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MT-DP – 2015/44

Economic convergence and structural change in the new member states of the European Union

Convergence in volumes, prices and the share of services,
with implications for wage convergence: an expenditure-side analysis

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Abstract

We analyze four interrelated aspects of economic convergence and their linkages over the period 1999-2013, drawing on the experiences of 26 member states of the European Union, with special focus on the ten Central and East-European new members (the EU10). These aspects are (1) real economic, (2) price level, (3) structural and (4) wage level convergence. Real economic and price level convergence, respectively, refer to the narrowing of the income (productivity) and the price level gap between the more and less affluent countries. Regarding structural convergence, we focus on the evolution of the share and the relative price of private and public services, measured from the expenditure side. As for wage convergence, we address the catching up of nominal and real labor costs, as well as net earnings of the poorer countries to the more developed ones. Our empirical analysis of convergence draws on both the cross-section and the dynamic relationships revealed by the data. Regarding real and price convergence, we show that there was a rapid catch-up in both per capita GDPs and general price levels of the less developed EU-countries until 2008, followed by a significant slow-down. We also show that there is a tendency for price levels to converge towards the trend implied by the longer-term relationship between real per capita GDPs and price levels. Our research affirms and amends the finding that positive/negative deviations from the trend ("over/undervaluations") have a negative/positive effect on real economic convergence. Relying on cross-country price level indices (PLIs), we demonstrate that the relative price of services does, but their "real" share (measured at common prices of the EU) does not increase along with real income. We show that this is mainly due to the fact that non-market services (in particular government transfers in kind) have a relatively high, though slowly declining real share in the less developed EU countries, which also helps us understand, why net real wages are relatively low in these countries (as compared to their relative level of income/productivity). We construct a model, which is consistent with developments in the EU10. Our findings relate to factors affecting real economic convergence, the ambiguous relationship between economic development and the change in the real share of services, to real exchange rate misalignments within the EU26, and reflect to the notion of "excessively low wages" in the EU10 countries.

Keywords: economic convergence, structural change, international comparison of productivity, prices and wages

JEL classification: E01, O11, 040, O47, O52, P27, J30

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Reálgazdasági, szerkezeti, ár- és bérfelzárkózás az Európai Unió közép- és kelet-európai tagországaiban

OBLATH GÁBOR - PALÓCZ ÉVA - POPPER DÁVID – VALENTINYI ÁKOS

Összefoglaló

A tanulmány a gazdasági felzárkózás (konvergencia) négyféle, egymással összefüggő vonatkozásával foglalkozik az EU-tagországok – elsősorban tíz közép-kelet-európai új tagország (az EU10) – 1999 és 2013 közötti időszakra vonatkozó tapasztalatai alapján. A konvergencia vizsgált metszetei a következők: (1) reálgazdasági, (2) árszint-, (3) szerkezeti és (4) bérszintfelzárkózás. A reálgazdasági és árfelzárkózást a fejlettebb tagországoktól való távolság mérséklődéseként értelmezzük, a szerkezeti felzárkózást tekintve pedig elsősorban a piaci, illetve az állami szolgáltatások részesedésének változásaira összpontosítunk az Eurostat (kiadásoldali) vásárlóerő-paritás adatbázisára támaszkodva. A bérfelzárkózást tekintve a nominális és a bruttó reálbérköltségek, valamint a nettó nominális és reálbérek alakulására egyaránt kitérünk, és rámutatunk: noha a bérköltségekben nem létezik, a nettó bérekben kimutatható a relatív termelékenységhez viszonyított kelet-európai bérlemaradás. Elemzésünk szerint 2008-ig mind a reálgazdasági, mind pedig az árfelzárkózás igen gyors volt az EU10-ben, ezek a folyamatok azonban a későbbi években lelassultak. A konvergenciára vonatkozó elemzésünk alapján, amely keresztmetszeti és idősoros adatokra egyaránt támaszkodik, bemutatjuk, hogy a relatív árszintek a relatív fejlettségi szintek által megszabott pálya felé tartanak, s a trendtől való, negatív, illetve pozitív eltérések (amelyeket a valuta alul, illetve túlértékeltségeként értelmezünk) pozitív, illetve negatív hatást gyakorolnak a reálgazdasági felzárkózásra. Az EU tagországira vonatkozó eredményeink megfelelnek egyes korábbi, a fejlődő országokra vonatkozó becsléseknek. Azt is bemutatjuk, hogy noha a szolgáltatások folyó áron mért részaránya a gazdasági fejlettség szintjével együtt emelkedik, ez döntően a szolgáltatások relatív árszint-emelkedésének a következménye. Ez utóbbi hatást kiszűrve – a relatív volumenváltozásokat tekintve – az EU10 országok felzárkózását az áruk szerkezeti térnyerése és a szolgáltatások szerepének mérséklődése kísérte. Ebben fontos szerepet játszott a nem piaci szolgáltatások, főleg a figyelmünk előterében álló természetbeni állami transzferek visszaszorulása, amelyek fajlagos volumene a vizsgált időszak elején kiemelkedően magas volt, ám a csökkenés ellenére viszonylag jelentős maradt az EU10-ben. Az erre a tényre támaszkodó statisztikai elemzésünk, illetve modellünk egyfajta magyarázatot ad az EU10-országcsoportnak a nettó bérekben mutatkozó lemaradására.

Tárgyszavak: gazdasági felzárkózás (konvergencia), szerkezeti átalakulás, termelékenységi, ár- és bérszintek nemzetközi összehasonlítása

JEL kód: E01, O11, 040, O47, O52, P27, J30

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Contents

1. Introduction

Our study departs from the observation that economic convergence – the catching up of less developed nations to the level of the more affluent ones – is not a universal feature of the world economy or any of its sub-regions. Convergence, where it occurred, proved to be a long-term and uneven phenomenon. However, there are some examples of relatively rapid convergence. One example is that of the present less developed member-states of the European Union (EU), in particular, the catching up of the former socialist East-European EU-members (the EU10), which joined the EU in the mid-2000s. Our study deals with a historically short episode involving the rapid convergence of these countries over the period 1999-2013, pointing out that in most of them a slow-down in convergence occurred after the international crisis of 2008-2009.

A further point of departure of our work is the observation that economic convergence is a highly complex phenomenon. While the major part of the related literature deals with real economic convergence (catching up in terms of per capita income and/or productivity), the former entails convergence in price levels as well. In addition, it involves structural changes regarding sectoral shares and relative prices, as well as convergence in nominal and real earnings (labor costs). Although there are other important aspects of economic convergence (e.g. catching up in the capital stock, or in the quality of institutions), we focus on the aforementioned four facets, namely: (1) real economic, (2) price level, (3) structural and (4) wage level convergence. Facets (2), (3) and (4) are related, directly or indirectly, to the level and changes in the real exchange rate, a focal issue of our study. In particular, we address the relationship between alternative interpretations/measures of real exchange rate misalignment and real economic convergence. We also aim to clarify the relationship between real economic convergence and the evolution of the nominal and real share of private and public services. International differences regarding the importance of public services, especially those in transfers in kind (compared to household income or consumption expenditures) are essential for understanding why the nominal and real wage gap between EU-member countries appears to be higher than warranted by differences in GDP per capita or GDP per hours worked.

Thus, the present study pursues two closely related goals. The first goal is description: how has real economic, price level, structural and wage convergence evolved over the period 1999-2013 in the EU10, with considering the EU15 (the "elder" member states) as a reference. In this context, we wish to clarify the quantitative relationships among different aspects of convergence. Relying on the experiences of the EU10, we also aim to find out whether the increase in the nominal share of services – an important "stylized fact"

characterizing real convergence – is a phenomenon mainly related to changes in relative prices or those in relative volumes. Separating market services from government services is crucial in addressing this question.

The other goal of the study relates to policy issues. Our results offer tentative indications regarding real exchange rate misalignments (and changes therein) in member states of the EU – in particular, the EU10 countries – based on alternative interpretations and measures of over/undervaluation. More generally, we intend to clarify: which are the constellations of the different aspects of economic convergence that have turned out to be more/less conducive for *real* economic convergence. The notion of "too low" earnings in the EU10, as well as the idea of a "large scope for wage-increases" in these countries, is addressed and interpreted in this context.

Our quantitative analyses – including those concerning the nominal share, the relative price and per capita volume of services – rely on expenditure-side data from the purchasing power parity (PPP) dataset of the Eurostat. (This is important, because the share of services in GDP, as measured by expenditures is lower, than if calculated from the production side.) The substantive and technical reasons for using PPP-based indicators from the expenditure, rather than the production side of GDP are explained later, when discussing the statistical sources of the analysis. Depending on the type of questions addressed, our analysis uses data based on both current and constant PPPs.

The rest of our study is organized as follows. Section 2 addresses the main questions and concepts of the study, offers a selective review of the related literature, presents the statistical counterparts of the economic concepts underlying, as well as the stylized facts motivating, our analysis. In section 3 we first present the results of our statistical analysis on the relationship between real economic and price level convergence, quantify exchange rate misalignments and estimate the effect of the latter on comparative growth rates in the EU. This is followed by analyses regarding the level of, and changes in, wages (labor costs and net earnings) as compared to labor productivity. Our model, designed for explaining the observed differences between the EU16 and the EU 10 is presented in the Appendix. In section 4 we summarize the main results.

As our study covers issues relevant from the perspective of public/political discussions, it aims to serve educational purposes as well. In particular, questions regarding the relationship of wage convergence with price and real economic convergence have been subjects of heated debates. These topics tend to attract the attention of both populist politicians and economists willing to support the public perception that "wages are too low" in the EU10 (as compared to prices and productivity in these countries.) We shall demonstrate that these perceptions are based on inappropriate international comparisons. However, since a part of our targeted audience is unfamiliar with the concepts and terminology of international comparisons, in

the next section we address some of the basic conceptual/statistical questions related to our analyses.

2. Real economic, price level, structural and wage convergence: concepts, issues and an overview of the statistical evidence

In the following, we outline the main motivations, questions, concepts and sources of the study, clarify the relationship between our topics, formulate our hypotheses, briefly review the related literature and present a statistical overview of four aspects of economic convergence within the EU.

2.1. MOTIVATIONS, QUESTIONS, HYPOTHESES AND A SELECTIVE REVIEW OF THE LITERATURE

Our study addresses developments related to economic convergence in 26 member countries of the EU[1], focusing on ten new, formerly socialist, members of the Union (the EU10[2]). The period covered is 1999-2013, as our most important statistical source, the Eurostat PPP database, provides detailed data on the EU10 for these 15 years. Using a panel consisting of annual data on the EU26 countries, we address the evolution of real economic, price, structural and wage convergence on the one hand, and their possible interactions on the other.

There are two main motivations of our study. The empirical one is that while the EU10, as a group, displayed rapid real convergence to the level of the EU15 (the average of the "elder", more developed members of the EU) over the last two decades, there are also significant differences among the EU10 countries in this respect. The catching up process turned out to be more successful in some countries, while less successful in others. What are the possible explanations? This leads to our other motivation: we consider economic convergence to be a multidimensional process, consisting not only in catching up in terms of GDP per capita or in GDP per hours worked. The former relates to convergence in output per capita, while the latter to that in productivity. These two entail (are accompanied by) convergence in price levels, changes in relative prices and sectoral shares, as well as catching up in real and nominal wages. The differences in growth performances among the EU10 raise the question:

[1] We do not include Luxembourg in our empirical analyses and Croatia is included occasionally. Luxembourg is left out because its small size is associated with extremely outlying data, while several important time series on Croatia are incomplete or unavailable.

[2] The 10 countries are the following: Bulgaria (BG), the Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Poland (PL), Romania (RO), Slovakia (SK) and Slovenia (SI). Cyprus and Malta, though also relatively new members, do not belong to this group of countries.

what particular constellation of these aspects – controlling for other factors – have turned out to be more (less) conducive for real convergence.

A further motivation is trying to understand the changing role of services in the EU10. It is a well-established stylized fact that real economic convergence involves the increase in the macroeconomic role of services. This is certainly true regarding the sectors' share in employment and the increase in the relative price of this sector. However, does this also hold for the "*real share"* of services?[3] Alternatively, and perhaps statistically more precisely, we may also ask whether convergence in terms of per capita real GDP involved a slower or faster catching up in per capita expenditures on services than on goods. When addressing this issue, it will be essential to differentiate between private and public services, as PPP-based comparisons indicate that the per capita volume of public services has been relatively high in the EU10 countries (as compared to the level of their per capita GDP). Thus, the questions to be discussed in this context concern the "initial" nominal share, relative price and volume of public and private services on the one hand, and their evolution over time in relation to real economic convergence, on the other.

Finally, some widely held notions regarding nominal and real wages in the EU10 also motivate our work. In both the countries concerned and abroad, there is a sense – mostly expressed in political slogans and popular writings, rather than in professional articles – that wages (labor costs) are unreasonably low in the EU10. Relying on various measures of earnings and labor costs, we shall try to clarify whether or not this is the case. As to be shown, the answer to the question is closely related to the previous point on the relatively high per capita volume (real share, or relative real ratio) of public services in the EU10.

2.1.2 Main hypotheses

Our main hypotheses with respect to the three broad topics of our study are the following:

Regarding *macroeconomic real and price convergence*

- Drawing on the observation that, in international comparison, there is a long-term, close positive relationship between relative price and relative income (productivity) levels, deviations from the long-term relationship can be interpreted as indications of currency-misalignments.

[3] As explained later, by the "real share" of a sector we refer to its share measured at international (in our case: average EU) prices: thus, "real shares" are nominal shares, corrected for cross-country differences in relative prices. Since the concept may be subject to criticisms, we shall also rely on a corresponding, perhaps less controversial, indicator: the relative "real ratio" (RR) of the per capita volume of an expenditure category to the per capita volume of GDP (both compared to the EU15 average).

- While misalignments tend to decrease over time, their (positive/negative) sign may be persistent, with an effect on real economic developments.
- In particular, currency misalignments, as interpreted above, may either contribute to, or hinder the real economic convergence of countries within the EU. While undervaluation may assist, overvaluation is expected to impede real economic convergence (relative growth). This hypothesis has been tested for developing countries, but has only tentatively been addressed with respect to EU-member-states.[4] We have no prior assumptions regarding the possible asymmetry between effects of under/overvaluations. Moreover, we consider this as a partial effect, reinforced or mitigated by other factors contributing to economic growth, extensively discussed in the literature.

As for *structural convergence,* our hypotheses – related to levels/changes in the EU10 vs. the EU16 – rely on casual observation of the data, to be verified by more rigorous analyses.

Levels (based on observations between 1999 and 2013):

- The *price level* of services has been relatively low, while the price level of goods has been relatively high in the EU10 as compared to the price level of GDP.
- The per capita *real expenditures* on services have been relatively high, while those on goods relatively low in the EU10.
- In particular, the per capita volume of *government services* (especially government individual services) has been relatively high (as compared to relative per capita income) in the EU10 countries. (This was the case in 1999, it is still likely to hold in 2013, although to a lesser extent.)

Changes during the period observed**:**

- Macroeconomic convergence has mainly been accompanied *by the price level* convergence of *services*. There has been much less convergence regarding the per capita *volume* of services.
- In contrast, the per capita *real (volume) convergence in terms of goods has been steeper*, *while the price convergence of the latter expenditure category has been slower*, as compared to services. (This is expected to hold more for *total services* – which includes government services – vs. goods, and less for consumer services vs. consumer goods.)

With respect to *wage convergence,* it is important to make a clear distinction between *net wages* and *gross wage costs* (compensation of employees). Our hypotheses are the following:

- Relative *gross wage costs* in the EU10 have been roughly in line with relative labor productivities.

[4] Regarding developing countries, see e.g., Rodrik (2008), Berg – Miao (2009), Bhalla (2014) and further references in section 2.1.3. For the EU, see Podkaminer (2010) and Oblath - Szörfi (2008).

- Relative net wages in 2007 – the only year for which we have data for all of the EU26 countries – appear to be unreasonably low in the EU10, as compared with their level of labor productivity.
- However, considering the relative importance of individual government services (transfers in kind to households) within household consumption, net wages may be in par with the relative level of productivity of the EU10.
- To test for endogeneity between net wages and individual government services, we compare net wages with both collective (police, army, bureaucracy etc.) and individual government services. We expect that, in cross-section comparison, net real wages are not significantly related to the share of collective government services, while they have a significant negative relationship with the real share of individual government services.

2.1.3. A selective review of the literature

There is a huge literature on two of our topics: the relationship between real economic and (1) price level convergence, (2) structural convergence. Our third topic, the relationship between real economic and wage convergence, and in particular the latter's relation with structural convergence, has been addressed by a much smaller number of *professional* articles, which is surprising in view of the heated popular debates surrounding the issue. We aim to contribute to all of the three topics, but we consider our main contribution in connecting the diverse stings, focusing on the EU, particularly on the converging member states, i.e., the EU10.

In the following we present a selective review of writings on the relationship between real economic and price level convergence and continue with the literature on structural convergence (in terms of relative prices and volumes). We return to the literature on some of the themes in further sections, including the idea of "disproportionally low wages" in Eastern Europe.

Real economic and price level convergence and their interactions (RER misalignment and economic growth)

In cross-section comparisons, levels of per capita GDP (measured at purchasing power parity, PPP) and their price levels show a significant positive relationship. However, this does not necessarily hold for their dynamics. (Recent studies of this issue are summarized in Devreaux (2014); we return to some further related contributions in section 2.2.2., when discussing the "Penn effect") In the long run, the price level of GDP converges to the trend determined by

the level of development, but in the short run, its change is likely to be affected by its misalignment – that is, by the magnitude and direction of its distance from the long-run trend. Thus, the year-over-year GDP growth does not necessarily induce a similar change in its price level (interpreted as the real exchange rate, RER). The question is whether there is an opposite relationship: does the RER misalignment affect the dynamics of the GDP per capita?

Numerous studies have already examined this effect. Although there are differences in many aspects among the empirical estimations of this relationship, the conclusions are quite similar. The results suggest that an overvalued RER involves lower GDP growth, while an undervalued RER enhances it. Nonetheless, some authors doubt that this relationship can be efficiently used for policy purposes. Moreover, the relevance of this empirical finding heavily relies on the econometric method applied, the sample of countries, the time period and other underlying economic conditions and assumptions.

First of all, what strongly influences the results is the calculation of the RER misalignment. It was Balassa (1964) who first adjusted the RER using its positive relationship with the level of GDP. He defined misalignment as the deviation of the RER from its value predicted by the level of income. We use a similar framework for our estimations. As a consequence of this method, the misalignment depends on the assumed functional form between RER and GDP per capita. Balassa (1964) used a simple linear functional form, but there were studies using log-log form (see for example Rogoff, 1996 or Rodrik, 2008), quadratic form (see for example Dollar, 1992 or Easterly, 2001) while Bhalla (2012) estimated an "S-shaped" exponential model. For different samples of countries different functional forms may be appropriate, therefore it is crucial to choose the best fitting model for the estimation of misalignment.

The results are also sensitive to the chosen econometric method. Some authors estimated the misalignment using cross-sectional data for each year (see for example Johnson, Ostry, & Subramanian, 2007), while others applied advanced panel techniques (see for example Prasad, Rajan, & Subramanian, 2007, Rodrik, 2008, or MacDonald – Vieira, 2010). The conceptual difference between cross-sectional and panel estimations is whether one believes that the GDP per capita and its price level have a time-invariant stable relationship or it may change over time.

In addition, there are authors who disagree that the "equilibrium RER" is only the function of the level of development; they suggest the inclusion of other variables in the RER equation for the estimation of its misalignment. For example Aguirre and Calderon (2005) controlled for differences in terms of trade index, labor productivity and government spending in their equilibrium RER equation. Depending on the included control variables, the estimation technique and the underlying assumptions and simplifications of many

different concepts have been established for the equilibrium RER estimation (for more details on this point, see Isard, 2007 and Berg –Miao, 2009).

As a consequence of these different approaches the estimated RER-income elasticities vary widely. Depending on the theoretical assumptions and the used econometric method one can estimate different level of RER misalignment even for the same country in the same year. However, defining RER misalignment is only the first stage of the estimation, since the main question is its effect on economic growth. Depending on the chosen econometric method, sample of countries and time period, one can find various estimates for this in effect in the literature.

One of the most profound works about this effect is by Bhalla (2012). He carried out the estimations on a sample of 130 countries between 1950 and 2011. His results clearly support the hypothesis that misalignment has a significant negative effect on real economic growth, which means that undervaluation boosts GDP per capita growth, while overvaluation impedes it. This effect proved to be very robust in his estimations, regardless of the chosen econometric method or the sample selection.

Rodrik (2008) and MacDonald – Vieira (2010) also used a large sample of countries for the estimation and arrived at similar results as Bhalla (2012), who, in addition, examined whether the effect varies across countries at different levels of development. He found that the negative relationship between misalignment and growth is much stronger for less developed countries than for more affluent ones. This finding suggests that in the catching-up of developing countries the undervaluation of the RER might be an important factor.

Although Rodrik's (2008) and Bhalla's (2012) large sample estimations clearly support the growth-boosting effect of undervaluation, it is not evident whether this relationship can be used for policy formation as well. To answer this question one needs to know the proper mechanism how RER misalignment affects GDP growth. Rodrik (2008) outlined a possible channel that may be responsible for this effect. He argued that bad institutions and market failures have a much stronger impact on the tradable sector than on nontradables. Since in developing countries these problems are probably more serious, suboptimal amount of resources will be used in the tradable sector. RER undervaluation makes the production of tradables more profitable, thus it pushes the economy closer to the optimal level of production. He empirically tested this hypothesis and found that the effect of RER misalignment on growth proved to be larger for economies with bad institutions.

Podkaminer (2010) reviewing developments in the EU, emphasized that the short-time dynamics of GDP per capita and its price level often contradict the relationship presented so far. Therefore this econometrically supported relationship cannot be used for policy making

purposes in general. The real process through which RER undervaluation affects real GDP growth strongly depends on country-specific factors.

It is also not evident to what extent policy makers can influence the real exchange rate. Bhalla (2012) pointed out that even if it can be theoretically established that the RER is an endogenous variable, looking at the economic history of fast-growing countries, one can usually find RER undervaluation during the catching-up process. This phenomenon contradicts the notion that the real exchange rate cannot be influenced by economic policy.

We should note that as yet very few studies addressed the issue of exchange rate misalignment on economic growth with respect to the EU-member states. Oblath-Szörfi (2008) made an early attempt, followed by Podkaminer (2010), but we are not aware of further contributions to this theme, regarding EU-countries.

Structural convergence with an emphasis on the role of services

Several indicators demonstrate the growing importance of services in advanced economies. According to standard statistics (based on current prices and exchange rates), the share of services is generally higher in countries at a higher level of economic development than in less developed ones. Several theoretical attempts have been made to explain why the share of services grows with economic development. Most explanations focus at the *production* side of GDP; these emphasize the difference in the scope for increasing productivity between sectors producing goods on the one hand, and services, on the other. The main argument is that labour productivity grows at a higher rate in manufacturing than in services, which leads to a relocation of labour from manufacturing towards the service sector (Fourastie, 1934, Fuchs, 1969, Baumol, 1967). While productivity-differences may shed light on why the share of services increases in total employment, they have no direct implication for the changes in *output shares*. The latter issue is taken up by the approach focusing at services "embedded" in goods: this calls attention to the fact that, in advanced economies, all sectors that produce goods increasingly rely on both business and trade services (Gadrey and Gallouj, 1998; Podkaminer, 2010a). There is an additional argument, emphasizing the role of *outsourcing* of service functions from goods producing activities: this also contributes to the growing share of service in production (Kox and Rubalcaba, 2007)

The other set of explanations *depart* from the *expenditure* (demand) side of GDP. These emphasize the growing *demand* for services accompanying the increasing income of households. At higher levels of income, people can spend more on services, after having covered their demand for goods, which implies that the income elasticity of expenditures on services is higher than that on goods (Fischer 1935, Clark, 1940), Gershuny and Miles, 1983; for a recent demand-side approach, see Buera–Kaboski, 2009). Until recently, the growing

size of public services in welfare states, enabled by increasing government revenues, had also contributed to the expansion of services (and their increasing share in GDP) in advanced economies (OECD, 2000).

