distribution (asymptotically).

In addition to these tests, we also use cross sectional extension of the Augmented Dickey Fuller test, called CIPS proposed by Pesaran (2005) and which explains cross section dependencies by dynamic factor model. In this setting, cross-sectional correlation is caused by

[46] Problem of cross-sectional dependencies has a serious consequences and use of them was questioned (see e.g. Konya 2001) as tests tend to overreject unit root. However, cross-sectionally demeaning of the series before application of the panel unit root test could partly deal with the problem as mentioned by Pesaran (2003). This is our case as we examine convergence relative to EU-15 average. Still, we will also apply test that does not assume cross-sectional independence (see below).

common component identical to all panel members, i.e. errors from equation (2) can be modeled by a single factor. Pesaran assumes that the common component is stationary and proposes a single factor approach using cross-sectional mean and its lagged values.

Use of this test is motivated by the fact that, if we have not sufficiently well removed cross-correlation in errors, the power of the test is drastically reduced. The contemporaneous correlation in residuals for the simple ADF test was between –0.5 to 0.7 despite the fact that we implicitly adjusted our data by examining convergence to the EU average and hence by demeaning individual labor costs data. If the results of CIPS and tests mentioned above are the same, we can conclude that cross-correlation was not a major concern. However, if the results were opposite, we should regard the CIPS tests as more objective, since MW, LLC and Breitung (and tests that assume zero cross correlation in general) tend to biased towards stationarity hypothesis if the cross-section correlation is substantial (Dreger and Reimmers 2006).

For the CIPS the usual ADF regression is modified to include cross sectional averages of lagged variables as well as average differences of lagged difference. Formally, the full version of ADF, which controls both for serial and cross-section correlation, takes the following form (Pesaran 2003:18, time trend added):

$$\Delta lc_{it} = \mu_i + \beta_i t + \gamma_i lc_{i,t-1} + \varphi_i \overline{lc}_{t-1} + \sum_{j=0}^{P} d_{ij} \Delta \overline{lc}_{t-j} + \sum_{j=0}^{P} \delta_{ij} \Delta lc_{i,t-j} + \varepsilon_{it} \qquad (5)$$

where $\overline{lc}_{t-1}$ is lagged cross-sectional average and $\sum_{j=0}^{P} \Delta \overline{lc}_{t-j} = N^{-1} \sum_{i=1}^{N} \Delta lc_{it}$ is average labor costs growth. This averages-based augmentation will be used for a test proposed by Im, Pesaran and Shin (2003). The test statistics for cross-sectionally augmented IPS test (thereafter CIPS) is computed as

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i(N,T)$$

where $t_i(N,T)$ is the Augmented Dickey Fuller statistics for γ_i from (5), (N,T) denotes the dimension of panel- N cross sections, T observations each. Other advantage of CIPS is that $t-$values are readily available, and the CIPS test can be computed easily. We take number of lags P from individual ADF. For all but NMS we have also dropped the time trend variable.[47]

[47] This choice is rather arbitrary since as stated by Kutan and Yigit (2005) it is not yet completely resolved in panel unit root literature what to do in case of incidental trends, i.e. when nature of the trend differs across cross

We apply panel convergence tests to the three separate groups of countries:

1. EU 15+6 (EU-15+ Jap, Ca, US, Nor, Aus, Kor)
2. EU-core (Bel, Ger, Neth, Lux, Fr)
3. NMS (CR, Est, Pol, Hun, SK, SL, Lit, Lat)

In the first step we examine how do they converge to the average of EU-15. Secondly, we will examine how countries converge to each other in specific regions (EU-south, EU-north, EU-core, NMS).

5.6.2 Results-Panel Data

Looking at the results in Table 5.3, Breitung's test statistics rejects the null of non-stationarity for the two most populous group EU-15+6 and EU-15. As we performed this test without constant (no individual fixed effect) and given the assumption of common unit root, this test questions the absolute convergence hypothesis. The fact that it is significant for these two groups can be interpreted such that this group includes countries (e.g. UK, It, Fin) that converge to EU-15 steady state (they are converging absolutely). For EU-core Breitung's test does not allow to reject null hypothesis that core countries do not converge to EU-15 average. The question arises whether these countries converge to some different values, for example to average of its group mean. Turning back to Table 5.2 Breitung and CIPS test confirm results of Dickey-Fuller test in way that they do not show convergence to the EU-15 mean. Hence, the non-rejection of unit root for Belgium or the Netherlands was not caused by low power of ADF test or by slow mean reversion but rather to diverging nature of time series.

MW test focuses on the relative convergence and we performed it with a constant term. This test quite convincingly rejects the joint null hypothesis of non-stationarity for all the groups. This is also because it is more flexible than Breitung in terms of heterogeneity of the unit root parameters. Obviously, this does not mean that all labor cost series converge, indeed some can actually diverge and some converge.