In the recent economic literature, however, both types of arguments were critically examined. Eichengreen and Gupta (2009) demonstrated that the relationship between the share of services and the level of income is far from linear: it increases more rapidly at both relatively low and relatively high income levels; and grows more modestly, if at all, in between. In addition, several studies called attention to the *heterogeneity* of services regarding changes in productivity (Barras, 1986, Baumol, 1967 and 1984; and, in a general review, Jorgenson and Timmer, 2011). But the notion of the higher income elasticity of *expenditures* on services has already been surrounded by doubts. Fuchs (1968) found that the income elasticity of goods was 0.97 and that of personal services 1.12, measured at current prices over the period 1938-58 in the US.

However, the work of Herrendorf, Rogerson and Valentinyi (2013) suggests that the relationship between structural change and income elasticities is more complex than previously thought. They use long time series, 1947-2010, for the U.S., and they find that income elasticities are important to explain structural change in expenditure shares between goods and services. However, they also find that income elasticities are not important to explain structural change in value added shares between goods and services. In this case they find that relative price movements are the dominant force behind structural change. In a complimentary paper, Herrendorf. Herrington and Valentinyi (2015) analyse empirically the supply side of the U.S. economy over the same period, and find that differential TFP growth is the key technological difference between sectors. Hence relative price effects and not income elasticities must be the primary source of structural change in value added, and consequently, employment shares.

Summers (1985), relying on *international* comparisons, showed that while there was a positive relation between per-capita *real* income and the *nominal* share of services in GDP, if these shares are expressed at comparable (international) prices, the relationship disappears. The reason was that the positive association between real incomes and the *nominal* share of services reflected a much closer positive relationship with relative *prices*, than with relative *volumes*. We consider our analysis as a follow-up of Summers' study, as applied for the EU-countries. Regarding structural convergence, we also focus on expenditures on (the demand for) services in the EU10, as compared to older members (EU16) in the period 1999-2013. The ten, former socialist, countries typically have lower per capita GDP than old members, so

they represent a suitable field for examining the comparative role of services (and its change over time) in countries at different levels of economic development.[5]

2.2. MAIN CONCEPTS AND A REVIEW OF THE STATISTICAL EVIDENCE

In what follows, we define and illustrate the main concepts of the study. We begin with explaining the statistical categories and continue with the interpretation/illustration of real economic and price level convergence. Next, we discuss the concept of nominal and real share of particular sectors, as well as that of "external" and "internal" relative prices. The third set of concepts to be clarified and illustrated concern nominal and real labor costs, as well as nominal/real net earnings in cross country comparisons. All statistical illustrations relate to the EU26 and the EU10.

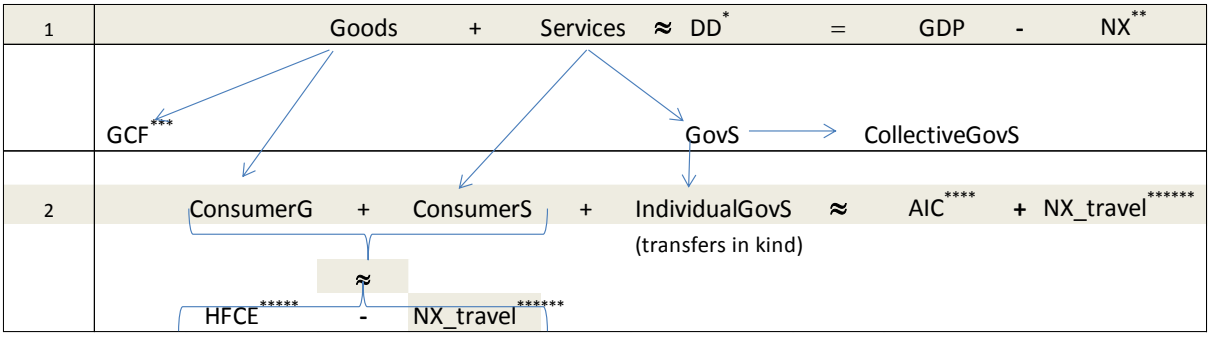
2.2.1. Statistical concepts and relationships

Analytical concepts and the SNA

Our quantitative analyses rely on expenditure-side categories of the Eurostat/OECD PPP-database, designed for international comparisons. These include items such as "goods" and "services" (the latter including "consumer" and "government" services, broken down into "collective" and "individual" services.) Table 2.1 shows the correspondence between these categories and those of the SNA (system of national accounts).

Table 2.1

The relationship between categories of the PPP database and SNA aggregates



Notations: *domestic demand; **net exports of goods and services; ***gross capital formation; ****actual individual consumption; ***** household final consumption expenditure;******net revenues from tourism
Source: our own reconstruction of the relations presented in the Purchasing Power Parity (PPP) manual (Eurostat-OECD, 2012)[6]

[5] Gács (2003) analysed structural changes accompanying convergence in this group of countries from the production side, reviewing developments during the first decade of transformation. He found clear evidence of the "emancipation" of services in the EE10, based on changes measured at current prices (see also Oblath-Richter, 2002; their study showed similar results.)

At the highest level of aggregation (row 1), the sum of total goods and total services is *expected to be* (but actually, only approximately *is*) equal total domestic demand, which, by definition, is equal to GDP minus net exports of goods and services. (The "≈" sign in the table indicates a conceptual correspondence, which does not necessarily hold exactly in practice, while "=" refers to an accounting identity.[7]) *Goods* are broken down into those used for gross capital formation (GCF) on the one hand, and the ones used for private consumption ("consumer goods"), on the other. Total *services*, in turn, consist of consumer (private) and government services. The latter includes *collective* services (e.g., expenditures on defense, police, central and local government) and individual services (e.g., health, education and family care).[8]

At the next level (row 2) we can see that the sum of *consumer* goods and services plus *individual* government services corresponds to *actual* individual (i.e., household) consumption, corrected for net exports related to travel.[9] Consumer goods and services together add up to household consumption *expenditure*, *less* net exports of travel (revenues from tourism).[10] Thus, actual individual consumption (AIC) is a measure of household's total consumption of goods and services. Household final consumption expenditure (HFCE), in turn, indicates households' total spending. For the purposes of international comparisons AIC is the concept more closely corresponding to "well-being", since there are significant differences among countries regarding the relative importance of household expenditures vs. services provided by the government.

Cross-country comparisons of levels and "structures": relative prices and quantities

We now turn to *concepts* necessary *for cross-country comparisons of prices and volumes*. One of the principal objectives of international comparisons is quantifying differences in

[6] http://www.oecd.org/std/prices-ppp/eurostat-oecdmethodologicalmanualonpurchasingpowerparitiesppps.htm

[7] Note that an accounting identity can hold exactly in actual statistical data only if: (1) there is an item explicitly revealing the statistical discrepancy; (2) it is included in a particular item (on the expenditure side of GDP, this used to be the change in inventories); (3) the statistical discrepancy is eliminated by "spreading" it among the components of the identity. As a matter of fact, the accounting identity that GDP = domestic demand +net exports holds exactly for the data in the PPP database of the OECD (benchmark results for 2011). However, the relationship that goods + services = domestic demand does not hold for most countries; in some of them there are large discrepancies.

[8] The concept of collective and individual government services, respectively, match the SNA categories of collective and private final consumption of the government.

[9] The respective category in the PPP database is "net purchases abroad" (by households), which is the inverse of net exports related to tourism/travel.

[10] The SNA considers "non-profit institutions serving households" (NPISH) as a separate sector, however, the PPP database includes the expenditures of NPISH into household consumption expenditures.

volumes across countries. This, just as in the case of comparisons over time in individual countries, requires adequate price indices. Purchasing power parities (PPPs) are the relevant price indices for cross-country volume-comparisons, developed over several rounds of the International Comparison Program (ICP).[11] There are three main (on-line) sources for PPPs and PPP-based volume comparisons: the Penn World Tables[12], the OECD[13] and the Eurostat[14]. As mentioned, we chiefly rely on the Eurostat-data, but below we also refer to the 2011-benchmark results in the OECD database.

Price and volume level indices. To motivate the need for, and the uses of, PPPs, we depart from a nominal comparison. Let N_i denote the nominal value (in *domestic* currency) of the i-th component of GDP (i may refer to categories like final consumption, gross capital formation, net exports and their sub-components, or goods and services and their sub-components.) Let N_i^* denote the nominal value (in foreign currency) of the same component of GDP in a reference country (or a region, like the EU-average). The *relative* nominal value of category i in the home country as compared to the reference country is simply $(N_i/E)/N_i^*$, where E is the exchange rate (units of home currency per a unit of the reference currency). For the purposes of international comparisons it is useful to scale the values by population-size, so the relative nominal value per head of item i, referred to as the per capita *nominal level index* with respect to the reference country is $NLIc_i = [(N_i/pop)/E]/(N_i^*/pop^*)$, where *pop* denotes population size.

The problem with $NLIc_i$ is that it expresses the combined effect of two distinct factors: the difference in volume per head on the one hand, and the difference in price levels between the home and the reference country, on the other.

$$NLIc_i = \frac{P_i V_i / pop}{E} \div \frac{(P_i^* V_i^*)}{pop^*}$$

where P_i and V_i, respectively, denote the price and the volume of item i. In order to decompose NLI_i into a relative price and a relative volume component, a spatial price index, i.e., purchasing power parity (PPP) is necessary. Thus

$$PPP_i = P_i/P_i^*$$

is the *purchasing power parity* for item i, where P and P^*, respectively, indicate the domestic price (expressed in domestic currency) and the foreign price (in foreign currency). The ratio

[11] See e.g., the World Bank on the ICP:
http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/ICPEXT/0,,contentMDK:20118237~menuPK:62002075~pagePK:60002244~piPK:62002388~theSitePK:270065,00.html
[12] http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1
[13] http://stats.oecd.org/Index.aspx
[14] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=prc_ppp_ind&lang=en

of PPP_i to the exchange rate is the *price level index of item i* with respect to the reference country/region[15]:

$$PLI_i = PPP_i/E.$$

Both PPP_i and PLI_i can be used for calculating the per capita *volume level index* (*VLIc*) of *item i* with respect to the reference country/region:

$$VLIc_i = \frac{N_i/pop}{PPP_i} \div \frac{N_i^*}{pop^*} = \frac{NLIc_i}{PLI_i}$$

The comparison of the formulae for NLI and VLI reveals that the difference between "nominal" and "real" cross-country comparisons is not simply in whether the exchange rate or PPPs (PLIs) are used as deflators for comparing magnitudes between countries. It is equally important that while the exchange rate is a common deflator for all items, there is no such thing as "the" purchasing power parity. Each (*i*-th) component of GDP has its own PPP; and the purchasing power parity for GDP, PPP_{gdp}, is obtained as a weighted average of its components.[16]

PPPs (or PLIs) may be used for various purposes, but we apply them for two types of international comparisons. The one discussed above concerns the external (or direct) comparison of the price level (*PLI*) and the per capita volume level (*VLIc*) of particular aggregates (e.g., GDP, private consumption, expenditures on goods, services etc.) in one country relative to others. The other type, addressed in the next subsection, relates to the comparison of domestic *relative* magnitudes between countries *at common international prices*. (We refer to the latter as "internal" or indirect international comparisons). To demonstrate the necessity of latter type of comparisons, we offer three examples in Figure 2.1. of simple external comparisons, drawing on the pooled cross-section data of the EU26 countries over the period 1999-2013, with the EU15 as the reference region (the weighted average of the EU15 = 100).

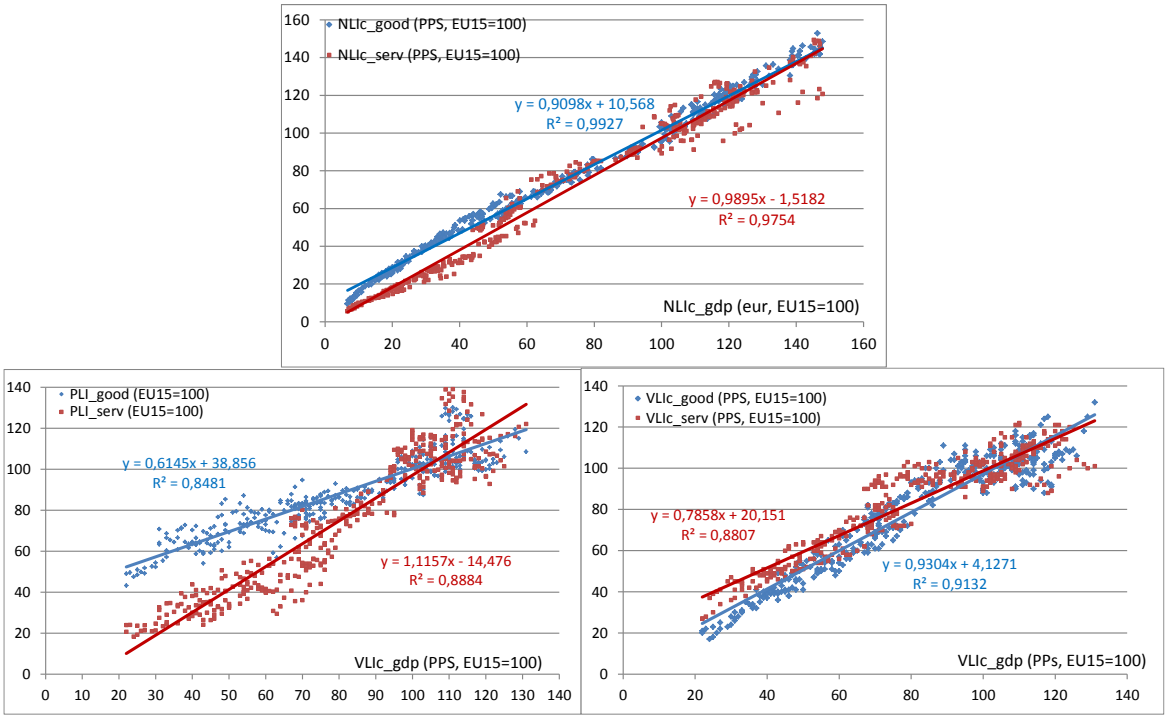
[15] In the Penn World Tables the US is the reference *country*, in the OECD – Eurostat comparisons alternative reference regions are offered (the average of the OECD, EU28, EU27 and EU15). The Eurostat uses a special PPP, the *PPS* (purchasing power parity standard). PPS is defined so that 1 PPS has the same purchasing power as 1 euro with respect to the EU average. (The average price level of the EU is the same, whether measured in euro or PPS.)

[16] Alternative methods of aggregation, as well as the actual practice of the Eurostat-OECD are discussed in the PPP-manual (Eurostat – OECD, 2012, pp 235-247). The manual suggests the application of so-called EKS (Éltető – Köves – Sultz) PPPs for comparing levels, and G-K (Geary – Khamis) PPPs for comparing structures (the two rely on different methods of aggregation). However, G-K PPPs had been published only for benchmark years (every third year), and regarding the last available benchmark year(at the time of writing our study) 2011, G-K PPPs have not been released. We therefore, tentatively, rely on EKS PPPs for comparing structures as well. In 2008, the last year for which both type of PPPs are available, the differences between the two were not significant.

The upper pane of the figure shows per capita nominal expenditures (in euros) on goods and services in relation to per capita nominal GDP (in euros). The lower left pane shows the external *relative price* of goods and services, while the right pane displays the *per capita volume* of goods and services as a function of real (PPP-denominated) per capita GDP.

Figure 2.1

Nominal per capita level indices for goods and services in relation to the nominal level index of per capita GDP (upper pane); the price level index (lower pane, lhs.) and the volume level index of per capita expenditures on goods and services (lower pane, rhs.) vs. the volume level index of per capita GDP in the EU26. (1999 -2013; EU15=100)



Source: Eurostat PPP-database

Nominal comparisons (see the upper pane) suggest that (i) at lower levels of per capita GDP, expenditures on goods tend to be higher than on services; and (ii) there is no substantial difference between the slope of the regression lines of goods and services. However, the lower panes of the figure indicate that this results from the fact that the relative price of services is significantly lower at lower levels of development (left side). When controlling for differences in external relative prices (right pane), it turns out that at low real per capita GDP levels per capita real expenditures on services tend to be higher than real expenditures on goods. In addition, the slope of the regression line regarding real expenditure on goods is steeper than that of services.

These phenomena call for an explicit discussion of the internal relationships indicated by external price and volume comparisons.

Structures: comparison of internal relative prices and volumes across countries. An alternative use of PPPs (PLIs) is related to the cross-county comparison of *domestic* relative magnitudes (e.g., the share of expenditures on services, or the ratio of expenditures on services to those on goods.) We illustrate the use of PPPs (or PLIs) for this purpose by comparing the ratio of expenditures on services to GDP between Austria and Hungary in 2011 (the latest benchmark year of Eurostat-OECD PPP comparisons).[17]

Table 2

The nominal vs. "real" share and the nominal vs. real "internal" ratio of services to GDP in Austria and Hungary in 2011: an illustration of the analytical concepts

		Austria	Hungary	HU/AT
1	NS_serv/GDP (%)	49.6	46	0.93
2	PLI_gdp (EU28=100)	110	59	0.54
3	PLI_serv (EU28=100)	114	45	0.39
4 [(3/2)]	IRP_serv/GDP	1.04	0.76	0.74
5 [(1/4)]	RS_Services/GDP (%)	48	60.3	1.26
6	GDP/pop (eur, EU28=100)	142	40	0.28
7	Services /pop (eur, U28=100)	134	35	0.26
8 [7/6]	NR_serv/GDP	0.94	0.88	0.93
9 [100*6/2]	GDP/pop(PPP, EU28=100)	129	68	0.53
10 [100*7/3]	Services/pop (PPP, U28=100)	118	78	0.66
11 [10/9]	RR_serv/GDP	0.91	1.15	1.26

Notations: *NS*: nominal share; *PLI*: price level index; *IRP*: internal relative price; *RS*: "real" share; *NR*: nominal ratio; *RR*: real ratio.
Source: calculations based on OECD dataset, 2011 PPP Benchmark results. http://stats.oecd.org/index.aspx

Rows 1-5 show comparisons based on shares; rows 6-11 display results of comparisons relying on ratios; we begin by discussing shares. Measured at each country's *domestic prices*, the ratio of expenditures on services to GDP (the *nominal share*) was 49.6% in Austria and 46% in Hungary (see row 1 in Table 2). However, by simple observation of these nominal proportions, we cannot state that the "real importance" of services was higher in Austria. The reason is that the difference between nominal shares is the product of differences in the *internal* relative *price* of services (the price level of services relative to the price level of GDP) and in *internal* relative *volumes*. By applying PPPs, the effect of cross-country variations in internal relative prices can be adjusted for. In our example, as compared to the average of the

[17] We temporarily set aside that the PPPs (PLIs) to be applied are calculated by the EKS-method (see the previous footnote), meant for the cross country comparison of individual items rather than for comparing shares in GDP, but we return to this point.

EU, the (external) price level of GDP was at 110% in Austria, and stood at 59% in Hungary (row 2). The (external) price level of services relative to the EU-average, in turn, was at 114% in Austria and 45% in Hungary (row 3). Thus, the *internal relative price* of services (as compared to the price level of GDP) was 1.04 in Austria and 0.76 in Hungary (row 4). By correcting the nominal shares by internal relative prices, we get the "*real share"* of services (measured at average EU-prices): it was close to its nominal share in Austria (48%), but considerably higher (60.3%) in Hungary (row 5). To sum up: the nominal comparison suggests that the share of services was higher in Austria than in Hungary, but the one based on PPPs reveals that in "real terms" (i.e., measured at EU-prices) the case was just the opposite (see the ratio of the two country's respective indicators in the last column of Table 2).

More formally, the *nominal share* of item *i* (e.g., goods, services etc.) in GDP is:

$$NS_i=N_i/N_{gdp},$$

where N_i represents the nominal value of item *i,* and N_{gdp} is the nominal value of GDP expressed at domestic prices.

The *internal relative price* of item *i* with respect to the price level of GDP (measured at average EU prices) is:

$$IRP_{i/gdp}= PPP_i/PPP_{gdp}\ (=PLI_i/PLI_{gdp})$$

where *PPP* and *PLI*, respectively, denote the purchasing power parity and the (external) price level index of the respective items, all measured relative to the EU average.

The "*real share"* of item *i* in GDP (i.e., the share measured at average EU prices) is

$$RS_i = NS_i/IRP_{i/gdp}\ \ or$$
$$RS_i= V_i/V_{gdp}$$

where *V* represents "volumes" in the sense that the items are measured at average EU prices.

Several objections may be raised against our statistical example and the formulae presented in the foregoing. As a practical matter, the EKS-PPP-s, applied above, are designed for comparing levels rather than shares, therefore, the sum of the individual "real shares" are unlikely to add up to unity. However, even if the additive (G-K) type of PPPs were used, it may be difficult to grasp the concept of shares in GDP measured at international prices, since the actual composition of expenditures is closely related to *actual* domestic relative prices.

Therefore, instead of "real shares" we may apply the concept of *real ratios* (RR), which has no direct implication for the *composition* of expenditures. As compared to the reference region, it shows how much higher/lower the volume level index of a particular item (VLI_i) is relative to the volume level index of GDP (VLI_{gdp}) – or relative to any another expenditure category.

The nominal (internal) ratio of item *i* relative to GDP is

$$NR_{i/gdp}= NLI_i/NLI_{gdp};.$$

The real (internal) ratio, in turn, is

$$RR_{i/gdp} = (NLI_i/PLI_i)/(NLI_{gdp}/PLI_{gdp}) = VLI_i/VLI_{gdp}$$

The differences between the concept of "real share" (RS) and that of real ratio (RR) are the following: (i) the latter does not imply additivity; (ii) it is applicable for the comparison of any pairs of expenditure items at international prices. Though the scale of the two indicators differs, they practically show the same.