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sections. As we test NMS in separate panel, we include time trend as it better characterizes time series behavior for this group.

Table 5.3: Panel Unit Root Tests

	EU-15+6	EU-15	EU-core	NMS
Breitung	-1.94**	-1.35*	-0.52	-1.03
CIPS	-2.13*	-	-1.97	-2.64**
MW	52.09***	52.06***	26.02**	70.0***

Source: Ameco, own calculations., *, **, *** denotes significance at 1, 5, 10% level of significance. Critical values for CIPS are tabulated by Pesaran (2003: Table 3b and 3c). Panel of NMS estimated with constant and trend, sample data 1995-2006. The Group EU-15+6 sample spans 1961-2006. We had 922, 278 and 98 observations at disposal for EU-15+6, EU-core and NMS respectively. For NMS and EU-core in case of CIPS test the critical values for truncated panel were used which are to be found in Pesaran (2003). Korea dropped as tests defined only for balanced panel.

The CIPS (being specified as MW with constant term for EU-15+6 and EU-core) test statistics confirms results of previous two tests for the EU-15+6 and NMS, though the levels of significance are lower. For core countries, where high spatial correlation of labor costs should not be surprising (long common economic integration, trading partners) test does not allow to accept relative convergence. On the other hand, contemporaneous correlation in labor costs seems to be a smaller factor for NMS (levels of significance almost same for MW and CIPS), perhaps due to heterogeneity of these countries and relatively short time for synchronization and creation of closer ties between economies.

Overall, we can conclude that as a whole our countries converge to EU-15 average, a result that is robust to test specification. On the other hand, EU-core as a group seems to be diverging to above from EU-15 average.

By using Levin-Lin-Chu test of panel data unit root (it reports estimates of common unit root coefficient, γ) we can also assess the speed of convergence, i.e. to answer the question how fast the group approaches the average labor costs. This is done in table 5.4, where we report estimates of ρ, where $\rho = \gamma + 1$ and associated half-lives.

Table 5.4: Speed of Convergence-Panel Data

	ρ	Half-lives	Test statis.
EU-15+6	0.919***	8.2	-3.73
EU-15	0.918**	8.1	-2.72
EU-core	0.883	5.6	-1.67
Gre, Sp, Por	0.913*	7.6	-1.76
Fr, Lux, Swe	0.914**	7.7	-1.71
NMS	0.824***	3.6	-6.42
CEE	0.871	5.0	-1.29
BALT	0.81***	3.3	-7.2

Source: Ameco, own calculations. ρ estimated by LLC, constant term included in all specifications to capture country-specific fixed effects (transformation country, appreciating currency etc.). We estimated γ both restricting number of lags to 0 (AR(1)) as well as letting number of lags to be determined by Schwarz Information Criteria (SIC), results were not quantitatively much different, table reports estimates based on SIC. CEE includes CZ, SK, SL, Pol, Hun. For NMS, CEE and BALT (EST, LAT, LIT) data 1995-2006 were used. Half-lives are in years.

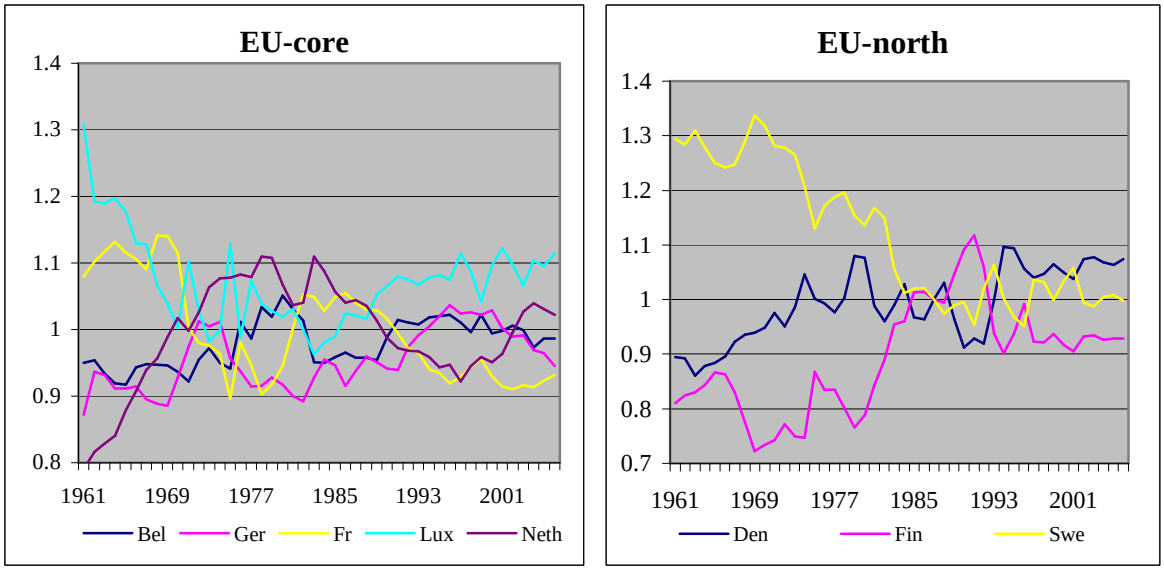
We see that for the large samples (EU-15+6, EU-15) convergence is quantitatively comparable pointing to some common trend in convergence. Moreover, speed of convergence in countries converging from above (Fr, Lux, Swe, US, Ca, Aus) as well as in countries converging from below (Gre, Sp, Por) is similar. Such findings are comforting in a sense that peripheral countries (Gre, Port, Sp) as well as the EU core countries (Fr, Lux) show intensive convergence process which appear to affect both high and low labor cost countries with the same vigor. The half-lives for EU-15 countries averages around 8 years to cover half a distance to the mean. Relatively fast convergence as measured by coefficient ρ for NMS will be discussed in the section 5.7.

5.6.3 Convergence Clubs[48]

Finally yet importantly, we look at convergence within our sample of countries, i.e. we would like to answer the question whether there are convergence clubs. We divided our sample into three sub-groups for which we can assume the idea of convergence clubs relevant. These groups are: EU-core, EU-south (Por, Sp, Gre) and EU-north (Swe, Fin, Den).

[48] Term introduced by Baumol (1986). For our purposes we understand the term convergence clubs as a situation when within a group of countries a sub-group converges to the mean of its own. This sub-group can, however , freely wander with respect to the mean of the whole sample population.

Graph 5.3: Convergence Clubs



Source: Ameco, own calculations

We determined these groups based on geographical proximity and their involvement in integration process. The graphs show a remarkable convergence between EU-core and EU-north vis-à-vis the average of their group. While the former area shows a tight band in which labor costs oscillate since the beginning of the 1970's (and indirectly confirms result of σ convergence and panel data tests), the latter group fluctuates in narrow band since mid 1980's and from the year 2000 on. Both bands are in the range narrower than +/- 10% of respective average perhaps showing a natural barrier to convergence. We also performed the LLC test on these data, which indicated relative convergence on 10 percent level (country-specific fixed effects). We have not found much of support in the data for the idea of convergence clubs in the Central and Eastern European countries.

5.7 Central and Eastern European Countries

The labor costs gap between EU-15 and countries of Central and Eastern Europe is significant as the upper part of Table 5.5 suggests. With exception of Slovenia with labor costs over 50% of EU average, other countries enjoy the advantage of having labor costs of 1/3 or less of the EU-15 average. In terms of levels, the difference is between 31 000€ (Latvia) and 18 000€ (Slovenia) in 2006.

Keeping this in mind, Tables 5.3 and 5.4 suggest that for these countries convergence seems to be a significant and rapid process. Looking at the estimates of coefficient ρ, the group of Baltic countries (Est, Lit, Lat) has been catching quickly with EU average (half-lives less than

4 years) in the past decade given their low initial level. This also applies to CZ, Pol, SK, SL, Hun with half-live of 5 years. This is in line with expectation that lower labor cost countries demonstrate faster growth than their high labor costs counterparts.

The estimated convergence coefficients for NMS need to be interpreted with caution due to two major concerns. First, as we estimated LLC test with intercept and in some cases lagged variables (to control for autocorrelation) were included in LLC test, the number of degrees of freedom went to less than 10 for s single series. Consequently, we are on the very edge of reasonable statistical inference. At best, we employ time series with 11 observations (1995-2006). For this reason, the ADF test is out of question.

On the other hand, given relative growth differentials of 12.37 and 14.92 for Estonia and Lithuania respectively (Table 5.5) these countries would fully catch up with the EU average in 10 years and in this light, half-lives of approximately four years do not seem overtly unrealistic. However, be aware that low half-lives especially for Baltic countries and NMS are given by their enormous growth in the second half of 1990's (even over 20% with their small base) which is unlikely to be replicated. Nevertheless, there have been sustained growth differentials between EU-15 (Germany) and NMS as the lower part of Table 5.5 convincingly documents.

Table 5.5: NMS, EU-15 and Germany (1995-2006)

	CR	**SK**	**Hun**	**Pol**	**SL**	**Est**	**Lat**	**Lit**
	Labor Costs (in levels, 1000 euro)							
1995	3.77	2.98	5.63	3.83	9.78	1.92	1.82	1.20
2006	10.94	8.06	12.69	8.75	19.67	9.78	6.00	7.47
	Relative Labor Costs (in % of EU-15 average)							
1995	0.15	0.11	0.22	0.14	0.38	0.07	0.07	0.05
2006	0.29	0.21	0.34	0.23	0.52	0.26	0.16	0.2
	Growth Differential (in pp)-Relative							
to EU 15	6.68	5.99	4.33	4.71	3.15	12.37	7.93	14.92
to Ger	8.16	7.46	5.8	6.19	4.62	13.85	9.4	16.4
	Growth Differential (in pp)-Absolute							
to EU-15	1.32	0.90	1.09	0.77	1.32	1.69	0.81	1.38
to Ger	1.25	0.90	1.21	0.65	1.64	1.49	0.74	1.21

Source: Ameco, own calculations, average growth of labor costs relates to EU-15, growth rates in ecu/euro and pp refers to percentage points, in our case percentage points above EU average.