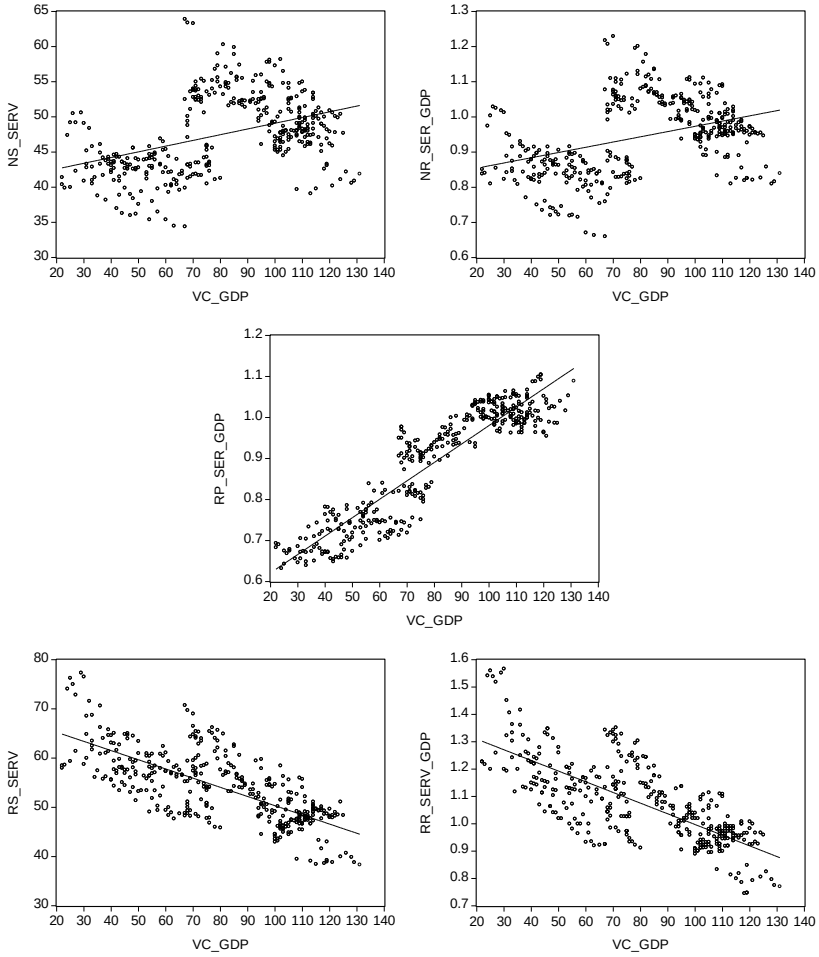
We demonstrate this in the lower part of Table 2 (rows 6 -11), by continuing the comparison between Austria and Hungary in 2011. Rows 6 and 7, respectively, show *nominal* per capita GDP levels and expenditures on services (in euros) as compared to the EU average. The *nominal ratio (NR)* of per capita expenditure on services to per capita GDP was 0.94 in Austria and 0.88 in Hungary (see row 8). Rows 9 and 10, in turn, respectively show *real* per capita GDP levels and expenditures on services (in PPPs) as compared to the EU average. (The real comparative levels are obtained by deflating the nominal levels by the respective price level indices in rows 2 and 3). Finally, row 11 displays the *real ratio (RR)* of services to GDP: its value was 0,91 in Austria, and 1,15 in Hungary. Here again, we see that the "real importance" of services – measured at international prices – was higher in Hungary than in Austria.

It should also be observed that the nominal and real comparison of shares vs. ratios yields identical comparative results (compare row 1 with 8 and 5 with 11 in the last column). Both types of comparisons indicate that, in nominal terms, the macroeconomic importance of services was by 7% lower in Hungary than in Austria, however, in real terms, it was by 26% higher in Hungary. Still, the concept of the real ratio may be more appealing to those, who have an aversion from the concept of "real shares".

As a more general illustration, figure 2.2 shows the pooled cross-section data on the relative share/ratio of services in the EU26 countries in function of per capita real GDP ($VLIc_{gdp}$, abbreviated as VC_GDP). The upper pane on the right side shows nominal shares, while the left side shows nominal ratios to GDP as compared to the EU15 average. The central pane shows the relative price of services, i.e., the item that transforms nominal magnitudes (shares and ratios) into "real" ones. The lower two panes show real shares and ratios at average EU15 prices.

Figure 2.2

The nominal share and ratio (upper panes), the relative price (middle pane) and the real share and ratio of services to GDP (lower panes)



Source: Eurostat and our own calculations

Figure 2.2 draws attention to four important phenomena based on observations of the EU26.

- First, nominal/real shares and nominal/real ratios practically show the same, with different scales (compare the upper two and the lower two panes) of the figure.
- Second, *nominal* shares and ratios are (mildly) positively related to real income (see the upper two panes).
- Third, there is a close positive relationship between the *internal* relative price of services to GDP and per capita real income (see the middle pane).
- Fourth, the relationship between the *real* share/ratio of services and per capita real income is clearly negative (see the lower two panes).

The features displayed by figure 2.2 are useful points of departure for discussing structural convergence, a topic addressed in section 2.2.3.

It is important to restate that though we refer to the real and relative price comparisons shown above as "internal" (since they have to do with the comparison of *domestic* relationships *across* countries at common prices), they have no direct implications for actual domestic developments. Their relevance, among others, is in helping to explain seemingly odd phenomena shown by other types of international comparisons. A case in point is the apparently low level of net wages in the EU10, as compared to the EU 16 – to which we return in section 2.2.4.

2.2.2. Real economic and price level convergence

Economic convergence is a central concept of growth economics, but it has different meanings and measures. Convergence may relate to the world economy, one of its regions, a group of countries, or to a single country within a region. Although the term most often refers to "real" economic catching up, it is also relevant for interpreting relative changes in countries' price and wage levels. Our analysis on real economic convergence (section 4) relies heavily on the association (as well as the possible disconnections) between real and price convergence.

Real economic convergence

Real convergence is generally measured by relative changes in per capita real GDP. A less affluent country's level of income gets closer (converges) to that of richer nations if its annual average per capita GDP growth exceeds the mean of the latter over a longer period. This is generally considered as an indication of *convergence in income levels*.[18] Although, as emphasized, we regard convergence as a long-term, historical phenomenon, we believe that it makes sense to ask whether convergence could be observed over a period covering 15 years among the present members of the EU, with a focus on the EU10. [19]

[18] This is a misnomer, as GDP is an indicator of domestic production, which may differ from indicators of macroeconomic income. The level of total income of the economy is measured by GNDI (gross national disposable income = GDP corrected for primary and secondary net foreign income). *Changes* in macroeconomic income are shown by variations in RGNDI (gross national disposable income at constant prices, corrected for changes in the terms of trade) [see Eurostat (2013), p. 302]. As compared to GDP, in several EU countries significant differences exist in both the levels and changes of indicators of macroeconomic income. Therefore, convergence in per capita GDP should to be considered as a rough approximation of convergence in domestic/national income.

[19] In section 3 we touch upon the works discussing the convergence of the new EU member-states.

For analyzing real convergence, indicators measured at current and constant PPPs are both necessary; the two concepts serve different types of analyses. [20] Beside per capita GDP, a further indicator of convergence, namely GPD per hours worked (labor productivity), should also be considered, both on its own right, and in the context of its role in explaining international differences in wages (labor costs) – which is an important theme of our study.

We illustrate the use of currents vs. constant PPPs by two examples regarding convergence measured by per capita GDP.[21] While doing this, we present an overview of real convergence within the EU. A region (as the EU) is characterized by real convergence if the following conditions hold:

- The cross-section dispersion in levels of income declines over time. This is referred to as *sigma convergence*. Measuring convergence in this sense requires indictors *at current PPPs*.
- A statistically significant negative relationship exists between the "initial" per capita GDP of individual countries on the one hand, and their per capita growth rates on the other. This is referred to as *beta convergence*. For establishing whether beta convergence exists, we need to combine comparisons at current PPPs (for "initial" levels) with real growth rates (changes measured at constant PPPs). [22]

We begin with the question whether sigma convergence exists among the present member-countries of the EU, considering the last two decades. The left pane of figure 2.3 shows the evolution of the (arithmetic) mean of (log) per capita GDP, measured at current PPS, in the EU26 and the two sub-regions in our focus, the EU16 and the EU10.[23] The right hand side shows the standard deviations behind the means.

[20] See OECD (2014), Schreyer–Koechlin (2002) and Dey-Chowdhury (2007) on the interpretation and uses of current and constant PPPs.

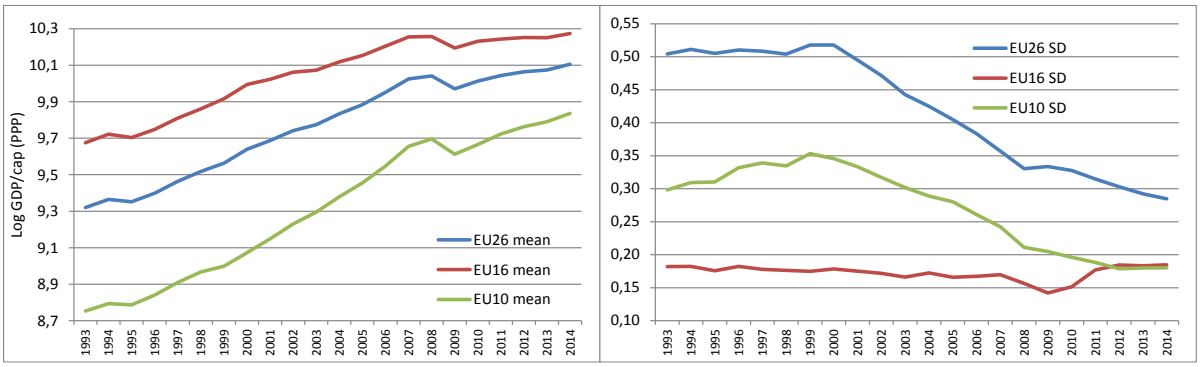
[21] The difference between constant (QVC_gdp) and current (VC_gdp) PPP-based indicators – both interpreted as levels in each year relative to the EU average – is that QVC_gdp is based on VC_gdp in 1999, chained in further years by the volume index of GDP/pop relative to the EU15. Therefore, dlog(QVC_gdp) reflects "pure" volume changes. VC_gdp, in turn, shows real levels (relative volumes) only in cross section (annual) comparisons. *The change* of VC_gdp [dlog(VC_gdp) is affected by both volume changes and changes in relative prices and the composition of the samples compared. Moreover, in 2005 there was a major methodological revision in PPP-comparisons, which may have had different effects on the data of different countries. While dlog(QVC_gdp) is conceptually clear (it reflects volume changes), dlog(VC_gdp) may also be considered as an indicator of economic convergence, reflecting changes not only in volumes, but in relative prices and composition as well.

[22] On the two interpretations, the possible conflict between the two indicators, as well as the distinction between absolute and conditional beta convergence see Barro and Sala-i-Martin (1995)

[23] To remind, the EU26 does not include Croatia and Luxembourg; the EU16, in turn, beside the "elder" member-states, includes Malta and Cyprus.

Figure 2.3

The mean of log per capita GDP (in PPS, left pane.) and its dispersion (right pane) in the EU26 and two sub-regions (EU16 and EU10) between 1993 and 2014



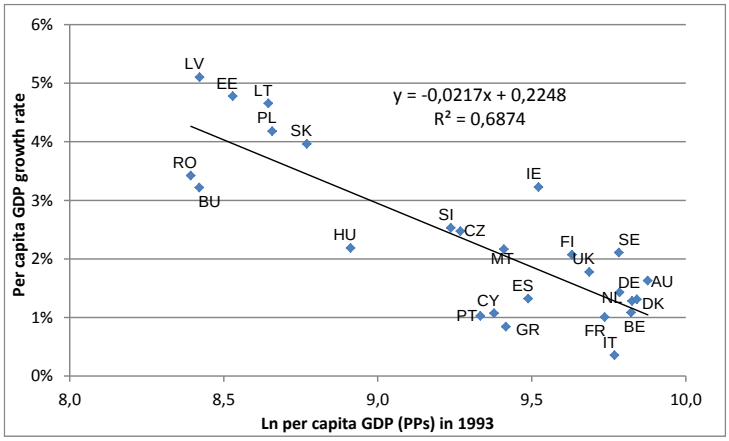
Source: own calculations based on the AMECO (2015) database

The relative distance between the EU16 and EU10 (left pane) clearly shrank over the last two decades. Regarding the variance in income levels (right pane), there is clear evidence of sigma convergence within the EU26 since the early 2000s. This is related to developments within the EU10, as the dispersion within the EU16 did not change (it increased somewhat after the crisis in 2009). The right side of the figure is especially instructive, as it places the period covered by our study (1999-2013) into a longer perspective. The rapid decline in dispersion within the EU10 began in 2000; the former years were characterized by divergence, mainly due the poor performance of Bulgaria and Romania.

Our next question concerns the existence of beta convergence. Figure 2.4 corresponds to the left pane of figure 2.3, as the "initial" income levels, measured at current PPPs, correspond to the initial levels of 1993. The changes, however, are measured differently than in figure 2.3, where developments in income levels are presented at *current PPPs*. Figure 2.4 shows the relationship between log real income (measured at current PPP) and annual average real growth rates of per capita GDP (which corresponds to growth measured at constant PPPs).

Figure 2.4

Per capita GDP levels in 1993 (horizontal axis) a current PPPs vs. annual average growth rates of per capita GDP at constant prices between 1993 and 2013 (vertical axis) in the EU26 countries

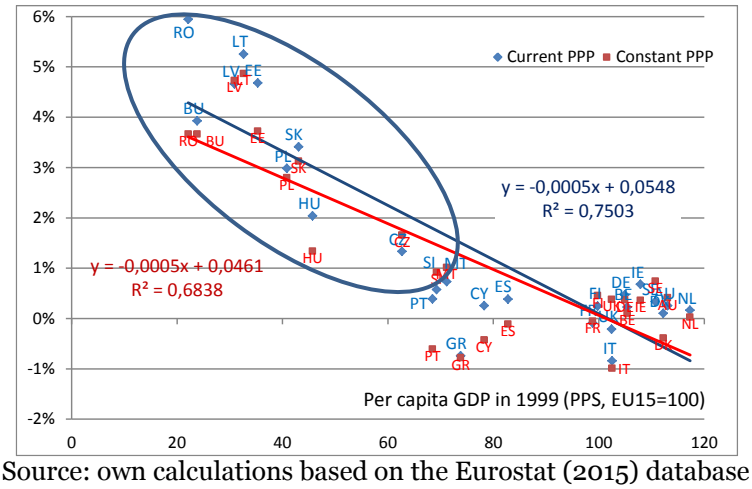


Source: own calculations based on the AMECO (2015) database

Figure 2.5 brings us closer to the actual themes of our analysis. The figure shows relative levels of per capita GDP in 1999 on the horizontal axis and growth rates as compared to the EU15 average on the vertical axis; changes relative to the EU15 are shown both at current and constant PPPs.

Figure 2.5

Growth of per capita GDP over the EU15 average, at current and constant PPPs 1999-2013



Source: own calculations based on the Eurostat (2015) database

The two regression lines are alike; the difference is due to data points of some countries (in particular, Romania and Hungary within the EU10 and Portugal and Cyprus within the EU16), where relative growth measured at current PPP is much higher than at constant

prices. This observation, as well as a recent study by the ECB on European convergence (drawing on current PPP comparisons), motivates the following digression on alternative measures of growth performance. Beside differences between relative growth measured at current and constant PPPs, we also address the effect of population change on indicators of relative per capita growth.

Alternative measures of comparative growth performance and the decomposition of relative growth rates measured at current PPPs: how did individual EU member-states perform? A digression. The following figures illustrate the results of alternative statistical interpretations of "real economic convergence *to the EU28 average*", focusing on changes between 1999 and 2014. Naturally, the concept of convergence (in the sense of "catching up") applies only for countries with income levels below the EU average. However relative performance, as well as the opposite of convergence (divergence from the level once achieved) is relevant also for those countries, whose relative level of development was above the EU28 average in 1999.

On the left pane of the following figures, the horizontal axis on all figures indicates the level of per capita GDP in 1999, measured at current PPP, while the vertical axis shows alternative indicators of convergence (comparative growth) relative to the average of the EU28. The negative slope of the regression line, indicating the relationship between the two variables, reflects convergence among member states (i.e., lower "initial" income levels involve larger increases in income and the opposite holds for higher "initial" levels). The right pane of the figures displays the distance of individual countries from the trend (i.e., the residuals of the regression) in ascending order.[24]

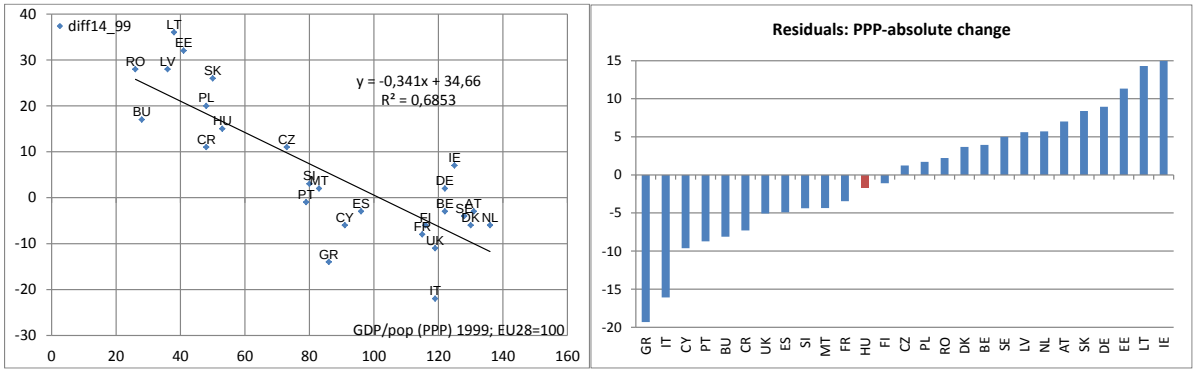
This comparison is intended to demonstrate that though the overall picture regarding convergence within the EU does not depend on the indicator chosen, the choice does affect the relative position (or the "convergence performance") of individual countries.

The left pane of the first figure replicates Chart 1 of a study prepared by the ECB (2015), where the change measured in %-points in per capita GDP (relative to the EU28) is used as the indicator of convergence. The residuals of the regression, shown on the right pane, suggest that Ireland performed best within the EU – somewhat better than the Baltic countries, and much better than the low-income Central-East European (CEE) member states, in particular Bulgaria and Romania.

[24] Sources: PPP-based data: Eurostat; changes at constant prices: AMECO. Luxembourg is not included for the reasons discussed above, but Croatia is included in the comparisons of this section.

Figure 2.5

Left pane: change in per capita GDP at current PPP relative to the EU 28 (in %-points) between 1999 and 2014 (Y axis); the level of per capita GDP in 1999 relative to the EU28 at current PPP (X axis). Right pane: residuals of the regression on the left pane



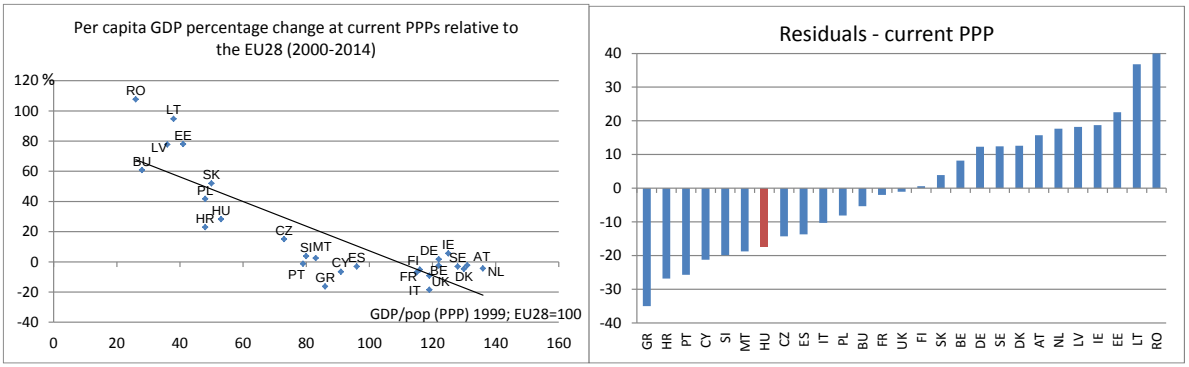
Source: Eurostat PPP database and own calculations

There are two conceptual problems regarding the interpretation of real convergence underlying the chart. *First*, the notion of convergence is related to economic growth, i.e., *relative* (rather than absolute) changes in the position of countries at different levels of economic development. *Second*, real convergence is expected to reflect changes in *volumes* (changes measured at constant prices, rather than at current PPPs). The first issue is addressed by Figure 2.6; the second by Figure 2.8.

The right pane of Figure 2.6 shows that if *relative* change (growth over the EU average) based on current PPPs is considered as the indicator of convergence, Romania highly outperformed both Ireland and the Baltic countries. On the lower end, Italy's performance appears to be somewhat better, and Croatia's worse than suggested by Figure 2.5

Figure 2.6

Left pane: percentage change in per capita GDP at current PPP relative to the EU 28 between 1999 and 2014 (Y axis); the level of per capita GDP in 1999 relative to the EU28 at current PPP (X axis). Right pane: residuals of the regression on the left pane



Source: Eurostat PPP database and own calculations

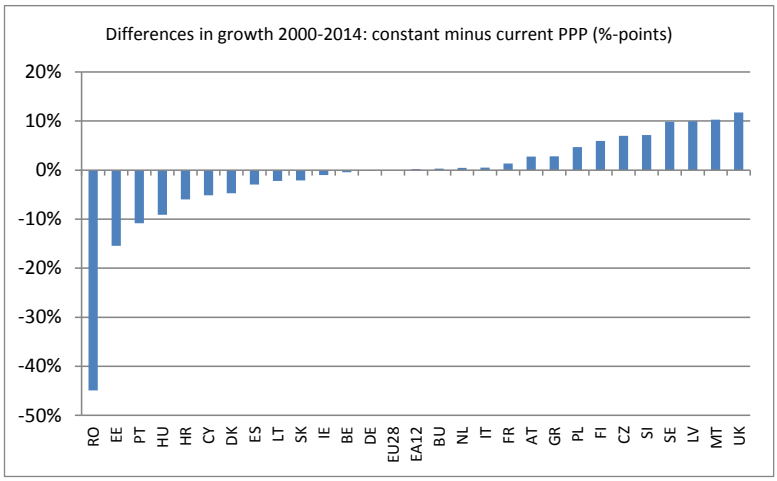
However, it is important to confirm these rankings by observing volume changes (measured at national constant prices) in per capita GDP relative to the EU28. This is necessary, because relative changes measured at nominal PPPs are influenced not only by real (volume) changes, but also by changes in relative prices and in the composition of the samples compared across the years.

This effect is shown by Figure 2.7, which calls attention to the fact that differences between measures of comparative economic growth at current PPPs vs. constant domestic prices is rather significant in several countries. In 10 countries there is practically no difference, but in half of the remaining countries there are substantial positive differences; and in the other half they are negative. The clarification of the reasons behind these contrasting country specific patterns requires further investigation.[25]

[25] More specifically, it is time that the statisticians working separately on PPP-comparisons on the one hand, and on national accounts on the other, combine their expertise and provide *some* (perhaps alternative) explanations for the diverging national patterns characterizing the relation between relative growth measured at PPPs and at constant prices.

Figure 2.7

The difference between per capita GDP growth between 2000 and 2014 measured at constant prices and at current PPPs relative to the EU28 (in percentage points)

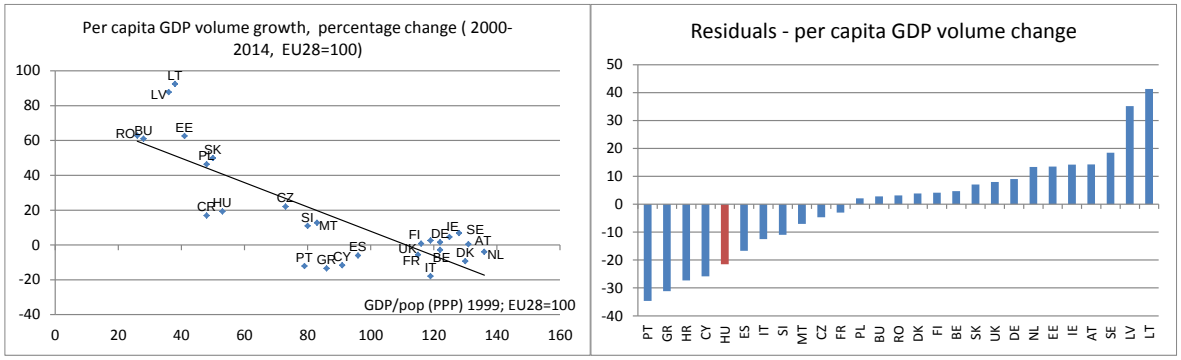


Source: Own calculations based on the Eurostat PPP database and AMECO

Figure 2.8 shows convergence measured by relative *real per capita* GDP *volume growth*, which is the closest to the most widely used indicator in growth economics. In this comparison it turns out that two of the Baltic countries performed best, while the performance of both Bulgaria and Romania was almost the same, and both countries' per capita growth corresponded to the cross-section European trend.