The relative growth differential relates to average growth of ecu/euro-converted relative labor costs. It states the annual difference in share of labor cost in country i relative to the EU-15 average (i.e. $\frac{lc_{i,t}}{\overline{lc}_t} \Big/ \frac{lc_{i,t-1}}{\overline{lc}_{t-1}}$) Hence, it is an indicator important from country i point of view and a measure of relative convergence. On the other hand, from the point of view of EU-15 is important to assess convergence based on catching-up in levels ($\frac{lc_{i,t}}{\overline{lc}_t} - \frac{lc_{i,t-1}}{\overline{lc}_{t-1}}$) given the low base (low initial labor costs levels) from which labor costs in NMS are growing. Therefore, we report the growth of relative differential as well in order to assess absolute convergence in labor costs in country i relative to the EU average.

We see that Baltic countries have experienced a booming growth in terms of relative growth with Lithuania and Estonia exceeding a double-digit growth differential. We see respectable performance for the Czech Republic and Slovakia, Hungary and Poland being slower. Slovenia's relative differential was the smallest, however as the absolute growth differential suggests due to growth from initially higher base (0.38 in 2006) it has managed to climb over the 50% of EU average. Between 1995 and 2006, Slovenia's relative labor costs increased by 14 percentage points.[49] This is the same case for CR and Lat, Hun and Pol (higher relative growth for the former, yet lower base and hence lower relative labor costs in 2006). Note that labor costs in Germany has grown slower than in EU-15 as the relative differential documents. Nonetheless, for all but two (SL, Hun-initially two highest labor costs) the absolute differential has been lower for EU-15 than for Germany as labor costs in Germany are roughly 10% above the average. The average growth differential vis-à-vis EU-15 has been 7.5 and 1.16 percentage points for relative and absolute convergence respectively.

Differentials for CEE countries are considerably higher compared to the growth of EU-15 in the past. For example, Spain's average growth differential (a 10-year average) in the time of its strongest convergence (1960-1994, relative labor costs moved from 0.42 to 0.93) accounted successively for 3,12%, 2,8%, 1,7%. Given the relatively high base even lower growth differential permits convergence. However, Portugal, which between 1989-2006 climbed from 0.28 to 0.48 of EU-15 labor costs average, has demonstrated average differential of 2.6%. Hence, a twice or more as high differential in CZ, SK, Est, Lit with relative labor costs between 0.20 and 0.30 will, if sustained, imply significantly faster

[49] This the same number of percentage points as the Czech Republic has managed despite the fact that the latter has shown more than twice as high growth differential. Hence, it is important to assess convergence not only on growth rate differential but also on the relative values.

convergence than in case of Portugal. The pace could be comparable to Korea where sustained average relative growth differential of 7% between 1977-86 and 1989-1997 increased labor costs up almost 60% of EU-15 average from initially low base of 17%.

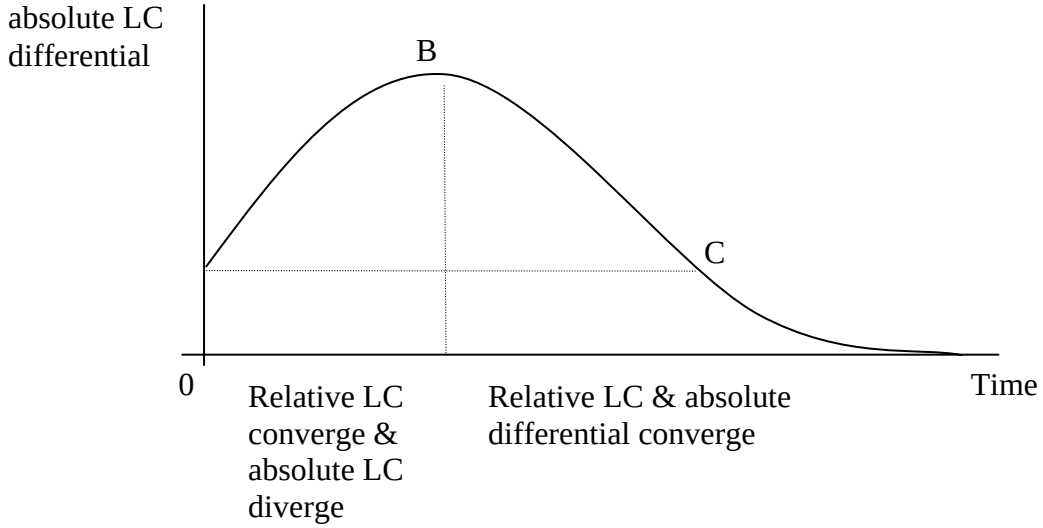
We also report the actual levels of labor costs to describe the magnitude of differential. On average, labor compensation per worker in Germany (EU-15) exceeded labor compensation per worker in CEE by 26 800€ (16 700) in 1995 and by 27 400€ (21 000) in 2006. This suggests that despite relative growth differential the absolute difference ($lc_{i,t} - lc_{t,GER}$) has increased as Germany in 1995 has growth from almost ten-times higher base than the Czech Republic, for example. In fact, it was only Slovenia who managed to reduce the absolute gap vis-à-vis Germany from 23 900 in 1995 to 21 700 in 2006 and whose labor costs increments overtook those of Germany.

Observing past developments of Spain, Korea, Slovenia suggests that with growing to higher labor cost base we will observe falling rates of relative growth differential (non-linear convergence process) and relatively faster progress of absolute catching-up.

If this scenario would be relevant also for CEE countries, then for small labor cost base even quite high differential of 6% as of case of the Czech Republic, or 12% of Estonia is not yet sufficient for convergence in levels. Low labor costs countries can hence enjoy a cushion in which relative labor cost converge, yet the labor costs levels differential are (still) diverging. For labor cost based competitiveness is the absolute differential (labor arbitrage) central since as long as it holds, a firm considering employment of otherwise identical workers generates increasing savings even under positive relative growth differential in CEE as shown in Scheme 5.1. The maximum savings is reached at point B in which the marginal labor costs increments between a considered country and benchmark are equal. Past this point, a combination of positive growth differential and higher base causes absolute convergence to begin.[50]

[50] In the diagram, we describe convergence past point B by concavely decreasing growth differential. This of course does not have to be a rule.

Figure 5.1: Relative and Absolute Convergence



As a result, a swift labor costs growth of labor costs does not necessarily have to discourage foreign firms when deciding on location on the labor cost criteria. Thanks to the higher base differential preserves the growth inertia up to the breaking point B. Up to this point, country can base its competitive advantage on low labor costs, however from then on the cushion will start to decrease given the differential remains unchanged. Past point B absolute convergence does not have to be automatic; it can be reversed (as for Portugal, or Spain) conditioned on growth differential.

We have tried to estimate point B for several countries. Any such considerations are crucially influenced by assumptions on the long-run differential. For estimates based on assumption that past differentials will remain unchanged, Czech Republic, Slovakia and Hungary will reach breaking point in 6, 17, and 13 years respectively. For more conservative expectation of 4% differential estimates are 13, 21, 9 years and 19 years for Poland. Past these points absolute labor cost differential will begin to catch up at increasing rate, if differential is sustained. We interpret these points as time which converging countries have to prepare for competitiveness based on more than low labor costs since past these points absolute labor costs differential will start to decrease. On average, the Czech Republic and Hungary have less than a decade, Slovakia and Poland around 15 years.

To conclude, we also reflect on rough estimates of how long it will take for labor cost in NMS to level off with those of EU-15.[51] This is based on growth differential as we discussed it above. In other words, we project growth differential and relative labor costs in year 2006.

[51] These estimates are rather simple but fitting any ARMA model makes no sense with 12 or less observations. Enders (1995: 105) warns about any prediction based on fewer than 50 observations.

This implicitly assumes that these countries have same steady state as EU-15 including production function, endowment etc. Table 5.6 shows the results.

Table 5.6: Projected Time for Labor Costs Equalization

Growth diff.	CR	SK	HU	Pol	SL	Est	Lit	Lat
3%	2048	2059	2043	2056	2034	2052	2061	2069
6%	2028	2033	2025	2032	2018	2030	2034	2038
concave	2034	2042	2030	2040	2029	2044	2038	2041

Notes: Growth differential to EU-15 average, Scenario "concave" assumes decreasing average growth differential from Table 5.5 by rate $1/\mathbf{log}(N)$, where $N = 10,11,...$. For Est and Lat we let growth differential decrease by $1/\mathbf{log}(N) * 10/(1+N)$, hence taking into account "extreme" average differential for 1995-2006.

Given sustained growth differential of 6% with respect to EU-15, the labor costs in the Czech Republic will level with EU average in the year 2028. For Central European countries, the average, under 6% differential, is 21 years. However, it is unlikely that convergence will be linear, and for this reason we consider concavely decreasing growth differential reflecting the continuingly increasing labor cost base. For these, more conservative estimates, the average to catch-up in levels is 27 years. Baltic states are approximately 6 to 8 years behind in convergence for the 6% and concave scenarios. Overall, it seems realistic to expect (if CEE countries) have the same steady state as EU-15 countries) that full equalization will take place in slightly more than 20 years.