Figure2.8

Left pane: percentage change in per capita GDP at constant prices relative to the EU 28 between 1999 and 2014 (Y axis); the level of per capita GDP in 1999 relative to the EU28 at current PPP (X axis). Right pane: residuals of the regression on the left pane

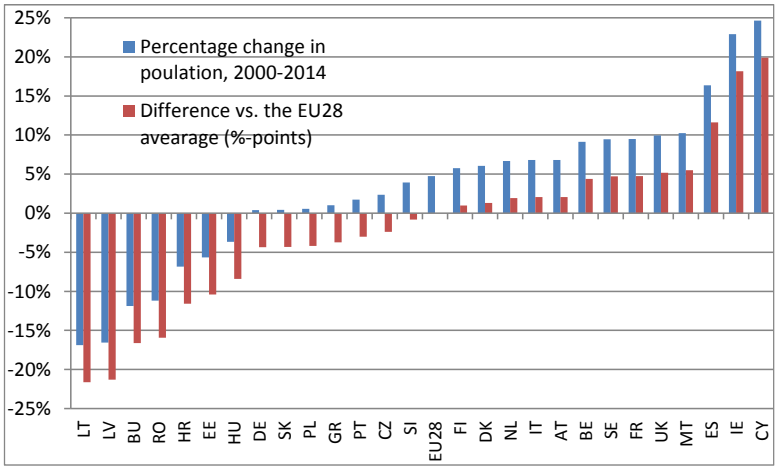


Source: Eurostat PPP database, AMECO database and own calculations

Finally, we consider the comparative growth performance of EU-members states without adjusting for differential changes in population size. Figure 2.9 reveals that there are large variations among countries regarding both the sign and the rate of change in total population during the period observed.

Figure 2.9

Change in total population (in %) and difference vs. the EU28 average (in %-points), 2000-2014



Source: Eurostat

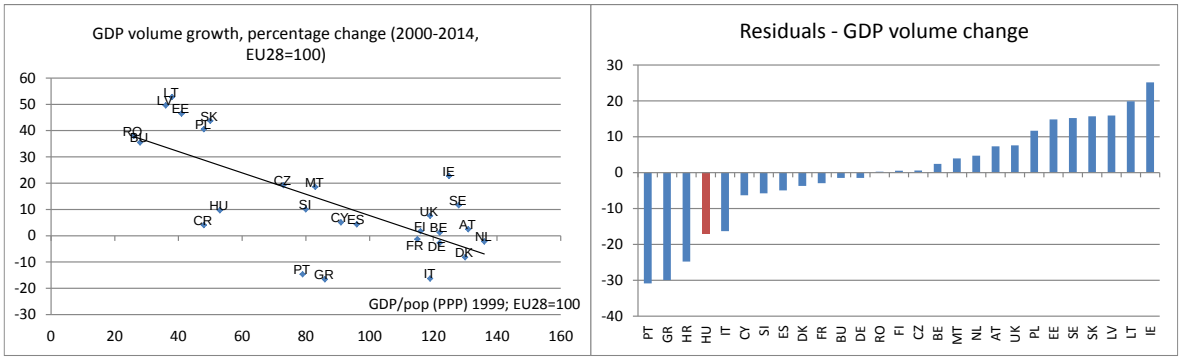
Since four of the countries having displayed the highest rate of per capita GDP growth are the same ones that have experienced the largest decline in population (Latvia, Lithuania, Bulgaria and Romania), it is important to check how the countries' position changes if GDP volume growth is considered (unadjusted for relative changes in total population).

The results are shown in Figure 2.10. As compared with Figure 2.8, there are several differences. First, the relative growth of the most rapidly converging countries is much slower. Second, there is no clear divide in the performance of the Baltic countries and that of Poland and Slovakia. Third, the comparison suggests that among the more developed nations Ireland's performance clearly stands out.

The last result has already been implied by Figure 2.5, which, however, lacked conceptual and statistical clarity. Figure 2.10, based on more clear concepts, confirms Irelands' outstanding performance in European comparison. In terms of GDP volume growth, controlling for the level of development in 1999, Ireland outperformed all of the rapidly converging central and east European member states of the EU.

Figure 2.10

Left pane: percentage change of per capita GDP at constant prices relative to the EU 28 between 1999 and 2014 (Y axis); the level of per capita GDP in 1999 relative to the EU28 at current PPP (X axis). Right pane: residuals of the regression on the left pane



Source: Eurostat PPP database, AMECO database and own calculations

In the foregoing we have demonstrated that the ranking of countries' performance depends on the selected indicator of convergence. However, this appears to have a minor effect on the composition of the groups having displayed the worst and the best relative performance. Among the old member states, Greece, Portugal (and in several cases: Italy) have clearly underperformed; on the other end of scale the performance of Ireland and Sweden turned out to be exceptional in most comparisons. Regarding the CEEU countries, Croatia's and Hungary's performance has been rather disappointing, while the Baltic countries, Poland and Slovakia were the best performers (in some comparisons the latter group includes Romania as well).

Figure *2.11.1* refines the comparisons above. It shows the decomposition of the annual rate of growth relative to the EU28, measured at current PPP, into three components.

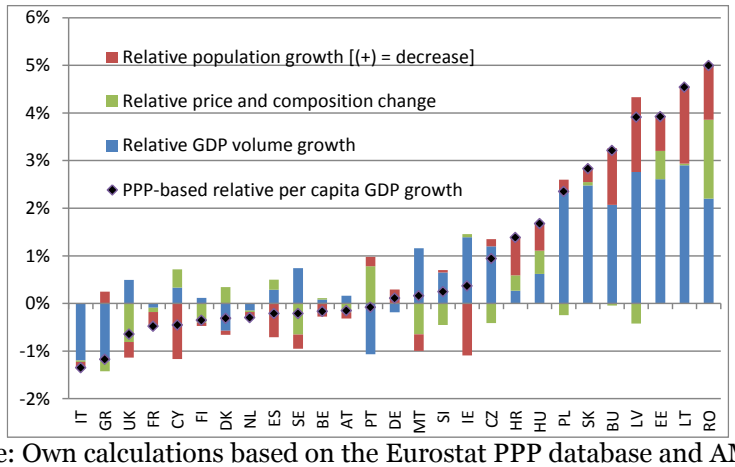
Annual rate of relative per capita GDP growth at current PPP =

- change in relative prices and composition (+ changes due to methodological revisions in PPP-comparisons, etc.)[26] *plus*
- annual rate of relative GDP growth at constant prices, *minus*
- annual rate of population growth (for easier visual interpretation, growth has a negative, while a decline has a positive sign on the figure).

[26] This component corresponds to the difference between relative per capita growth rate measured at current PPP on the one hand, and relative per capita growth rate measured at constant prices, on the other.

Figure 2.11.1

Contributions to per capita annual GDP-growth, measured at current PPP, relative to the EU28 between 2000 and 2014



Source: Own calculations based on the Eurostat PPP database and AMECO

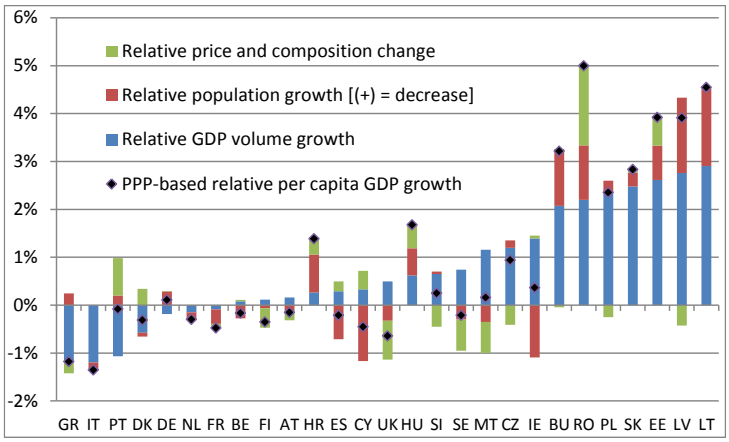
The countries are ranked in ascending order of per capita GDP growth rates *measured at current PPP*. It can be seen that there are sizable differences in the importance of the three factors across countries. In some of them, the change in "relative prices and composition" has a powerful (positive or negative) on "relative performance". The decline in population, which we do not regard as a favorable development, apparently also contributed to the "better performance" measured by per capita GDP in several new member states.

Therefore, until statisticians explain what actual factors are responsible for "changes in prices and composition", those comparisons are to be preferred, which are based on constant prices and do not imply the notion that an absolute, or relative decrease in population involves better economic performance.[27] In *Figure 2.11.2* countries are ranked according to GDP growth at constant prices – our preferred indicator of relative growth performance. The two rankings, as shown by Figure 2.12, are clearly different.

[27] This is a suggestion for further research on convergence within the EU. In the following, we keep to the standard practice and use per capita indicators for measuring convergence.

Figure 2.11.2

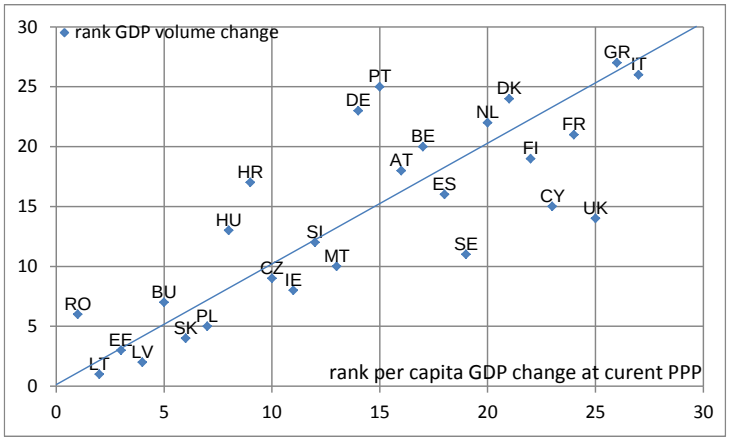
The EU27 countries in ascending order of relative GDP volume growth



Source: see the figure above

Figure 2.12

The ranking of 27 EU member-states according to relative per capita GDP growth at current PPP (horizontal axis) and GDP growth at constant prices (vertical axis) between 2000 and 2014 (best first, worst last)



Source: own calculations

The difference in rankings according to the vertical and the horizontal scale reflects the combined effect of two distinct factors: changes in prices, as well as changes in relative population size (positions on the horizontal axis include, while those on the vertical axis exclude these effects). If ranked by GDP growth at constant prices, Romania, Hungary, Croatia, Germany and Portugal perform much worse than if measured at current PPP per capita GDP growth. The case is the opposite regarding Sweden, Cyprus and the UK.

Note that these rankings are based on a different interpretation of relative performance than those underlying the right-hand side of the previous figures. In figures 2.11.1 and 2.11.2 we decomposed and simply compared relative growth rates (over the EU average), while on

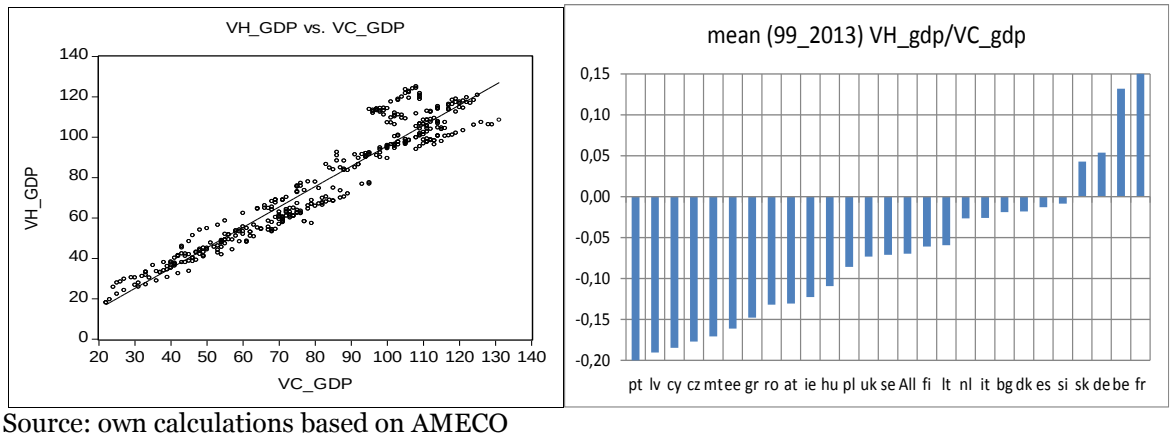
the previous figures growth rates were controlled for initial income. Both approaches make sense, but they reveal different aspects of comparative growth performance. In our following analyses we rely on both interpretations of comparative growth rates.

-*-

The foregoing review of the relative performance of individual member states within the EU would be incomplete without taking a brief look at the relationship between the levels of per capita GDP and labor productivity (GDP per hours worked), which is important for interpreting net wages and labor costs. As shown by the left hand side of Figure 2.13 (displaying the pooled cross section observations over 1999-2013), the longer term relationship between relative income and productivity is rather close. However, as indicated by the right side of the figure, there are significant cross-country differences in the ratio of the means of the two indicators.

Figure 2.13

The relationship between per capita GDP and GDP per hours worked in the EU26 (pooled-cross section observations – rhs; the ratio of the means by country –lhs)



Source: own calculations based on AMECO

The pattern in differences between mean relative productivity and relative income does not appear to be related to whether a country belongs to the EU16 or the EU10 group. Portugal, Latvia, Cyprus, the Czech Republic, Malta and Estonia are the countries characterized by the largest negative mean differences (relative productivity is much lower than relative income), while Slovakia belongs to the group where relative mean productivity over the period observed is above relative mean income (together with Germany, Belgium and France).

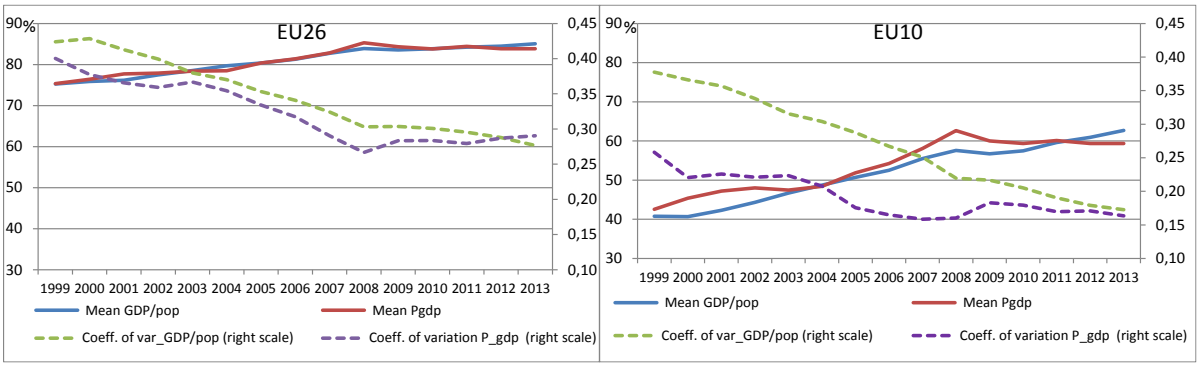
Price level convergence and the association between real and price convergence: the "Penn-effect"

The following graphs portray the convergence of general price levels – measured by the price level index (PLI) of GDP. Next, based on our sample covering the EU26, we show the empirical relationship between real and price level convergence, and briefly touch upon the conceptual background of the observed relationship.

Price level and real convergence. The left side of figure 2.14 shows the general pattern characterizing the EU26, while the right side displays the special features of the EU10 regarding the relationship between real (measured by per capita GDP at PPP) and price level convergence. The coefficient of variation is also shown on the figure.

Figure 2.14

The evolution of the mean per capita GDP, the mean GDP price level (relative to the EU15) and their dispersion in the EU26 (left pane) and the EU10 (right pane) between 1999 and 2013

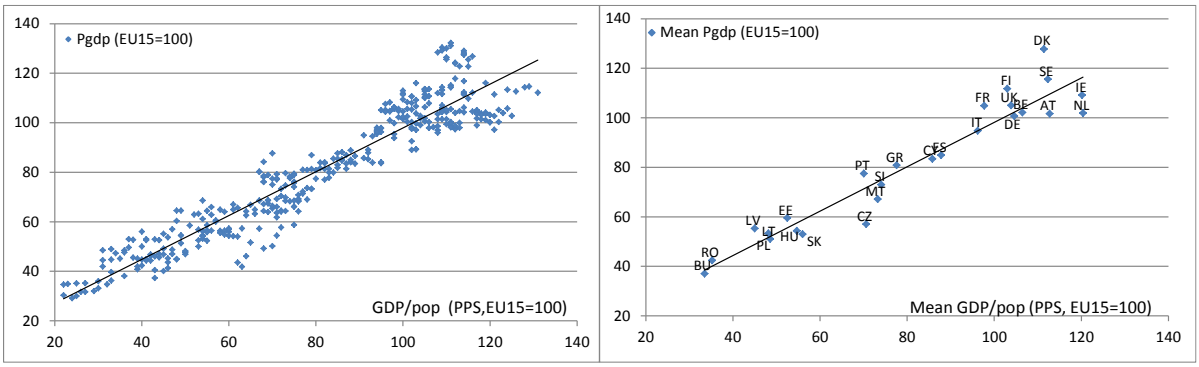


Source: own calculations based on the Eurostat (2015) database

The averages of relative price and income levels are closely associated with each other within both the EU26 and the EU10, and, furthermore, there is a tendency of decreasing dispersion. Within the EU10, the coefficient of variation regarding levels of per capita income was larger than in relative price levels in the initial period, but the narrowing in the gap between the two is also a reflection of convergence. Figure 2.15 shows the relationship between the pooled cross-section observations for the price level index of GDP and per capita GDP in the EU26 (left side), as well as the relationship between the means of observations regarding individual countries (right side). As discussed later, we regard the residuals of this relationship as approximate measures of currency-misalignment, which may affect real economic convergence.

Figure 2.15

Pooled cross-section and the mean of the 26 countries

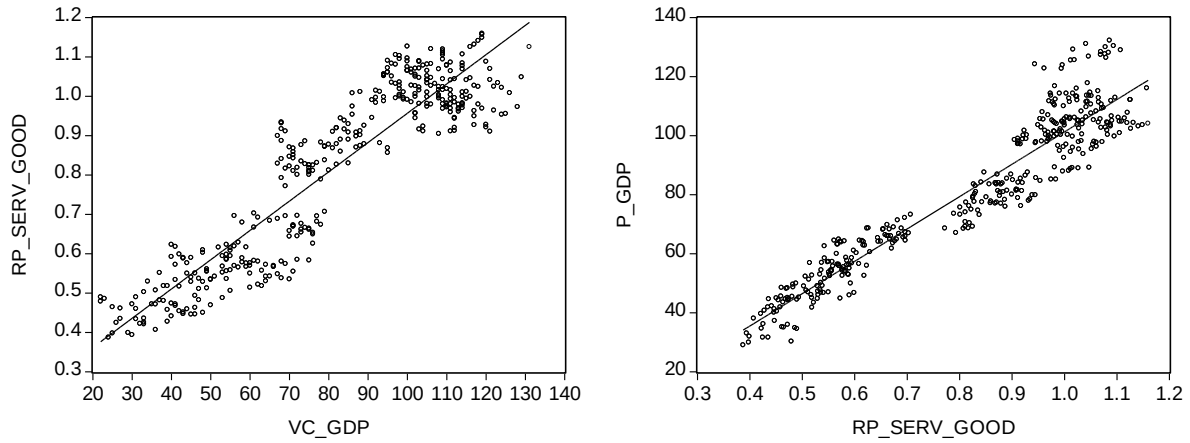


Source: own calculations based on the Eurostat (2015) database

Our next question concerns which "internal" relative price is behind the close association between the external relative price of GDP and per capita relative volume of GDP. As shown by Figure 2.16, displaying relationships between the pooled cross-section observations for the EU26, the internal relative price of services to goods is closely related to relative income (left pane); and the external relative price (i.e., the price level index) of GDP is also closely correlated with this particular internal relative price (right pane). This implies that the close correspondance between per capita GDP and the price level of GDP is via the internal relative price of services to goods (or, more modestly phrased: this is an important channel).

Figure 2.16

The internal relative price of services to goods, as explained by per capita GDP (left pane), and as an explanation for the external relative price level (P_GDP) of GDP (right pane)

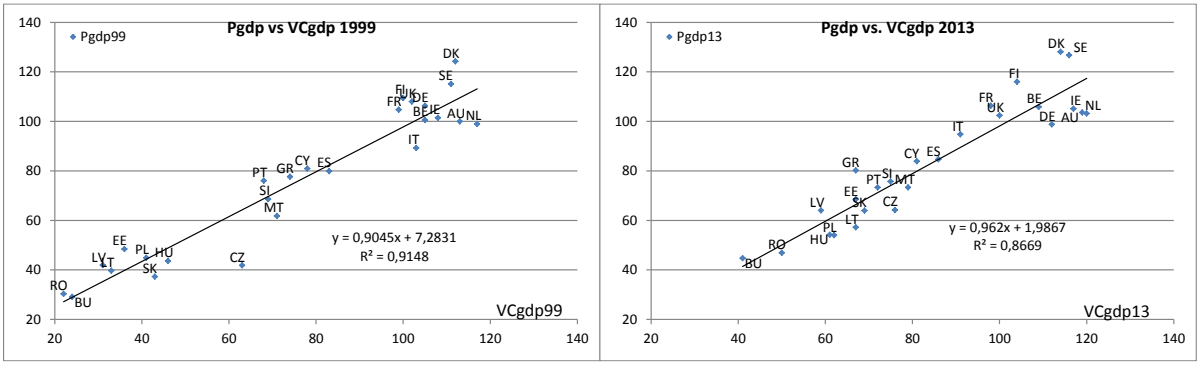


Source: own calculations based on the Eurostat (2015) database

Let us now turn to the relationship between *medium-term changes* in price levels and those in per capita income among the EU-member sates, relying on observations on individual countries. The left and right side of Figure 2.17, respectively, show the cross-section relationship in 1999 and 2013. The correlation was rather close in both years, though the coefficient of relative income increased over time – it was close to 1 in 2013.

Figure 2.17

The relationship between relative income and the relative price level of GDP in 1999 (left pane) and 2103 (right pane)

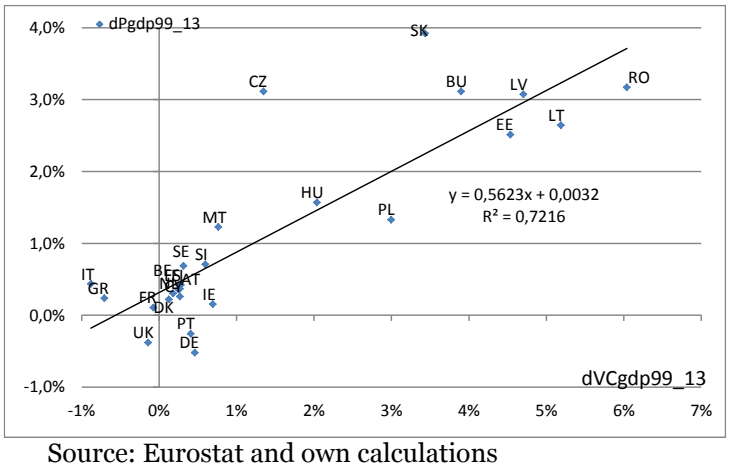


Source: Eurostat

In spite of the fact that the cross-section relationship is very close in each year of the period observed, this does not hold for short-term changes (the correlation between annual changes is 0.1 in our sample). However, if a longer time span is chosen, e.g., the average annual growth rates between 1999 and 2013 are compared, we get a different picture (see Figure 2.18).

Figure 2.18

The annual rate of change in PLIgdp and VLIgdp between 1999 and 2013

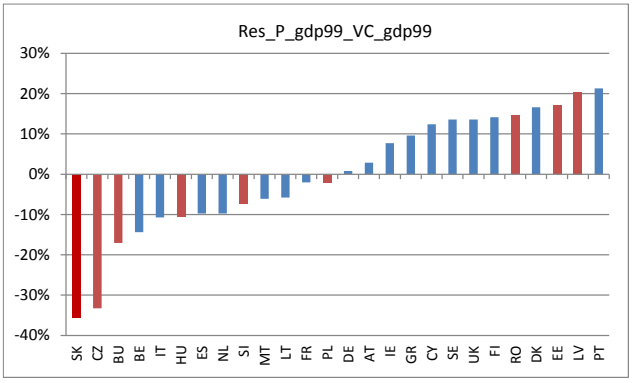


Source: Eurostat and own calculations

Regarding the average rates of changes, both the R^2 and the coefficient of the change in relative per capita income (dVLI_gdp) is lower than those in levels. This, however, may be fully consistent with observations on "initial" levels; moreover, it supports the existence of a longer term relationship between price and real convergence. In Box 1, we address the effect of *levels in 1999* on the *changes* between 1999 and 2013.

Box 1: What explains changes in GDP price levels?

The figure below shows, in increasing order, the *residuals* of the log-log transformation of the regression shown in the left pane of Figure 2.17. [(i.e., ***e*** in the equation *log(Pgdp99) = a + b*log(VCgdp99) +e*]. The EU10 countries are indicated by red bars.



As mentioned in section 2.1.3, and to be discussed later on, these residuals can be interpreted as reflections of exchange rate misalignments. At this point, however, we focus on the potential effect of the relative positions in 1999 on relative changes between 1999 and 2013. By comparing the position of countries regarding the residuals for 1999 with above-trend increases shown in Figure 2.18, there appears to be a correspondence (Bulgaria, the Czech Republic and Slovakia, the countries that were most significantly below the trend in 1999 were the ones displaying the most significant above-trend increases during the period observed).

The results of the regressions aimed at explaining changes in price levels are shown in the table below. They suggest that relative per capita volume GDP growth, combined with the residuals of the cross section regression of GDP price levels on the per capita GDP volume levels in 1999 (shown in the figure above) offer the best explanation for changes in relative GDP price levels.

Factors affecting the average annual rate of change in PLIgdp between 1999 and 2013 in the EU26

	Dependent variable: annual average change in PLIgdp							
	1	2	3	4	5	6	7	8
Explanatory variables								
Annual average change in	0.567**		0.589**		0.198*			
	(7.92)		(12.10)		(-1.83)			
Res_P_VC_gdp99		-	-					
		(-	(-5.41)					
log(PLI_gdp99)				-	-			
				(-10.19)	(-3.98)			
Annual average change in						0.648*	0.653**	0.287**
						(8.50)	(11.36)	(2.76)
Res_P_VC_gdp99							-	
							(-4.39)	
log(PLI_gdp99)								-
								(-4.20)
Adj R^2	0.711	0.067	0.868	0.804	0.822	0.741	0.853	0.846
Obs.	26	26	26	26	26	26	26	26

Notations: PLIgdp: price level index of GDP, VLIgdp: volume level index of per capita GDP; Res P_VC_gdp99: the residuals of the cross section relationship for 1999, QVLIgdp: per capita GDP measured at constant prices.(t-statistics in parentheses) *significant at 10%, ** significant at 5%, *** significant at 1%.

The results show that over the period observed, the change in the relative price level of GDP is related positively to the change in relative per capita GDP (either measured at current or constant PPP), and negatively to the "initial" relative price level. Actually, the "initial" price level by itself (column 4) is a better explanation of its change than per capita GDP growth by itself (see columns 1 and 6), which is an indication of price level convergence. The residuals of the regression for the initial year do not explain anything (column 2), however, if combined with per capita GDP growth, they show a somewhat better fit (rows 3 and 7), than the combination of the initial price level and per capita GDP growth (columns 5 and 8). This, in turn, suggests the existence of longer-term equilibrium relationship between the relative price and per capita levels of GDP. It is worth mentioning that the coefficient of the fixed exchange rate dummy regarding annual changes is negative, but it turns out to be statistically insignificant, if combined with any other economically meaningful explanatory variable. The dynamic relationship between the price and volume level of GDP does not depend on whether a country has a fixed exchange rate (belongs to the Eurozone/maintains a currency board regime) or its exchange rate is floating. (The latter results are not shown in the table.)

Both the cross-country and the dynamic relationship between relative price and income levels (shown by the previous figures) are often referred to as reflections of the "Balassa-Samuelson effect". However, Samuelson considered this term as a misnomer; he suggested the "Penn effect" instead. A brief review of the related literature follows.

The Penn-effect and the Balassa-Samuelson model. Paul Samuelson (1994) coined the strong positive association between real per capita GDP (*VLIc_gdp)* and the price level of GDP (*PLIgdp*), shown by Figure 2.15, as the *"Penn-effect"*.[28] He – as one of the contributors of the renowned Balassa-Samuelson (BS) *model* (Balassa, 1964 and Samuelson, 1964) – considered it important 30 years later to distinguish the observed *statistical regularity* (the Penn-effect) from one of its possible *explanations,* which happens to be the BS-model.[29] This important distinction is frequently overlooked, whereby the "BS-effect" is regularly used as a synonym of the Penn-effect. [30]

There are several layers of understanding/explaining the Penn-effect; here we refer only to two of these. One relates to the following question: the external relative price (PLI) of witch particular GDP-aggregate is chiefly responsible for the observed effect? In this respect, there has been a broad consensus among economists and economic statisticians: the relative price of *services* (vs. goods or GDP) increases in line with the level of economic development (for earlier works see e.g. Harrod, 1933; Clark, 1940; Fourastié, 1947; Kuznets, 1971).[31] This is confirmed by Figure 2.16.

The second concerns *explanations* of the observed effect. The most well-known is the BS hypothesis, which, building on rather restrictive assumptions, focuses on differences in productivity between goods (an approximation of tradables) and services (an approximation of nontradables). An alternative explanation was offered by Bhagwati (1984), who built his model on differences in factor endowments of the two sectors.

There is a long tradition of explanations from the demand side as well (in particular Fourastié, 1947), but there were several later attempts to this end (see e.g., Bergstrand 1991; Podkaminer, 2010a.) The Box below addresses some of the issues involved.

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[28] Samuelson referred to the results of international comparisons performed in the framework of the ICP project in which the University of Pennsylvania had a major role. The Penn World Tables constitute a major statistical source for worldwide comparisons of real GDP and its components. The data indicate a close positive association between the level of real incomes and relative price levels of GDP. The existence of the Penn-effect contradicts a long-respected notion in international economics, namely the absolute version of the purchasing power parity (PPP) doctrine, which asserts that nominal exchange rates correspond to differences in general price levels. (See Cassel, 1922 on a classical exposition of the PPP-theory.) More precisely, the Penn-effect limits the scope of the absolute PPP-theory of exchange rates to countries at similar levels of economic development. (The Penn-effect implies that the PPP doctrine holds only if differences in real income levels are adjusted for.)

[29] The term "Balassa-Samuelson *model*" was suggested by Asea - Corden (1994) in their review of the related literature. For further reviews on alternative tests of the model, see e.g. Égert - Halpern - MacDonald (2005) and Tica- Druzic (2006)

[30] For a discussion of the relationship between the Penn and the BS effect, see Pancaro (2011).

[31] Balassa referred to "tradables" and "non-tradables", but he approximated these categories by "goods" and "services". Our figure above suggest that this remains a useful approximation.

Box 2: Demand-side explanations of the Penn-effect

Although the Balassa-Samuelson effect may be a reason for the observed positive relationship between GDP per capita and its relative price level, it is not the only possible explanation. Bergstrand (1991) argued that there is a demand-side channel that may also play a role in this process. His argument was based on the assumption that services are "luxury goods" while tradable commodities are "necessities". Therefore, as national income grows, the demand for nontradable services increases more than that for tradable goods; this leads to an appreciation of the real exchange rate.

Bergstrand built an empirically testable model to support this assertion. Using a sample of 21 countries, he distinguished the effects of three possible theoretical explanations for the different real exchange rate levels: his demand-side approach, the Balassa-Samuelson effect and the role of different capital-labor endowment based on Bhagwati (1984). His results supported the hypothesis that income has a significantly positive effect on the real exchange rate through higher demand for services even after controlling for productivity and capital-labor endowment differences between the tradable and the nontradable sector. This implies that, beside the supply-side, there is a demand-side channel responsible for the observed regularity.

Regarding the catching-up process in the European Union Égert (2010) also emphasized the importance of the demand-side channel. He found that the l Balassa-Samuelson explanation hardly holds in this sample because of two reasons. First, the productivity growth in services was not far from that in the tradable sector in some of the new member states. In addition, the (nominal) share of nontradables is usually low in these countries. As a result, he found that the implied Balassa-Samuelson effect is very low in the EU member countries.

Égert also tested the possible drivers of price level convergence with various econometric models. His results corroborated that the Balassa-Samuelson effect was not an important factor in the process. Regarding the nontradable sector, inflation showed a strong positive correlation with regulated service prices that usually account for a large part of the HICP in the new member states. House prices and commodity prices also proved to be important drivers of inflation. These results led him to the inference that during the economic catching-up process higher incomes result in changes of the consumption structure of households towards higher quality goods and services. Therefore, price level convergence is due to developments in both the tradable and nontradable sector. However, our results, presented below, suggest that price increases in the service sector are mainly responsible for the catching up of the general price level in the EU10.

Our study does not deal with alternative explanations; it simply considers the Penn-effect as a statistically firmly based stylized fact, which certainly holds for *the EU26 in the period in our focus*.[32] However, two points have to be made. The first concerns the implications of external and internal relative prices. For the Penn-effect to hold, it is a sufficient condition that the *internal* relative price of services to goods be higher in more developed countries than in less developed ones, while the *external* price level of goods may be the same. (Actually, the latter assumption was explicitly made in Balassa's article.) However, all statistical sources confirm that not only services, but goods are also more expensive in countries at higher levels of development (See Box2).

This leads to the next point, the "dynamic" Penn-effect (see Ravallion, 2010). What are the major factors responsible for changes in price levels accompanying convergence in real incomes? Several studies have questioned the relevance of the dynamic version of the BS-model, calling attention to the fact that not only the increase in the external relative price of services but also that of goods have a major role in the catching up of price levels (often referred to as "structural inflation").[33] A more important, conceptual issue relates to the nature of the dynamic Penn effect. Over what time horizon do price levels change in response to changes in per capita incomes? Berka and Devereux (2013), similarly to our Figure 2.18, show that there is a medium-term correspondence between the cross-country and the dynamic version of the Penn effect. This appears to contradict the findings of Podkaminer (2010), also confirmed by our own results, that short-term changes in GDP price levels are unrelated to changes in relative per capita real GDP levels. However, the apparent contradiction may be resolved by the possibility that the longer term relationship is based on "error correction", whereby deviations from a common "European trend" may explain short-term changes in relative GDP price levels in Europe. This is the result suggested by our calculations presented in Box 1.

As a caveat to the foregoing review, it should be noted that it is far from trivial whether per capita GDP (a proxy of income) or GDP per hours worked (a proxy of total factor productivity) is to be considered as the better explanatory variable of the cross section Penn-effect (or its dynamic variant). The choice is partly related to whether one prefers the demand-side explanation of the phenomena (in this case, per capita GDP is relevant), or the supply side interpretation (involving the concept of productivity, approximated by GDP/hours worked). We do not have strong views on this issue; in Figure 2.19 we simply show the relationship between price levels and GDP per hours worked (left pane) and per

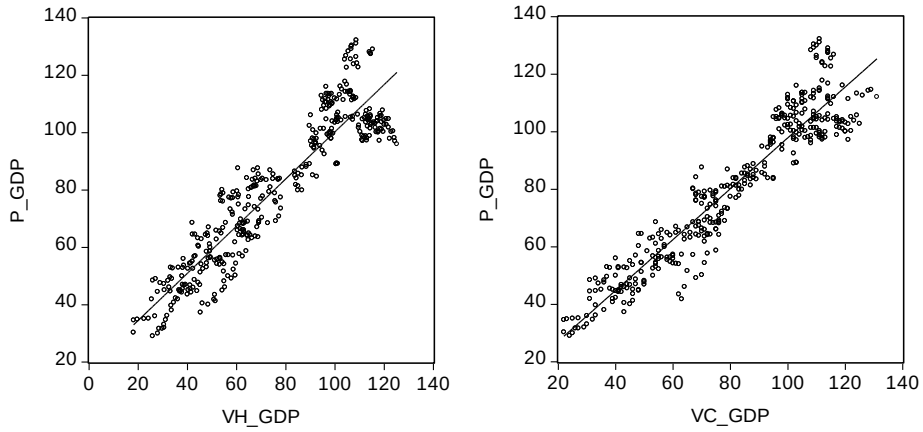
[32] As emphasized by Samuelson (1994): "The Penn effect is an important phenomenon of actual history but not an inevitable fact of life." Bergin-Glick-Taylor (2004) and Taylor and Taylor (2004) demonstrated that, historically, the existence of the Penn-effect is indeed recent: it did not exist in the early 1900-s and evolved (and strengthened) since the middle of the twentieth century.

[33] See e.g. Darvas – Szapáry (2008). For a non-technical exposition of the related ideas, see Égert-Podpiera (2008).

capita GDP (right pane) based on the pooled cross-section of the observations between 1999 and 2013 for the EU26.

Figure 2.19

The association between the price level index of GDP and the volume level index of GDP per hours worked (left pane) and per capita GDP (right pane)



Source: own calculations based on Eurostat

The correlation between the price level and per capita income is somewhat higher (0.96) than that between the price level and productivity (0.92), but this may be due to technical reasons (per capita *real* income is calculated as *nominal* per capita income deflated by the price level index of GDP). In any case, this simple comparison does not help in deciding whether per capita GDP, or GDP per hours worked is the more relevant *substantive* explanatory variable of the general price level. Our study does not seek to decide this issue. In analyses related to real economic convergence, as well as in those that are related to structural convergence, we rely on measures based on real income (per capita GDP). However, when analyzing developments in wages/labor costs, our point of reference is relative labor productivity, measured by GDP/hours worked.

2.2.3. Structural convergence: goods vs. services (the evolution of relative prices, relative volumes and relative shares)

The relationship between real economic and structural convergence has been discussed extensively in the literature (see our selective review in section 2.1.3). Here we address only a few of the numerous issues involved, focusing on the role of (expenditures on) services in the convergence process of the EU10 countries. Within services we distinguish between those supplied by the market (consumer services) and those by the government. Within the latter

category, we focus on "individual government services", which, as explained in section 2.2.1, is the synonym of "government transfers in kind" to households.

In the previous sections we have already touched upon some aspects of structural convergence. In Figure 2.2 we showed that while the nominal share of services appears to be positively related to real income in the EU26, the sign of the relationship is the opposite with respect to *real* shares (measured at average EU-prices). The figure also revealed the strong positive association between the relative price of services to GDP and per capita real GDP. In the present section we give a more systematic review of structural convergence regarding major expenditure categories. This is followed by graphical illustrations of real and price level convergence of different categories, as well as by figures showing some general patterns characterizing the relationship between the relative prices and relative per capita volumes of major expenditure items on the one hand, and per capita real income on the other.

However, before turning to the comparative levels and their tendencies, an important clarification regarding the interpretation of international comparisons of *government services* is in order. We consider the data in the Eurostat PPP database (2015) as the best available approximation of relative prices and per capita volumes of these services; in the following, we shall rely on these statistics. In Box 3, we explain our reasons for doing so.

Box 3: "Comparison-resistance"

Since market prices are unavailable for government services (their prices are "imputed"), these items are customarily referred to as "comparison-resistant" in the statistical literature.[34] Regarding our actual questions, the implication of "comparison resistance" is that the results of international comparisons may overstate the comparative real size of government services in low-income countries. The further implications, however, have never been clarified. Does it also imply that the comparative *level* of real GDP in low-income countries is overstated? Or, alternatively, it implies that the "actual" *composition* of GDP, measured at international prices, is markedly different from the one based on "official" PPPs?[35] If either of the alternative implications (or any combination of the two) were proven valid, all analyses relying on PPP-based comparisons, including the present one, would turn out to be irrelevant. However, since no evidence has been presented so far on the direct and indirect *quantitative* importance of "comparison resistance", we have no choice but to accept, and rely on, PPP-based comparisons of non-market services – acknowledging that the margin of error regarding these comparisons is higher than for goods and market services. Besides, for the two most important individual non-market services, education and health, new methods (based on output-comparisons) are applied (see Eurostat-OECD, 2012).

[34] See e.g. Szilágyi (2008) and World Bank (2008)

[35] This would involve that the real level of expenditures on goods and consumer services in the EU10 is much closer to the EU 16 than indicated by PPP-based comparisons.

We begin by identifying some general patterns characterizing the EU10 countries, relying on unweighted means of the respective indicators.[36] In table 2 the first and second column shows "initial" relative levels in 1999 (relative to the EU15) of prices and per capita volumes, respectively; the third and fourth column, in turn, shows the respective comparative growth rates (over the EU15) of the main expenditure items in our focus between 1999 and 2013.

Table 2

The comparative level of prices, per capita volumes (in PPS) of selected macroeconomic aggregates in the mean of the EU10 (EU15 =100) in 1999; and relative rate of changes between 1999 and 2013

		Levels in 1999 (EU15=100)		Average rate of change above the EU15 between 1999 and 2013 (in %)	
		PLI	VLIc	dPLI	dVLIc
GDP		43	41	2.5	3,4
Total	Goods	59	38	1.7	4,1
	Services	30	51	3.2	1,9
Consumer	Goods	60	39	1.8	4,1
	Services	35	40	2.5	3.0
Government individual services		23	71	4.4	-0.3
Memo: relative per capita GDP growth measured at constant prices					3.0

Notes: the table shows unweighted means of the EU10 countries. PLI: price level index; VLIc: per capita volume level index (in PPS).
Source: own calculations based on Eurostat.

The comparison of "initial" levels with their subsequent changes clearly indicates the existence of structural convergence regarding both prices and per capita volumes of the expenditure items considered: a lower (higher) "initial" relative level generally involves a higher (lower) comparative growth rate. This certainly holds for total goods and services, and it particularly holds for individual government services (see also Table 3, which shows internal ratios and their changes, as compared to GDP).

[36] Any kind of weighting scheme – e.g., GDP or population size – would bias the average towards the indicators of the larger countries, Poland and Romania.

Table 3

The comparative level/change in the main expenditure items relative to GDP in the EU10

		Internal ratios to GDP		Rate of change relative to GDP	
		IRP	RR	dIRP	dRR
Total	Goods	1.40	0.92	-0.8%	0.7%
	Services	0.71	1.25	0.7%	-1.5%
Consumer	Goods	1.40	0.95	-0.7%	0.7%
	Services	0.83	0.98	0.0%	-0.4%
Government individual services		0,54	1.74	1.9%	-3.7%

Notes: IRP: internal relative price, RR: real ratio relative to GDP.
Source: Table 2.

In the late 1990s (total) goods were relatively expensive, while (total) services were relatively cheap; and the opposite held for per capita volumes: expenditures on the former were relatively low, while expenditures on the latter were comparatively high. Developments between 1999 and 2013 seem to be strongly influenced by these "initial" conditions. The convergence *in prices* was modest in the case of goods and much more rapid regarding services. The convergence *of per capita real expenditures* on goods, in turn, was about twice as fast as that of services. Government individual services represent an extreme case, since – both in external and internal comparison – their relative price was exceptionally low, while their per capita volume was exceptionally high. Thus, their relative price increased particularly rapidly, accompanied by a relative decrease (divergence) in per capita volume.

Regarding Table 2, it is worth noting that the economy-wide real convergence (measured by per capita GDP) was more rapid than price convergence (measured by the price level of GDP), in spite of the fact that their levels in 1999 were close to each other. We have three*, not mutually exclusive*, explanations for this phenomenon:

- First, the averages for the EU 10 in Table 2 are unweighted means; this may affect the results.
- Second, in the last row of Table 2, we show the comparative growth rate of per capita GDP at constant prices, which is lower than the growth at current PPPs. Thus, a part of actual changes in price levels may be included in per capita level changes expressed at current PPPs.
- Third, and conceptually more importantly, the low rate of relative price increase of GDP in the EU10 (i.e., the relatively mild real exchange rate [RER] appreciation) may be the cause of (or, a contribution to) the favorable performance of the EU10 regarding real economic convergence. (For the conceptual relationship between exchange rate

misalignment and growth, see section 2.1.3, and for actual empirical relationships regarding the EU10, see Box 1.)

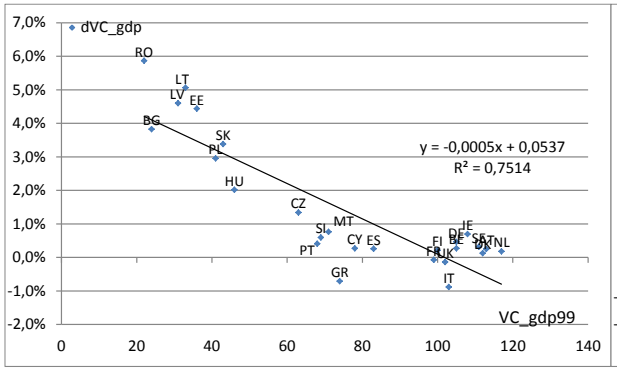
As Tables 2 and 3 were based on averages of the EU10, Figure 2.20 is an important addition: it presents relative growth rates in individual countries vs. relative positions in 1999. By observing the differences across countries regarding changes in price levels and per capita volumes in different expenditure categories vs. their initial levels, one can get an idea of the country-specific diversities behind the means. We do not discuss individual charts, but call attention to the fact that the only item where no evidence of real economic convergence can be detected is government individual services.