5.7 Conclusion

In this chapter, we have empirically assessed the process of labor costs convergence. Using convergence tests for individual time series as well as for the panel data labor cost hypothesis has been confirmed.

First, the labor cost dispersion in past 45 years has halved for EU-15 countries (σ-convergence). Dispersion for EU-core after reaching its minimum (with respect to EU-15 average) in the early 1970's has remained low and remarkably constant. Even though it still retains a positive gap to EU-15, the range has been gradually decreasing.

Second, for individual time series convergence of relative labor costs has been found for majority of countries. Our sample countries can be divided on those converging from above (Fr, Lux, Ca, Aus) and from below (Ir, Por, Kor, Jap, Sp) which catch-up with EU average. Absolute convergence applies for USA, UK, Swe, Jap and It. The average half-life for EU-15 is around 6 years.

Third, the range of relative labor costs was stretched between 30-160% of EU-15 average in 1960 and between 50-130% in 2006. By the means of Augmented Dickey Fuller test we estimated long-run steady state to which labor costs converge. The estimated range is expected to further narrow to about 75-115% of EU-15 average.

Fourth, panel data analysis has shown that as a group both EU-15+6 and EU-15 countries do converge. Yet as a subgroup, EU-core does not converge to the mean absolutely, rather the evidence points to relative convergence. These countries retain a positive labor cost gap of 8 to 18 % (Ger, Fr, Neth, Bel) and Luxembourg 29%.

Fifth, Central and Eastern European countries show a strong tendency to catch up with their counterparts by sustained growth differential. With exception of Slovenia (52%) and Hungary (34%), relative labor costs in CEE countries are less than 1/3 of EU average in 2006. On average in the past decade, the growth differential vis-à-vis EU-15 has been 7.5 and 1.16 percentage points for convergence of relative and absolute differentials respectively.

Sixth, we argue that for another decade the Czech Republic and Hungary will enjoy an increasing absolute labor costs differential, Slovakia and Poland for approximately next 15 years. This time earmarks period to prepare for non-price (quality) based competitiveness. In addition to that, we also made some rough estimates of time needed for labor costs to level with EU average. Depending on scenario and on assumption of identical steady states, the average mean time for labor cost equalization for the Czech Republic, Slovakia, Poland and Hungary was found from 21 to 26.

VI. Conclusion

The labor cost convergence although very important topic for employees, employers as well as policy makers has been rarely studied empirically. We have tried to bridge this gap and focused on how labor costs have evolved in the past half a century.

In general, our findings are encouraging in favor of the labor cost convergence hypothesis, we can conclude that our sample countries face increasingly similar levels of relative labor costs. The results are reasonably well supported both by individual time series tests as well as panel unit root tests.

Certainly, our results are more convincing than those of Abraham (2000), which is perhaps most closely comparable in focus and scope of our study. Unfortunately, he does not provide either estimated speed of convergence, half lives or statement with respect to absolute or relative convergence hence we are missing the possibility for comparing results of our calculations. As contrasted to for example Davis (1992), who includes both developed and developing countries, relatively more significant results in our study can be also explained by the fact that we have focused on a group of 20 industrialized countries, all of which are OECD members. For these countries, identical cone of diversification does not have to be an unrealistic assumption.

Overall, our results support the idea that economic integration significantly contributes to decreasing differences in labor costs. However, interesting are the observations that in case of EU-core where convergence (as measured by labor costs dispersion) took place mainly up to 1970. Subsequent integration has not seemed to play a major role in further labor cost convergence. One explanation can be partly assignable to the fact that trade and integration has been taking place since 1952 when the European Coal and Steel Community has been introduced[52] and, shortly afterwards, followed by creation of European Economic Community. Then, it may be the case that the factor prices might had been affected by expectations of increasing trade and community integration even before the common market was opened. Then factor rewards would had converged relatively rapidly in the initial phases of integration leaving latter phases with less factor price convergence.

Countries of Central and Eastern Europe have been in the past decade converging relatively quickly as indicated by positive (and sustained) growth differential. It is questionable whether

[52] In fact, as mentioned by Veneables (1999), Benelux countries have set up custom union as early as 1947 and currency convertibility was established in 1958.