Figure 2.20

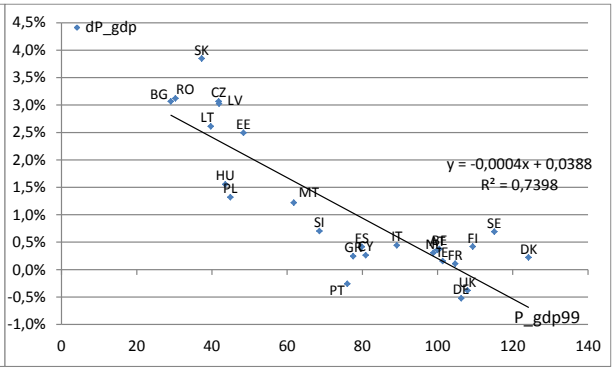
Relative growth rates between 1999 and 2013 vs. relative levels in 1999 of VLIc and PLI indices for GDP and five expenditure categories (EU15=100)

2.20.1: GDP

VLIc (per capita volume level index)

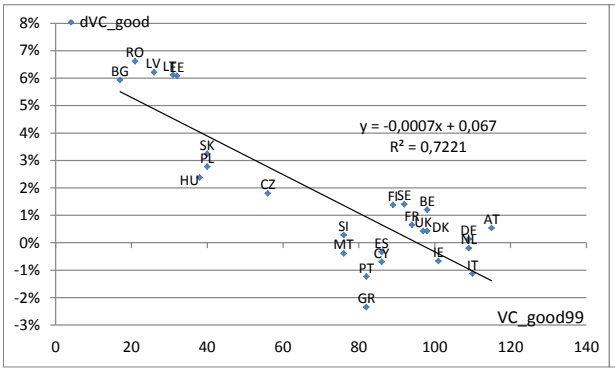


PLI (price level index)

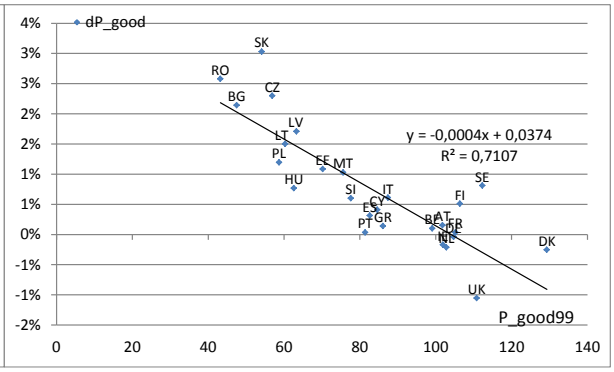


2.20.2: Goods

VLIc

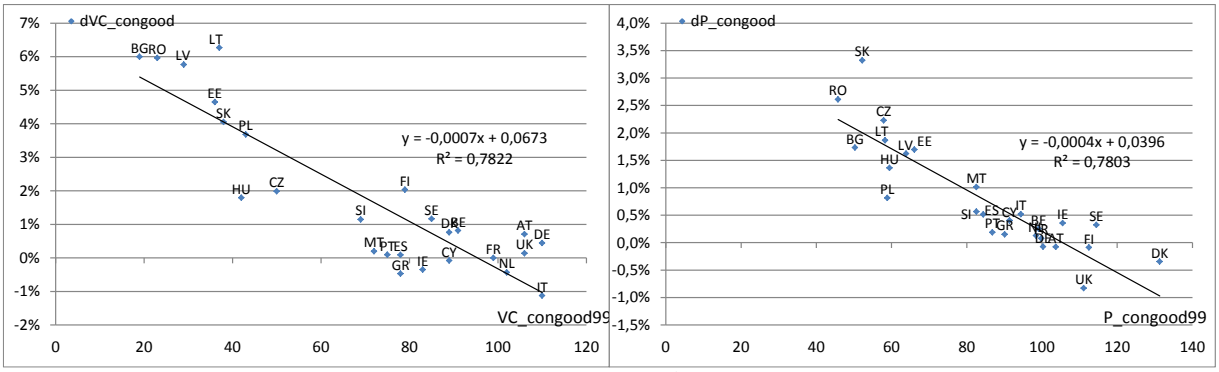


PLI



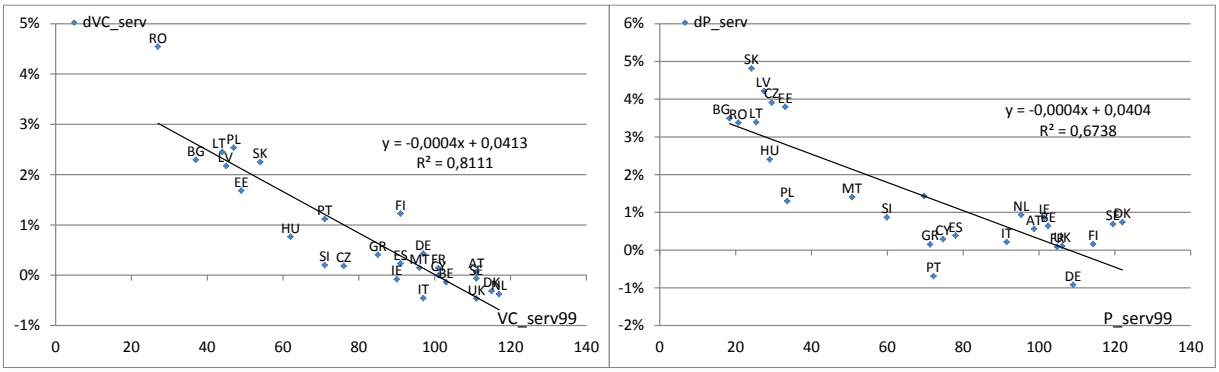
2.20.3: Consumer goods

VLIc PLI



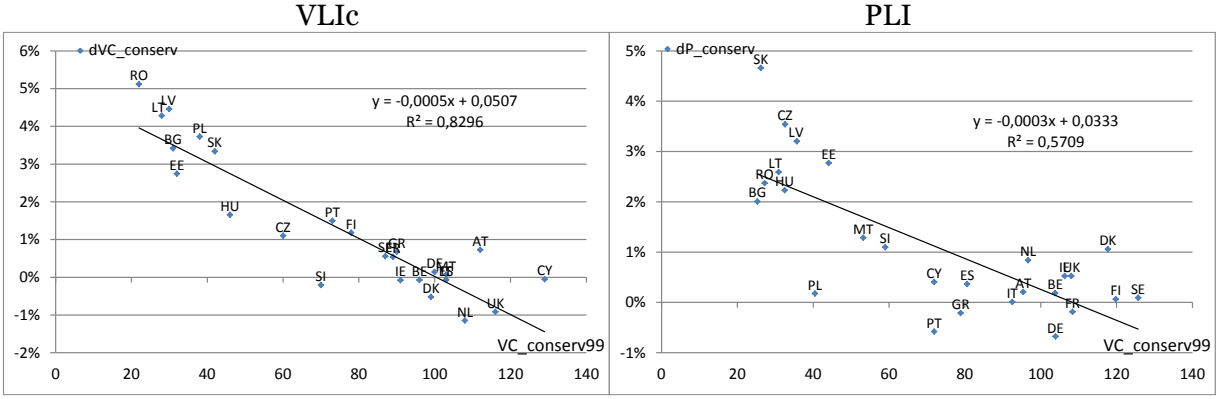
2.20.4: Services

VLIc PLI



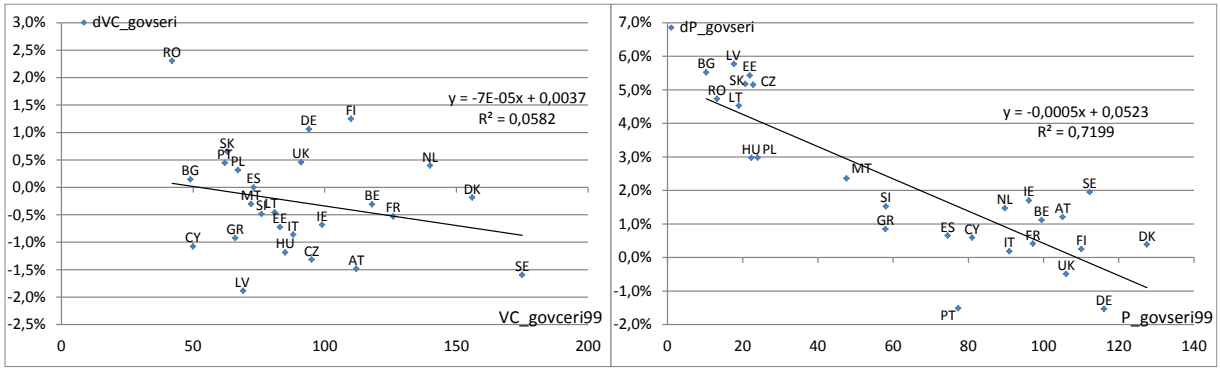
2.20.5: Consumer services

VLIc PLI



2.20.6: Government individual services

VLIc PLI



Source: own calculations based on Eurostat

While the charts above indicate the relative position of individual countries with respect to the price and real convergence regarding different expenditure items, the next figures are meant to give a general impression of the landscape in the EU 26, relying on the pooled cross section data, showing the nearest neighborhood fit.

By and large, the figures on internal relative price levels show that the price level of goods tends to decrease, while those of services increases with relative income. However, there is a marked difference between the shape of the curve characterizing consumer and individual government services: the latter increases very steeply between 20 and 80 percent of the EU average – this range roughly corresponds to the data of the EU10.

Figure 2.21

Internal relative prices (EU15=1) and per capita income at PPP (EU15=100)

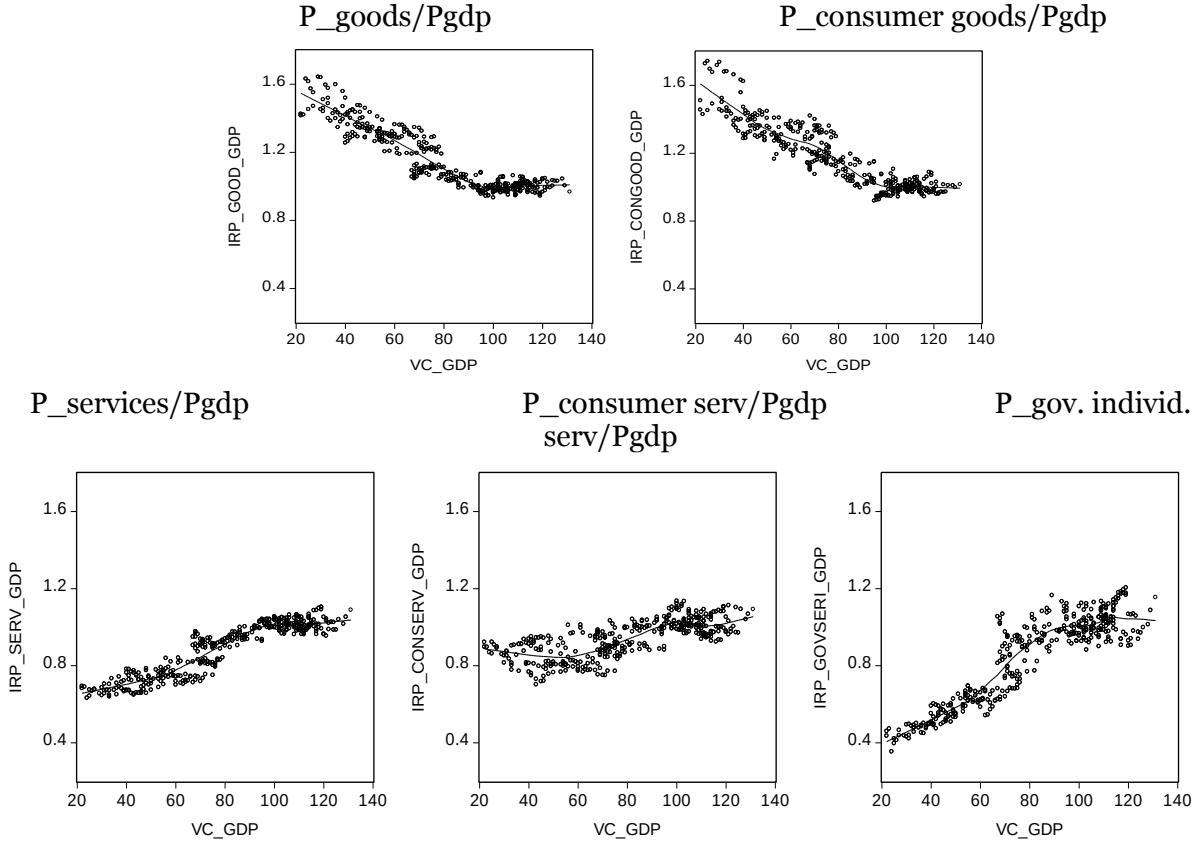
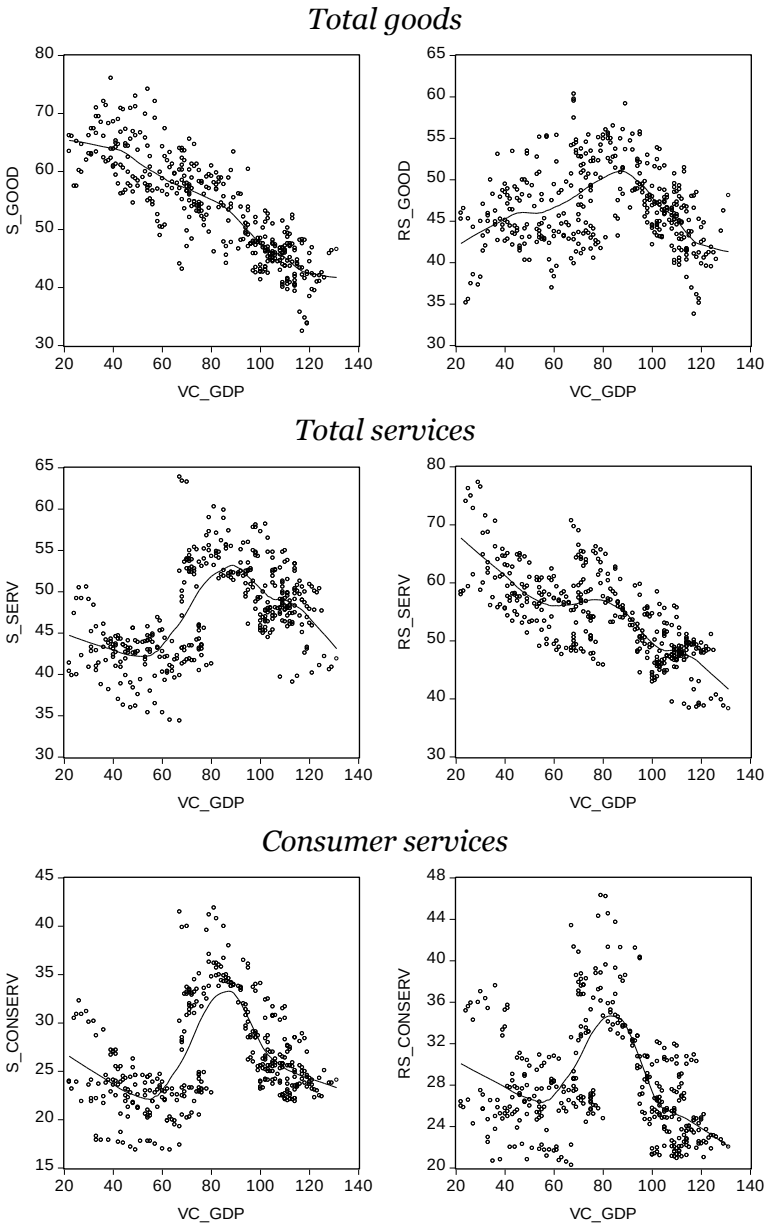


Figure 2.22 shows nominal (euro-based – left hand side) and real (PPP-based: calculated at average EU15 prices – right hand side) shares of the main expenditure categories in relation to per capita real GDP. There are marked differences in the relationship between the share of specific expenditure categories and per capita real GDP, depending on whether nominal or "real" shares of the categories are observed. Moreover, several categories display evidence of non-linear relationships. As for the nominal share of *goods*, there is a clearly declining trend, while their *real share* shows a reverse U-shaped relationship with per capita

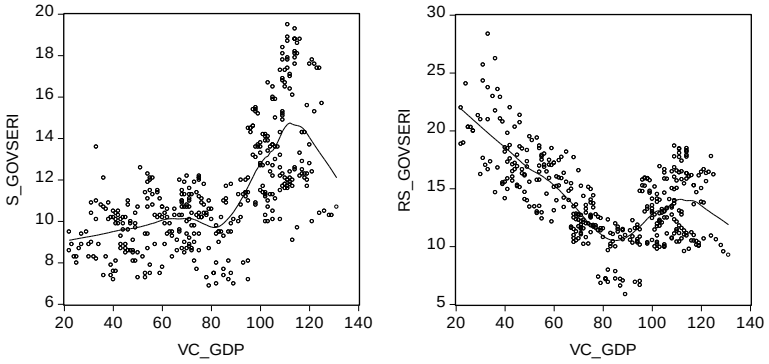
income. The *nominal share* of share of services shows a similar non-linear relationship with income (this is corresponds to developments discussed by Eichengreen-Gupta, 2009), but regarding *real* shares (measured at international prices), the non-linearity almost disappears, and a clearly declining trend (similar to the one characterising the *nominal* share of goods) takes its place.

Figure 2.22

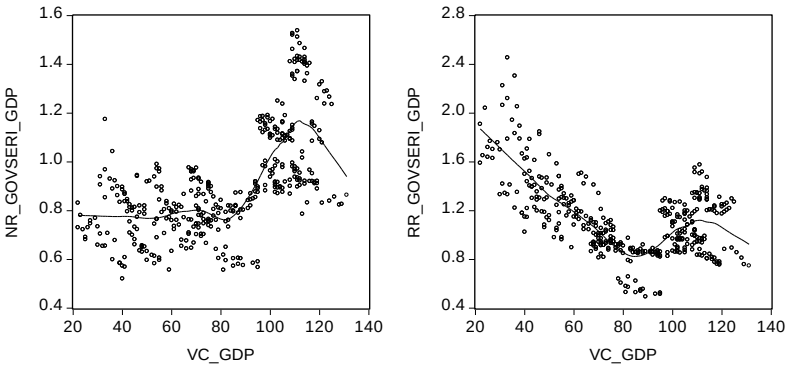
Nominal shares (S) and "real" shares (RS: shares measured at average EU15 prices)



Government individual services



Nominal and real ratio of government individual services



Consumer services represent a special case, as this is the only expenditure item where both nominal and real shares display almost the same form of non-linear relationship with per capita income. The nominal/real share of *government individual services* shows a totally different relationship to real income. In nominal terms, the share of these services is almost flat at low levels of development; it starts to increase above 80 % of the EU15 average income level. Regarding *real* shares, at low levels of per capita income, the share of these services is very high, and falls until about 80% of the EU average. At higher income levels, it first increases, and later tends to decrease somewhat. The same pattern is shown from a different angle in the last two panes of the figure, displaying nominal and real ratios to GDP.[37] The real ratio shows that in low income countries per capita real government expenditures on individual services relative to real per capita GDP have been significantly higher than in the wealthiest EU-member states.

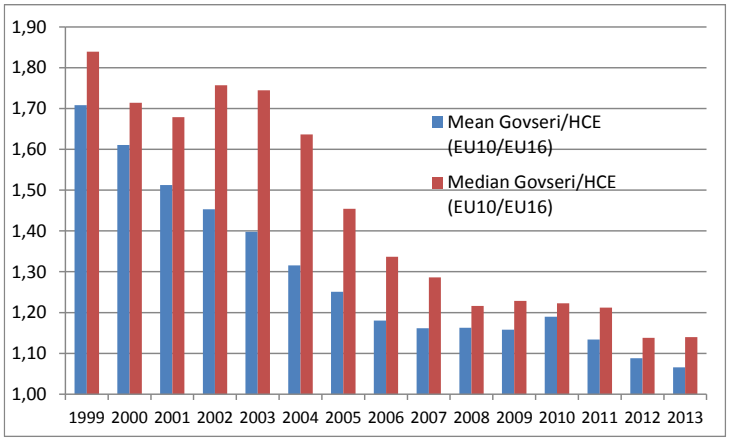
Finally, we show the evolution of an essential indicator signifying the changing relative importance of government transfers in kind in the EU10. Figure 2.23 displays the *real ratio* of government transfers in kind (Govseri) to household consumption expenditures (HCE) in the EU10, as compared to the EU16. Since the early 2000s, when the difference between the EU10 and the EU16 was huge, a declining tendency can be observed. The international crisis halted this tendency, but since 2011 it seems to have continued. In our analysis regarding net

[37] On the interpretation of nominal and real ratios, see section 2.2.1.

wages, we focus on the year 2007, when the mean of the ratios shown in the figure roughly corresponds to the average of the period 2006-2010.

Figure 2.23

The comparison of the mean and median ratio of government individual consumption expenditure to household consumption expenditure between the EU10 and the EU16



Source: Eurostat and own calculations

2.2.4. Productivity, nominal and real labor costs and net real wages

In this section we address issues related to wage levels and wage convergence, paying particular attention to the popular notion that the level of relative wages in the EU10 significantly lags behind the level productivity of these countries. As mentioned earlier, the literature on wage convergence within the EU, as compared to writings on real economic and price convergence, is rather narrow.[38] Moreover, the notion that wages are "too low" in the EU10, is mostly expressed in popular writings[39] and in slogans of political parties[40], rather than in scientific publications. But, however expressed, there is a sense in Eastern Europe that wages do not correspond to the level of productivity. In the following we review the statistical evidence and return a more rigorous analysis in section 3.

[38] See however, Mora - Lopez-Tamayo - Surinach (2005); Palócz (2011); Ramskogler (2010); Šlander, S. - M. Ogorevc (2010); Oblath (2015)
[39] E.g., Pogátsa (2015)
[40] Oblath (2105) quotes several examples of such political slogans.

We consider four (2x2) concepts of "wages"

- labor costs: compensation per employee - (i) nominal (in euro), and (ii) real (converted at P_gdp)
- net wages: we use a proxy - net wage of a single person without children at the average wage level: (i) nominal (euro) and (ii) real: converted at P_hce (PPP for household consumption expenditure)

Relying on these concepts, we consider the following questions:

- How nominal and real labor cost levels are related to productivity?
- Is there evidence of labor-cost convergence in the EU?
- What explains the large discrepancy of net wages between the EU10 and the EU16 (as compared to productivity)

Regarding labor costs, we have time series covering the whole period. However, with respect to *net* nominal/real wages our sample is incomplete, and we have to rely on a single cross-section observation (regarding 2007) covering all countries of the EU26. We begin by reviewing the statistics on nominal and real labor costs vs. productivity; continue by examining whether convergence exists regarding labor costs, and conclude by demonstrating that net wages – roughly in line with popular notions – are indeed relatively low in the EU10 countries. According to our hypothesis, this is compensated by (or alternatively, is a price for) the relatively high share of government transfers in kind.

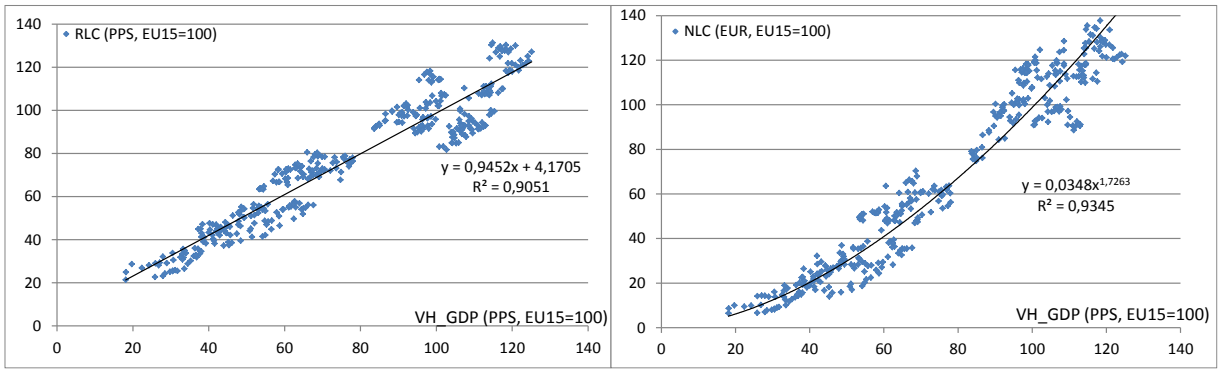
Figure 2.24 shows the pooled cross-section data on real (PPS-based) and nominal (euro-based) labor costs vs. labor productivity. Regarding the series on the right pane, the relationship appears to be linear, while the one the right pane is exponential; close to a quadratic form.[41] The explanation is that the nominal (euro) wage cost can be decomposed into the product of real labor costs at PPP (see the left pane of Figure 2.25) and the price level index of GDP (see Figure 2.15), and both are closely related to the level of real productivity, with coefficients close to 1. [42] Both panes of the chart indicate a very close relationship between labor cost and productivity in the European Union.

[41] For the year 2013, the relationship was almost exactly quadratic.

[42] Formally: NLC(i)/NLC(eu) = RLC(i)/RLC(eu)*PLI(i), where NLC, RLC and PLI, respectively, denote nominal labour cost (in euro), real labour cost (in PPP) and the price level index (the ratio of PPP to the exchange rate). The subscript i, denotes the i^{th} EU member state and eu refers to the EU-average.

Figure 2.24

Real (based on PPS; left pane) and nominal (based on euro; right pane) labor costs vs. labor productivity: pooled cross-section data for the EU26 (1999-2013)

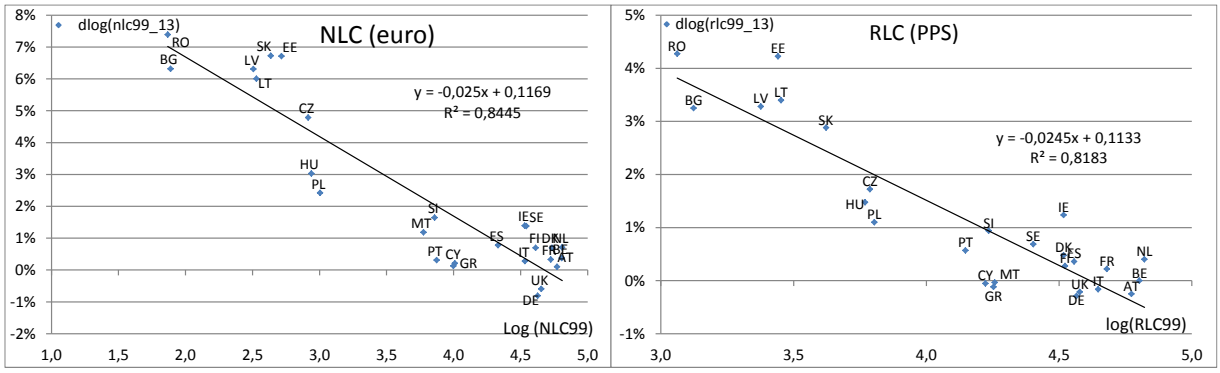


Source: AMECO and own calculations

Regarding convergence in labor costs, we show in figure 2.2.5, how annual rates of changes are related to "initial" (1999) levels. Figure 2.25 shows that initial levels and their changes are correlated for the EU as a whole, but within the two groups (in the EU16 and the EU10), the relationship is much weaker. As a matter of fact, practically no relationship can be detected within the EU16. This is likely to be related to the observation (Figure 2.24.) that labor costs are closely related to labor productivity, and there have been differences in changes among countries regarding the two indicators. It should also be noted that with respect to nominal and real labor costs, Slovenia appears to belong to the more developed group in the EU, rather than to the EU 10. However, in following figures, involving regional comparisons, we consider ratios of the EU10 averages (including Slovenia) to those of the EU16. This may somewhat bias the comparisons.

Figure 2.25

Nominal (euro, left pane) and real (PPS, right pane) labor costs: growth rates between 2000 and 2013 vs. levels in 1999

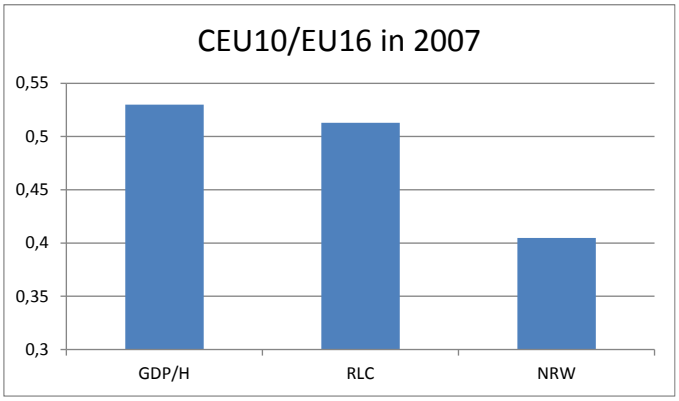


Source: AMECO and own calculations

The following four figures display important stylized facts motivating the statistical analysis in section 3.2. Figure 2.26 shows the constellation in 2007 regarding the mean of the ratio of the EU10 to the EU16, with respect to productivity, gross real labor costs and net real wages (the latter measured at PPP for household consumption expenditures). Relative labor costs were much closer to relative productivity than relative net wages in 2007 – this is the year for which statistics for all countries are available. The figure supports the notion that relative net real wages lag behind both productivity and real labor cost in the EU10. Relative real labor costs, in turn, roughly correspond to relative productivity.

Figure 2.26

Productivity, real labor costs and real net wages in the CEU10, as compared to the EU16 in 2007

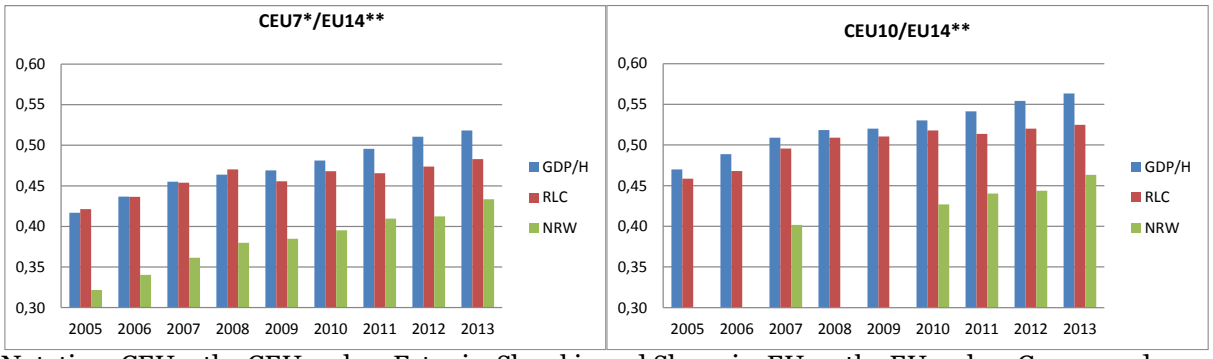


Source: own calculations based on AMECO and Eurostat

The following two charts amend the cross-section observation on 2007. In Figures 2.26 and 2.27 we show comparisons between the means of those members of the EU10 and EU16 group, respectively, for which data are available. Figure 2.27 shows comparative levels of labor productivity, real labor cost and net real wages. The figure suggests that net real wages in the observed EU10 tend to catch up, in line with both labor productivity and labor costs.

Figure 2.27

Productivity, real labor costs and real net wages in the EU10, as compared to the EU16: a comparison based on a limited sample.

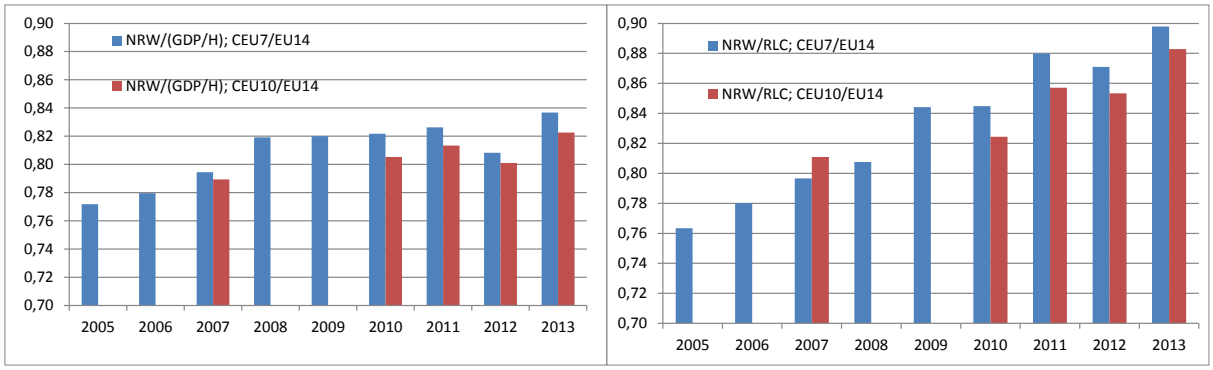


Notation: CEU7: the CEU10, less Estonia, Slovakia and Slovenia. EU14: the EU14, less Cyprus and Malta.
Source: own calculations based on AMECO and Eurostat

However, as shown by figure 2.28, the picture is more complex. In comparison to the more developed countries, the ratio of net real wages to productivity does not show a clear tendency, though there are some signs of a gradual increase (left pane). Then right pane, in turn, shows evidence of a catching up of relative net real wages to relative real labor costs in the new member states.

Figure 2.28

The ratio of net real wages to productivity (left pane) and to real labor costs (right pane)

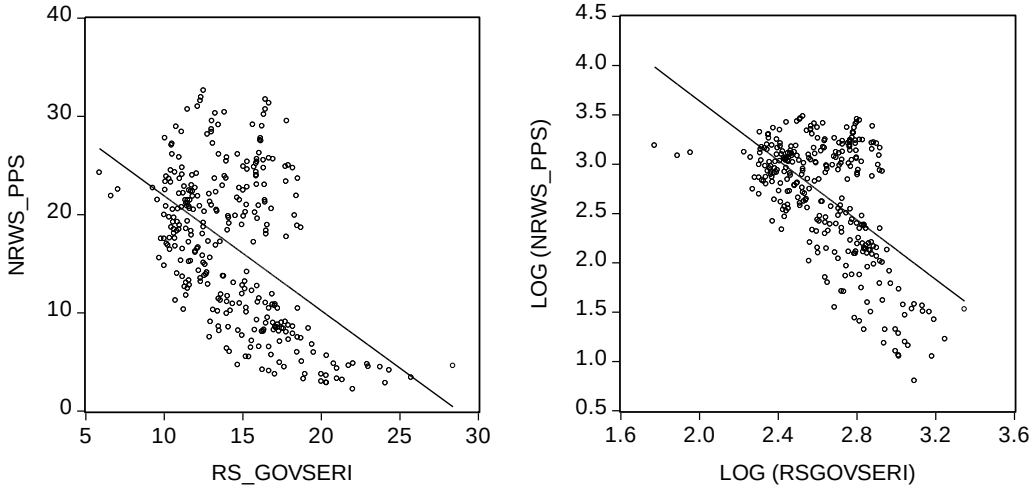


Notation and source: see Figure 2.28.

Figure 2.29 is an important reference for our further analysis regarding net wages. The figure shows – drawing on the unbalanced pooled cross-section data – that there is a negative relationship between net real wages and the real share of government individual services (both measured at PPP): in low-wage countries the real share of these services is generally higher than in countries affording higher wages. We return to the importance of this relationship in our statistical analysis section 3.2.

Figure 2.29

Net real wages (in PPS) vs. the real share of individual government services: the (unbalanced) pooled cross-section; primary data (left pane) and their logs (right pane)



Source: own calculations based on Eurostat.

3. The relationship between real, price, structural and wage convergence in the European Union: statistical analysis

In the following we turn to the quantitative analysis of two major issues brought up by the review of the statistical evidence on economic convergence within the European Union. The first concerns the relationship, and possible interactions, between price-level and real economic convergence. The second concerns the level of, and convergence in, wages – interpreted as both net wages and labor costs – in relation to labor productivity and the sectoral differences between the more affluent and the converging member states of the EU. In section 3.1, we show that misalignments between relative price and income levels affect growth. In section 3.2, we draw attention to the importance of government individual services in explaining the differences in wages between the EU16 and the EU10, regarding both their levels and their changes.

3.1. REAL ECONOMIC AND PRICE LEVEL CONVERGENCE AND THEIR INTERACTIONS: THE EFFECT OF CURRENCY MISALIGNMENT ON GROWTH

In this section we analyze the effect of incongruences between real economic and price level convergence on economic growth in the EU26. For the previous literature on our approach to

exchange rate misalignment, as well as its relationship with economic growth, see our overview in section 2.1.3.

3.1.1 Quantifying exchange rate misalignments

To quantify the extent of misalignments, we draw on the approach based on PPP-theory, corrected for the Penn-effect. Indicators of relative income, productivity and relative price levels are interpreted in comparison to the EU15. As already shown in Figure 2.19, countries at higher income (productivity) levels tend to have higher price levels (PLIs, i.e., cross-section real exchange rates, RERs): this is the Penn-effect proper. We quantify misalignments by the difference between actual PLIs and their estimated levels corresponding to relative income/productivity.[43]

The estimation of the "equilibrium" PLI is based on the following equations, where the explanatory variables of PLIs are, respectively, per capita GDP (VCgdp) and GDP per hours worked (VHgdp), both measured at PPS relative to the EU15. The first is a proxy of relative income, the later that of relative productivity.

$$\log(PLI_i) = \alpha_0 + \alpha_1 * \log(VCgdp_i) + u_i$$

$$\log(PLI_i) = \beta_0 + \beta_1 * \log(VHgdp_i) + v_i$$

Country-specific misalignments are defined as the residuals of the above equations:

$$MISAL_{GDP,i} = 100 * \widehat{u_i} = 100 * \left(\log(PLI_i) - \log\left(\widetilde{PLI_{GDP,i}}\right)\right)$$

$$MISAL_{WH,i} = 100 * \widehat{v_i} = 100 * \left(\log(PLI_i) - \log\left(\widetilde{PLI_{VH,i}}\right)\right)$$

In estimating these equations we followed the approach of Johnson - Ostry - Subramanian (2007), who made the estimations for each year by simple cross-section OLS method.[44]. Due to the logarithmic form, misalignment can be interpreted in relative terms (percentage deviations from zero misalignment). A negative value represents undervaluation, while a positive one indicates overvaluation.

3.1.2. Misalignments within the EU

Figure 3.1 shows boxplots of misalignments based on *VCgdp* ($MISAL_{GDP}$). The countries are sorted according to their average misalignment during 1999-2013. Comparing the EU16 countries (blue-colored) and new member states (green-colored) we cannot see much

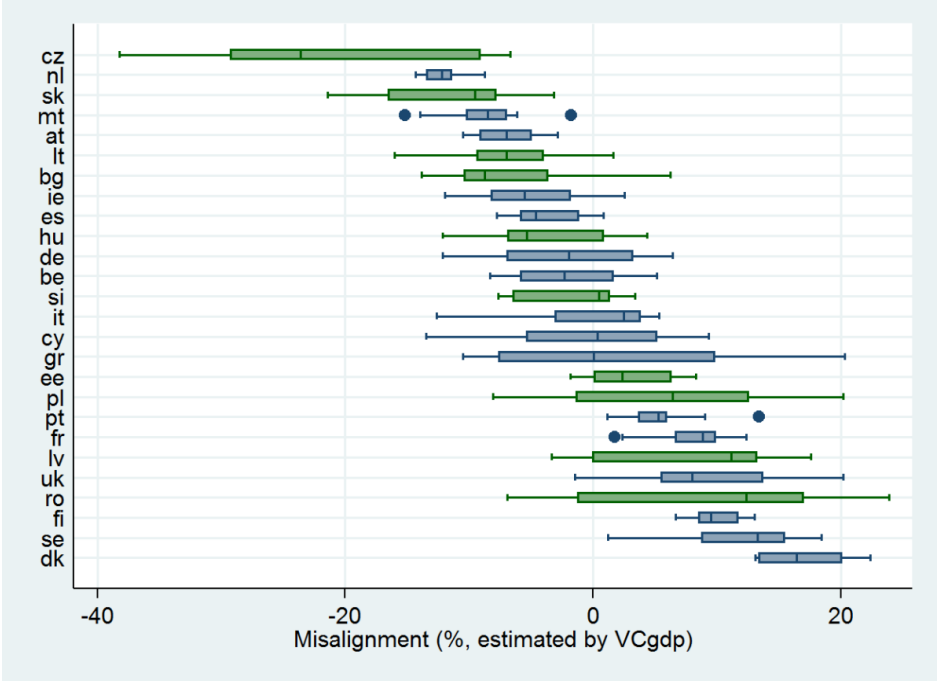
[43] For alternative approaches to the estimation of equilibrium RERs and exchange rate misalignments, see e.g. Isard (2007); Clark - MacDonald (1998) and Égert –Halpern –MacDonald (2005).

[44] In the estimations we controlled for the potential bias due to fixed exchange rates.

difference regarding average misalignments. However, the EU16 countries tend to have smaller boxes indicating that their PLIs did not vary as much as that of the CEE countries.

Figure 3.1

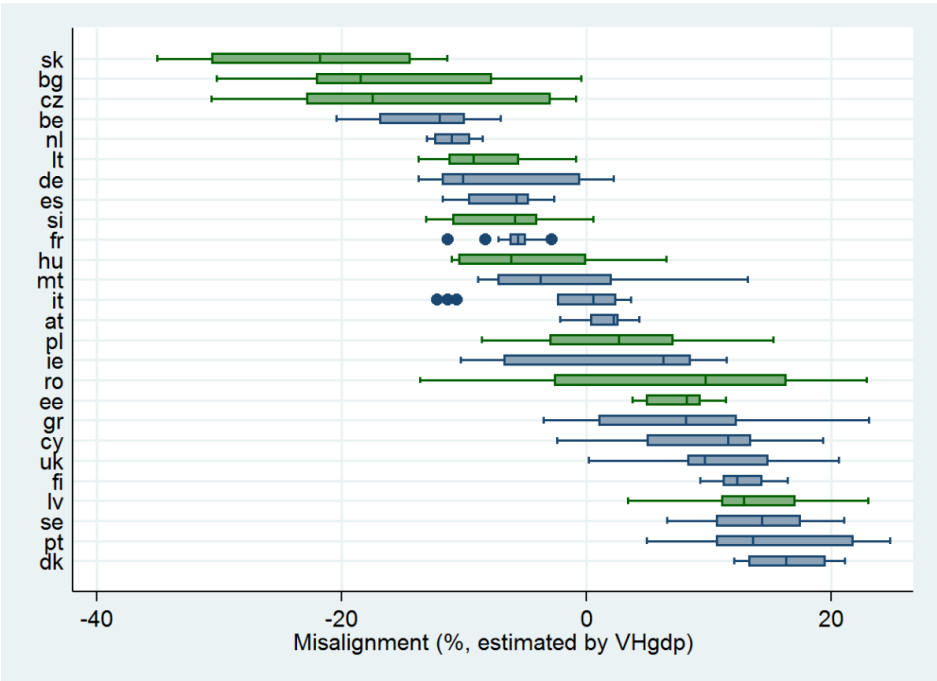
Boxplots of $MISAL_{GDP}$



Source: own calculations based on the Eurostat (2015) database

Figure 3.2

Boxplots of $MISAL_{WH}$



Source: own calculations based on the Eurostat (2015) and AMECO (2015) database

Similar patterns are displayed by Figure 3.2, which shows boxplots of misalignments based on *VHgdp*. The average misalignments of EU16 countries are not closer to the implied equilibrium, but they seem to be more stable compared to the new member states. The differences between the two groups of countries are quantified in Table 3.1.

Table 3.1

Descriptive statistics of misalignment

Group	Mean	Median	Avg. variance	No. of countries
Misalignment (estimated by *VCgdp*)				
EU16	1.40	1.45	24.25	16
CEE10	-2.34	-2.02	48.29	10
Misalignment (estimated by *VHgdp*)				
EU16	2.72	2.34	25.07	16
CEE10	-4.42	-4.58	54.70	10

Source: own calculations based on the Eurostat (2015) and AMECO (2015) database

Based on the numerical values there is a considerable difference between the EU16 and the new member states. The PLIs of the EU16 countries were around 1.4% overvalued, while the developing countries had PLIs undervalued by 2.34% in average. The difference is even larger for misalignment based on *VHgdp*. The average variances of the PLI misalignments reflect our conclusion based on Figure 3.1 and 3.2 that the new member states' PLIs were more volatile compared to the EU16.

3.1.3. Empirical results

Basic models

In the following part we estimate the effect of PLI misalignment on real GDP per capita growth. According to our hypothesis misalignment has a negative relationship with growth, that is undervalued PLI enhances, while overvalued PLI lowers the GDP growth rate. For the estimation we use Barro's (1996) framework that distinguishes the models of absolute and conditional convergence. While the former one assumes that countries with lower initial income grow faster than richer countries regardless other factors, the latter one controls for differences with respect to other economic variables. We place our variable of misalignment in these growth regressions in order to estimate its partial effect on growth. The estimated equations are the following:

Model based on the concept of absolute convergence:

$$VCGR_{it} = \alpha_0 * GDP_{i,t-1} + \alpha_1 * MISAL_{it} + c_i + u_{it}$$

Model based on the concept of conditional convergence:

$$VCGR_{it} = \beta_0 * GDP_{i,t-1} + \beta_1 * MISAL_{it} + \boldsymbol{\gamma} * \boldsymbol{X}_{it} + c_i + v_{it}$$

The dependent variable is the real GDP per capita growth (*VCGR*), while the explanatory variables are the previous year GDP per capita (*GDP*) and our variable for misalignment (*MISAL*). In the conditional equation $\boldsymbol{X}$ indicates the following control variables based on Barro (1996) and Iradian (2007): life expectancy, fiscal deficit (% of GDP), inflation rate, proxy for institutional quality, investment rate (% of GDP), terms of trade and schooling. In the equations c_i stands for country-specific fixed effects.[45]

Table 3.2

Estimated partial effects of $MISAL_{GDP}$

VARIABLES	2-1	2-2	2-3	2-4
GDP_{t-1}	-6.472***	-15.658***	-3.717**	-12.679***
	(2.037)	(3.271)	(1.719)	(3.015)
$MISAL_{GDP}$	-0.142***	-0.117***		
	(0.046)	(0.040)		
$\Delta MISAL_{GDP}$			-0.188***	-0.137***
			(0.040)	(0.029)
Observations	358	320	358	320
R-squared	0.663	0.761	0.655	0.751
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 3.2 summarizes the effect of misalignment estimated by *VCgdp* on economic growth. The coefficients in our interest proved to be significant at all usual levels and support our hypothesis. Based on the absolute model (2-1) if a country has a one percent more (less) undervalued real exchange rate then its growth rate is expected to be 0.14 percentage points higher (lower) on average. This effect is a bit smaller, but still significant in the model of conditional convergence (2-2).

Putting the change of misalignment rather than its level into the equations also led to a negative partial effect on growth (2-3 and 2-4). In the model of absolute convergence (2-3) one percent decrease in misalignment corresponds to 0.19 percentage points higher growth on average. In the controlled model (2-4) its partial effect is around 0.14 percentage points but still statistically significant.

[45] For the detailed results of various specifications, see Appendix 2.

We also estimated these partial effects using the misalignment based on GDP per hours worked and got similar negative coefficients. Nonetheless, their magnitude turned to be much smaller than in Table 3.2 and in some cases they were not statistically different from zero. We do not present these results here, but they are available on request.

We assumed so far that the partial effect of misalignment on growth is linear. However, it is also possible that the effect is different close to the implied "equilibrium" than in cases of highly undervalued or overvalued real exchange rates. To test this assumption we included the squared value of misalignment in the estimated equations. The results are summarized in Table 3.3.

Table 3.3

Estimated partial effects of squared $MISAL_{GDP}$

VARIABLES	3-1	3-2	3-3	3-4
GDP_{t-1}	-7.463***	-16.687***	-6.478***	-16.055***
	(2.057)	(3.183)	(1.742)	(2.998)
$MISAL_{GDP}$	-0.151***	-0.124***		
	(0.043)	(0.039)		
$(MISAL_{GDP})^2$	-0.003*	-0.003***		
	(0.002)	(0.001)		
$MISAL_{WH}$			-0.083**	-0.085**
			(0.035)	(0.037)
$(MISAL_{WH})^2$			-0.004*	-0.004**
			(0.002)	(0.002)
Observations	358	320	358	320
R-squared	0.674	0.773	0.641	0.759
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The estimated coefficients support the hypothesis that there is a nonlinear relationship between PLI misalignment and growth. The estimates are significant at the 10 percent level in the uncontrolled models (3-1 and 3-3) and at the 1 and 5 percent level in the controlled models (3-2 and 3-4). The negative signs indicate that the growth boosting effect of undervaluation is diminishing when a country gets further from the implied "equilibrium". On the other hand, the negative growth effect of overvaluation becomes stronger if the PLI of a country gets further from our calculated equilibrium level.