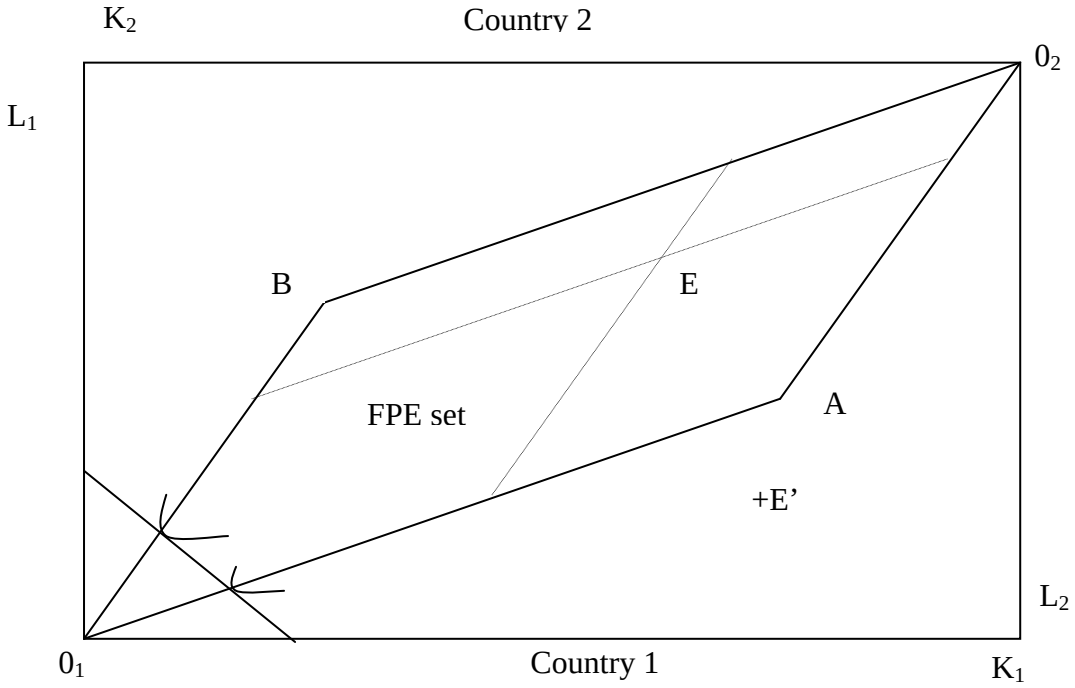
convergence could have been even faster. Gaspar (2001) suggests several factors of why convergence was relatively slow in transition countries (output lag, transformation slump). For sure, we can say that the growth differentials are higher than for EU-15 countries that converged from below in the past (Por, Sp) and comparable to differentials of South Korea.

The convergence of relative labor costs will continue for these countries; there are several factors that are likely to keep labor costs on sustainable growth path. First, in the short to medium run wage convergence is likely to be reinforced by nominal convergence as guided by the Maastricht criteria. This involves benefits of declining inflation, nominal exchange rate stability which may increase investments and output growth. Lower inflation allows more stable and less volatile real wage growth. Stable exchange rate decreases risk (beneficial for trade, investments into non-tradable sector). Second, labor costs convergence will be lead by positive productivity differential with respect to EU-15 (real convergence) based on high productivity growth in tradable sector. Real convergence increases room for non-inflationary wage increases, which presumably keeps inflation low, which in turn allows more stable real wage convergence. On the other hand, real appreciation should work in the opposite direction and restrain wage increases. Third, there is a potential for all CEE countries in closing negative residuum, which remains after controlling for the differences in real convergence given their levels of nominal convergence as proxied by labor costs per employee. Fourth, issue not discussed here but certainly relevant for labor cost convergence is the debate about labor taxation, tax wedge and tax competition. As the general tendency is to decrease the non-wage components of labor costs, lower labor taxation will contribute to convergence especially in currently high labor costs countries (convergence from above). Moreover, presence of multinational enterprises will likely to contribute to increasing wage level (wage, productivity spillovers etc.).

As far as Central and Eastern European countries concern, currently they base their competitiveness and comparative advantage on low labor and production costs in the first place. As the convergence proceeds, these countries will have to improve in terms of non-price (qualitative) competitiveness to compensate for higher labor costs. We estimated the absolute labor cost gap to reach its maximum in approximately 10 years for the Czech Republic and Hungary and decade and half for Slovakia and Poland.

Appendix A-FPE set

Figure Appendix A: Factor Price Equalization Set



As can be seen the parallelogram 0_1A0_2B marks the factor price equalization set for two countries. Lines 0_1A and 0_2B are results of optimizing production of labor-intensive and capital-intensive good. The point E is one of the possible integrated equilibriums, while the factor endowment E' does not lead to factor price equalization. The FPE set is constructed, other parameters equal, by looking for optimal combination of factor intensities for each sector (lines $A0_1$ and 0_1B) for which factors are fully employed. This is also done for Country 2 and intersection of both is a set of initial endowments for which trade equalizes factor rewards.

Appendix B-Wage Level

Table Appendix B: Regression Estimates for Price and Wage Level

Two following regressions were run

$$CPL_{C,2005} = \alpha + \beta GDP_{p.c.,PPS,2005} + u_i$$

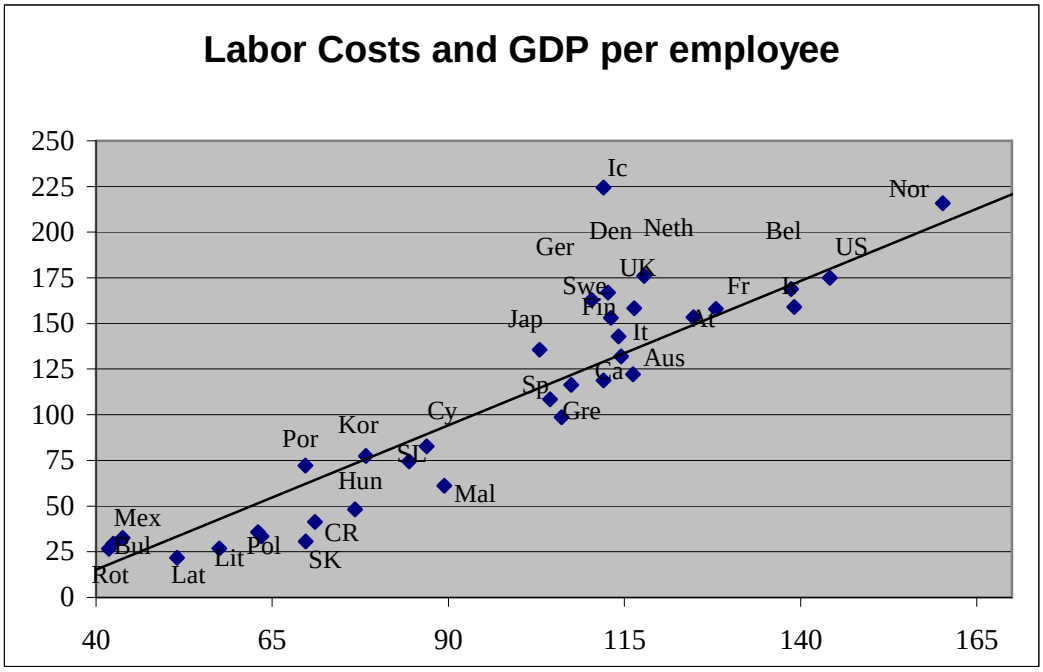
$$WageLevel_{C,2005} = \alpha + \beta GDP_{p.c.,PPS,2005} + u_i$$

All the variables normalized such as EU-25=100.

	Coefficient		Coefficient
CPL	0.82* (0.07)	**Wage Level**	1.98* (0.138)
Constant	13.67(7.26)	**Constant**	-85.49* (13.52)
Adj R-squ.	0.84	**Adj R-squ.**	0.90
number of obs.	24	**number of obs**	24

Note: White heteroscedasticity constistent estimates, * denotes significance at 1 percent level of significance, standard errors in parentheses.

Graph: Labor Cost Level (EU-25=100) and GDP PPS per employee



Source: Ameco, own calculations, variables given per employee in EU-25=100

Appendix C-Diploma Thesis Proposition

Thesis Title: Wages and Labor Costs in Europe-Is There a Convergence?
Author: Martin Kopecky
Thesis Supervisor: Ing. Michaela Erbenova, Ph.D.

In my diploma thesis I would like to explore development of wages and labor costs in European countries that were or still are attractive for foreign direct investment among others due to their relatively low labor costs.

In the first part I will focus on survey of theoretical contributions within the framework of wage dynamics, productivity and wage growth. The theoretical propositions from this part will be then assessed in the following empirical parts. Namely, we will turn attention to the wage development and wage convergence in European countries such as Spain, Portugal, Ireland as they are or were at the top of investor's agendas for FDI: The ultimate goal is to explore the effect on wage gap between these countries and more advanced ones with respect to labor arbitrage which we define as an ability to utilize less expensive labor to produce results with the same or better quality.

In the third part I would like to concentrate on the development of wages in Central Europe (Czech Republic, Poland, Hungary, Slovakia) as they are now in the center of attention of investors. I would like to take a closer look at the similarities and differences, determinants of the growth. Finally, my goal would be to focus on the outlook and prospects of wage growth in the relation to the wage arbitrage as a strong determinant of incoming investments.

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Figures, Tables, Graphs

List of Abreviations

ADF	Augmented Dickey Fuller Test
BS	Balassa-Samuelson Effect
CEE	CZ, SK, Pol, Hun, SL
EU-15	At, Bel, Fr, Sp, Port, Gre, It, Ger, UK, Fin, Swe, Den, Neth, Lux, Ir
EU-core	Ger, Bel, Fr, Neth, Lux

FPC	Factor Price Convergence
FPE	Factor Price Equalization
HOS	Heckscher-Ohlin-Samuelson Model
LLC	Levin-Lin-Chu test
LRR	Long-run relative
MW	Madala-Wu test
NMS	New Member States, 2004 enlargement (CZ, SK, Pol, Hun, SL, Est, Lit, Lat)
PPP	Purchasing Power Parity
ULC	Unit Labor Costs