Further specifications

Rodrik (2008) found empirical evidence that the growth effect of PLI misalignment is different for developing and developed countries. To test this hypothesis in our sample we

included interaction terms in the regressions capturing the difference between the CEE10 countries and the EU16. The results are presented in Table 3.4.

Table 3.4

Differences between CEE10 and EU16 countries

VARIABLES	4-1	4-2	4-3	4-4
GDP_{t-1}	-6.453***	-15.69***	-3.722**	-12.71***
	(2.016)	(3.205)	(1.728)	(3.062)
$MISAL_{GDP}$	-0.158**	-0.130**		
	(0.0623)	(0.0593)		
$CEEC*MISAL_{GDP}$	0.0287	0.0260		
	(0.0800)	(0.0829)		
$\Delta MISAL_{GDP}$			-0.179***	-0.129***
			(0.0530)	(0.0331)
$CEEC*\Delta MISAL_{GDP}$			-0.0174	-0.0140
			(0.0709)	(0.0570)
Observations	358	320	358	320
R-squared	0.664	0.762	0.655	0.751
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The coefficients of PLI misalignment ($MISAL_{GDP}$) and its change ($\Delta MISAL_{GDP}$) remained significant at 5 and 1 percent level, respectively. However, the coefficient of the interaction terms is statistically not different from zero. This indicates that in our sample there is no systematic difference in the misalignment-growth relationship between the two groups of countries. This may be the consequence of the fact that the member states of the European Union are not very far from each other regarding their economic attributes. Rodrik (2008) defined developed countries as those that had a real GDP per capita above $6000. Since every EU member-state in our sample meets this criterion, our results are not in contrast with Rodrik's findings.

Prasad, Rajan & Subramanian (2007) found asymmetric partial effect for undervaluation and overvaluation on economic growth. Their results suggested that the negative growth effect of overvalued PLI is stronger and more significant than the growth-enhancing effect of an undervalued real exchange rate. Table 3.5 summarizes our regression results including interactions capturing this effect.

Table 3.5

Estimates for asymmetric partial effects

VARIABLES	5-1	5-2	5-3	5-4
GDP_{t-1}	-7.298***	-16.65***	-3.827**	-12.64***
	(2.137)	(3.252)	(1.714)	(2.904)
$MISAL_{GDP}$	-0.210**	-0.183***		
	(0.0830)	(0.0646)		
UVAL*MISAL	0.130	0.131*		
	(0.104)	(0.0748)		
$\Delta MISAL_{GDP}$			-0.287***	-0.211***
			(0.0562)	(0.0308)
UVAL*$\Delta MISAL_{GDP}$			0.219***	0.161***
			(0.0625)	(0.0405)
Observations	358	320	358	320
R-squared	0.670	0.768	0.668	0.759
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Based on these results, there is little evidence for asymmetry in the case of the level of misalignment. The estimated coefficients are around 0.13 but they are not significant at the 5 percent level (5-1 and 5-2 models). However, in the case of the change of misalignment, we got highly significant estimates. In the uncontrolled model (5-3) one percent devaluation has – on average – a 0.29 percentage point growth boosting effect, if the currency is already overvalued. For undervalued PLI the partial effect falls to 0.07 percentage point. Therefore we can draw the inference that the partial effect of PLI undervaluation or overvaluation on growth is much stronger when the relative price level is above its implied equilibrium.

-*-

Our results clearly indicate that there is evidence for a negative relationship between PLI misalignment and economic growth, which is in line with the findings in the relevant literature. However, it is far from evident whether this relationship can be used for policy purposes. Podkaminer (2010) showed many examples among the EU member states during the last two decades, where real economic convergence did not speed up, in spite of a strongly undervalued real exchange rate. Therefore, it is crucial to take into consideration country-specific factors when reflecting on the possible applications of this relationship in the conduct of actual economic policy.

For reaching policy-relevant conclusions, it should be important to clarify: through what channels, and under which particular conditions do exchange-rate (PLI) misalignments affect real economic performance. One of the possible explanations was presented by Gala (2007), who argued that an undervalued (more competitive) real exchange rate makes investments

relatively more profitable. Accordingly, a higher investment rate enables the adoption of new technologies and the implementation of needed structural changes in the economy.

In our sample we found some evidence for the channel suggested by Gala. The correlation between PLI misalignment (based on *VCgdp*) and the investment rate (in percent of GDP) is around -0.23 indicating a weak negative relationship: undervaluations are accompanied higher investment rates. Regarding the changes of misalignment and investments, a weak negative correlation (-0.18) can also be found. Though these indicators simply mean statistical co-movements, rather than causal relationships, they suggest that investments may provide one of the channels whereby exchange rate misalignment can promote or hamper the growth rate of an economy.

3.2 THE LEVEL AND CONVERGENCE OF NET EARNINGS AND LABOR COSTS

3.2.1 Economic background and problems of measurement

Before turning to the quantitative analysis of the factors affecting the comparative level of wages – interpreted both as net earnings and labor costs – we recall some of our earlier findings. As demonstrated, the internal *real* share (volume ratio) of individual government services (e.g., healthcare, education etc.) to real income is disproportionately high in the EU10. We also saw that the opposite holds for *net real* wages: the latter are lower than implied by relative productivity. Our proposition is that the two are interrelated. Moreover, we claim that this relationship is not simply due to statistical conventions regarding the measurement of public (non-market) services, but to historical reasons, leading to differences between the EU10 and the EU16, regarding the composition of household income and consumption. More specifically, our claim is that the "cost" of the relatively high volume of government transfers in kind to households has been the comparatively low level of net wages in the EU10, and *vice versa*: the "compensation" for the low level of net earnings has been the relatively high volume of individual government services.[46] There is no presumption of a causal relationship: the two are joint legacies of the socialist economic system (as interpreted by Kornai, 1992). This already had (see section 2.2.4), and will certainly have future implications for changes in the composition of real household income and consumption, along with economic convergence of the EU10. However, the verification of the proposition is not simple.

[46] Kornai (1992b) was the first to call attention to the phenomenon of a „premature welfare state" in the former socialist countries, but he did not address its implications for comparative net real wages.

To start with, the interpretation and international comparison of *net wages* involves several conceptual and technical difficulties.[47]. A further problem stems from the fact that a *national average* for net wages is unavailable in our statistical source, the Eurostat database on net earnings. [48] Therefore, as a compromise, our choice for the representative *net nominal* wage (in euro) is that of a *single employee*, *earning the average gross wage*. For the purposes of *international comparisons,* we calculate the representative *net real* wage as this average deflated by the PPP for individual consumption expenditures. It is conceptually clear, comparable across countries and suited for our goal, which is clarifying whether the relatively low level of net wages is, or is not, related to the relatively high per capita volume (real share) of government services in the EU10.[49].

A further problem, however, stems from a possible endogeneity: most government services are measured from the input side; and inputs of these services are mainly labour costs. Furthermore, PPPs for most government services are derived from the comparison of "compensation of employees" in the public sector.[50] Therefore we have to face the question: if the asserted inverse relationship between the comparative real level of government services and net nominal/real wages exists, isn't it a statistical artifact (or more bluntly: a tautology), without actual economic content? (See also our view on the notion of "comparison resistance" of public services in Box 3. above.)

We believe that the issue can be decided on empirical grounds. The size of *individual* and *collective* government services are measured and deflated for the purposes of international real comparisons by the same statistical methods.[51]. If there was an endogeneity of the tautological type, we should expect that the assumed negative relationship with net real wages holds for both individual and collective government services. However, our proposition would be strongly supported, if we found that that a negative relationship exists regarding the former, but does not hold for the latter.

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[47] For example, family support in the form of tax allowances does, but cash transfers to households do not, affect net wages. Since there are mayor differences among countries regarding the choice between the two forms of family support, the comparison of net wages may be misleading with respect to wage-earners' nominal labour income.

[48] Depending on family size and other factors – e.g., the distance from the minimum/average gross wage – tax allowances are markedly different across countries. See the Eurostat database: annual net earnings: http://appsso.eurostat.ec.europa.eu/nui/show.do

[49] Actually, the cross-section averages of alternative measures of net real wages are very closely correlated with one another– the correlation coefficients are around 0.98 – suggesting that the cross-country variation in any of the indicators is large enough to make any of them "representative" of national net real wages when comparing member-countries of the EU

[50] Compensation of employees is the concept of labour costs used in our study: it includes gross wages and social security contributions paid by the employer.

[51] PPPs are calculated in a similar way for both types of public expenditures.

3.2.2. Statistical analysis and tentative results

Beyond the difficulties discussed above, a further statistical problem stems from the fact that – as mentioned in section 2.2.4 – 2007 is the only year for which comparable measures on net earnings regarding all of the 26 countries in our sample are available. Therefore, we focus on the year 2007 in the cross-section comparison of net wages and labor costs. Regarding changes, we use data for both net wages and labor costs, but on interpreting the results with respect to changes in net wages, it should be kept in mind that the estimations rely on an unbalanced panel of the EU26.

The level of net earnings and labor costs in the EU: a cross-section analysis for the year 2007

In the first round, we try to explain the log of nominal (euro) net wages (NNWS) in the EU26 by the following variables: log of labor productivity (VH_gdp), log of the price level of household consumption expenditures (P_hce) and a dummy for the CEU10.

$$NNWSi = \alpha_0 + \alpha_1 * VH\_gdp_i + \alpha_2 * P\_hce_i + \alpha_3 * CEU10 + u_i$$

The results are displayed in column 3 of table 3.6. (The single effects of productivity and the price level of household consumption expenditures are shown in column 1 and 2, respectively). The results in column 3 strongly suggest that belonging to the CEU10 group has a powerful and statistically significant negative effect on net wages – controlled for differences in levels of productivity and price levels. While, regarding the partial effects, relative productivity contributes to a 1 percent higher level of net wages by about 0.8 percentage points, and a higher consumer price level by 1 percentage points, the "CEU10 effect" decreases net wages by approximately 0.4 percentage points.

How are these results affected by replacing the CEU10 dummy with the real share of government individual services? As shown in column 4, the coefficient of the price level is higher, but the negative coefficient of government individual services is very close to that of the coefficient of the CEU10 dummy, suggesting that differences in the real share of these public services is a likely explanation of the relatively low net wages observed in the CEU10.

Table 3.6

The level of net nominal wages in 2007: full sample (EU26)

	Dependent variable: log (net nominal wage in euro) in 2007								
Explanatory variables	1	2	3	4	5	6	7	8	9
log(VH_gdp) 2007	1.83***	0.85***	0.78***	0.82***	0.92***				
	(13.56)	(3.76)	(4.11)	(3.96)	(3.66)				
Log(P_hce) 2007		1.55***	1.01***	1.52***	1.66***	1.83***	2,35***		
		(4.78)	(3.18)	(5.14)	(4.54)	(8.51)	(18,01)		
CEU10			-0.42***			-0,45***		-1.41***	
			(-3.28)			(-3.36)		(-9.78)	
log(RS_govseri) 2007				-0.37**			-0,40**		(-1.18)*
				(-2.41)			(-2,37)		(-1.90)
log(RS_govserc) 2007					0.222				
					(0.661)				
Adj.R^2	0.88	0.94	0.96	0.95	0.94	0.95	0.94	0.80	0.13
Obs.	26	26	26	26	26	26	26	26	26

Notation: VH_gdp: GDP per hours worked at PPP (EU15=100); P_hce: the price level of household consumption expenditure (EU15=100); RS_govseri: the real share (measured at average EU15 prices) of government individual services; RS_govserc: the real share (measured at average EU15 prices) of government collective services; CEU10: dummy for the EU10.
(t-statistics in parentheses; ***: significant at 1% ; **: significant at 5%; *: significant at 10%.)
Source: own calculations based on AMECO and Eurostat

Next, we ask whether this explanation is reliable in both the economic and the statistical sense. If we were to the observe that government *collective* consumption expenditures (police, army, etc.) are as strongly negatively correlated with the level of net wages, as *individual* expenditures (healthcare, education, etc.), we would have to dispose of the idea that differences in net wages have to do with government transfers in kind provided to households. However, as shown by column 5, collective government services are unrelated to net wages. The sign is positive, but the coefficient is not significantly different from zero. This is a partial confirmation of our hypothesis.

However, there is a further point to be tested. In section 2.2.4 we demonstrated that, in contrast with *net wages*, gross *labor costs* do not significantly lag behind relative productivity in the EU10 countries. Therefore, we expect that the associations shown in Table 3.6 between net wages and the CE10 dummy on the one hand, and the real share of government individual services on the other, do not hold with respect to gross labor costs. The results are shown in Table 3.7.

Table 3.7

The level of labor costs in 2007: full sample (EU26)

	Dependent variable: log (gross nominal labor cost in euro) in 2007					
Explanatory variables	1	2	3	4	5	6
log(VH_gdp)	1.68***	0.69***	0.68***	0.68***		
	(16.75)	(4.67)	(4.69)	(4.65)		
Log(P_gdp)		1.39***	1.24***	1.38***	2.01***	2.19***
		(7.21)	(5.83)	(7.25)	(10.92)	(21.16)
CEU10			-0.13		-0.160	
			(-1.57)		(-1.40)	
log(RS_govseri)				-0.13		(-0.16)
				(-1.32)		(-1.17)
R^2	0.92	0.97	0.97	0.97	0.95	0.95
Obs.	26	26	26	26	26	26

Notation: VH_gdp: GDP per hours worked at PPP (EU15=100); P_gdp: the price level of GDP (EU15=100); RS_govseri: the real share (measured at average EU15 prices) of government individual services; CEU10: dummy for the EU10.
(t-statistics in parentheses; ***: significant at 1%)
Source: own calculations based on AMECO and Eurostat

In line with our expectation, as demonstrated by the results presented in columns 3 through 6, the coefficients of both the CEU10 dummy and that of RS_govseri are statistically insignificant in all specifications.

We consider the estimation results shown in Tables 3.6 and 3.7 as indications supporting our hypothesis that the relatively high per capita real level (real share) of government services provided to households is a relevant explanation of the relatively low level of net wages in the EU10 countries. However, as the results are based on observations regarding a single year – 2007, for which data on net wages for all of the EU26 countries are accessible – they will have to be checked when statistics for other years on our full sample become available.

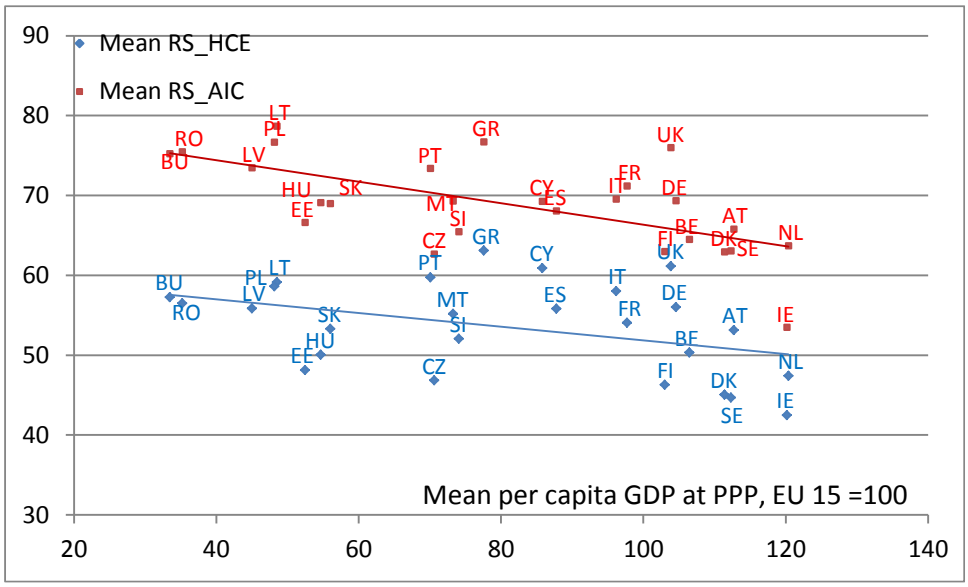
We considered it important to check whether our empirical findings can be reconstructed relying on economic principles. Therefore, we constructed a model, presented in Appendix 1, consisting of three household consumption categories: goods, market services and public services. The model is consistent with our empirical findings: it suggests that a higher level of public services provided to households is associated with lower wages. Quantitative exercises, to be performed later on, can tell whether the size of this effect is in line with the empirical evidence.

To confirm our results, we took a look at the macroeconomic relationship between per capita household consumption and and per capita income measured at average EU prices. As shown by figure 3.3, there is no sign of a lag in total household consumption (including

government transfers) or in consumption expenditures of households in the less developed countries of the EU. Instead, the figure indicates a mildly decreasing trend in the share of real household consumption as a function of real per capita GDP. This contradicts the notion that wages in the less developed countries fall behind real macroeconomic income.

Figure 3.3.

The share of total household consumption (AIC) and household consumption expenditure (HCE) vs. per capta GDP at average EU prices (averages for 1999-2013)



Source: own calculations based on Eurostat

Finally, we consider factors affecting *changes* in net nominal wages and labor costs. The estimations regarding net wages are based on an unbalanced panel, thus, the results are illustrative. In spite of the methodological concerns, it should be observed that in the EU10 there has been a strong (much stronger than in the EU16) negative association between the change in net wages and the change in government individual services (compare column 2 with column 3). This suggests that in the EU10 not only the level of net wages, but also their changes are negatively related to the real share of government services in kind. This finding is in line with the statistical evidence presented in section 2.2.4.

Table 3.8

Change in net nominal wages

	Dependent variable: dlog(net nominal wage in euro)		
	Full sample (mean: 0.046)	EU10 (mean: 0.076	EU16 (mean: 0.029)
Explanatory variables	1	2	3
dlog(VH_gdp)	0.564***	0.243	0.820***
	(6.55)	(1.64)	(6.26)
dlog(P_hce)	1.134***	1.172***	0.883***
	(17.96)	(13.11)	(7.93)
dlog(RS_govseri)	-0.160***	-0.233***	-0.104**
	(-3.46)5	(-2.72)	(-1.98)
R^2	0.573	0.646	0.319
Obs.	278	104	174

Notatios: see Figures 3.6. and 3.7 (t-statistics in parentheses; ***: significant at 1% ; ** significant at 5%)
Source: own calculations based on AMECO and Eurostat

Table 3.9

Change in nominal labor costs

	Dependent variable: dlog(nominal labor cost in euro); 1999-2013 (mean: 0,022)		Dependent variable: dlog(nominal labor cost in euro); 1999-2008 (mean: 0,037)	
Explanatory variables	1	2	3	4
dlog(VH_gdp)	0.521***	0.523***	0.492***	0.526***
	(8.94)	(9.11)	(6.21)	(7.54)
dlog(P_gdp)	1.210***	1.211	1.115***	1.132***
	(18.46)	18.931***	(15.93)	(15.14)
log(NLC99)	-0.002		-0.007**	
	(-1.54)		(-2.42)	
CEU10		0.0045*		0.0100*
		(1.71)		(1.92)
Adj R^2	0.808	0.809	0.810	0.805
No obs.	364	364	234	234

Notatios: see Figures 3.6. and 3.7 (t-statistics in parentheses; ***: significant at 1% ; ** significant at 5%)
Source: own calculations based on AMECO and Eurostat Notation:

As for changes in labor costs (table 3.9), there appears to be a divide within the period analyzed (1999-2013) – shown by columns 1 and 2. The results for the sub-period before the international crisis (1999-2008; columns 3 and 4) show evidence of convergence in labor

costs. Considering the period as a whole, however, the correspondence between initial levels of labor costs and their changes disappears. Almost the same holds for the CEU10 dummy.

These results suggest that there was a break in the convergence process of wages within the EU after the international crisis in 2008.

4. Summary and conclusions

Our study explored four interrelated aspects of economic convergence and their linkages over the period 1999-2013, focusing on the experiences of 26 member states of the European Union, with special focus on the ten Central and East-European new members (the EU10) We addressed the interrelations between real economic, price level, structural and wage level convergence. Regarding real and price convergence, we showed that there was a rapid catch-up in both per capita GDPs and general price levels of the less developed EU-countries until 2008, followed by a significant slow-down. We also showed that there is a tendency for price levels to converge towards the trend implied by the longer-term relationship between real per capita GDPs and price levels within the EU. Our research affirmed the finding that positive/negative deviations from the trend (i.e., over/undervaluation) have a negative/positive effect on real economic convergence. Relying on cross-country price level indices (PLIs), we demonstrated that the relative price of services does, but their "real" share (measured at common prices of the EU) does not increase along with real income. We showed that this is mainly due to the fact that non-market services (in particular government transfers in kind) have a relatively high, though slowly declining real share in the less developed EU countries' economy. These findings help us understand, why, in international comparison, net real wages are relatively low in these countries (as compared to their relative level of income/productivity): lower net wages have been compensated for by a higher level of public transfers in kind to households.

It is important to emphasize that our results are related to the description and explanation of observed phenomena and the implied policy recommendations are both tentative and asymmetric. Our results suggest that avoiding overvaluation is likely to be benefical for economic growth, but they do not suggest that the observed positive association between currency undervaluation and economic growth can actually be used as a policy instrument for boosting economic convergence in the less developed EU-member states. Policies contributing to a growth-friendly macroeconomic and institutional environment are much more promising for achieving sustained economic convergence.

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Appendix 1: A model of net wages and public services

1 Environment

Technology

There are three consumption commodities: goods, market services, and public services. Each commodities are produced with the following technologies:

$$Y_{jt} = A_{jt} L_{jt}^{\theta} \qquad \theta \in (0,1) \quad j \in \{g, s, p\} \tag{1}$$

where subscripts g, s and p stand for goods, market services, and public services, respectively.

Households

Households are endowed with one unit of time. The life–time utility is given by

$$\sum_{t=0}^{\infty} \beta^t \log(C_t) dt \tag{2}$$

where $\beta \in (0,1)$ is the discount factor and the consumption aggregator is of the nested constant–elasticity–of–substitution form:

$$C_t = \left(\omega_g^{\frac{1}{\varepsilon}} C_{gt}^{\frac{\varepsilon-1}{\varepsilon}} + \omega_s^{\frac{1}{\varepsilon}} \left(\phi_g^{\frac{1}{\sigma}} C_{st}^{\frac{\sigma-1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} C_{pt}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma-1}{\sigma}\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{3}$$

ω_j are positive weights and $\varepsilon \in [0, \infty)$ is the elasticity of substitution between the two consumption commodities (with $\varepsilon = 1$ being the Cobb–Douglas case). The household derives utility from goods, market services and public services. The structure of the preferences assumes that goods are substitutes/complements with composite services, while market and public services are substitutes/complements with each other. For example, the elasticity of substitution between goods and market services depends on the amount of public services. For gives values of ε and σ, more supply of public services make goods and market services more substitutable.

Resource constraints

The resource constraints are:

$$C_{jt} = A_{jt} L_{jt}^{\theta} \qquad j \in \{g, s, p\} \tag{4a}$$

$$1 = L_{gt} + L_{st} + L_{pt} \tag{4b}$$

The first equation simply combines the production technology of commodities with the market clearing conditions. The second is the labour market clearing condition.

2 Equilibrium

Production of goods and services

There is perfect competition in the markets for goods and services for the production factor: labor. The first–order condition to the problem of the private firm is:

$$W_t = P_{jt} \theta A_{jt} L_{jt}^{\theta-1} \qquad j \in \{g, s\} \tag{5}$$

where W_t denotes the rental price for labour. The perfect competition equalises wages across sectors. Using this relationship the relative prices are determined by

$$\frac{P_{st}}{P_{gt}} = \frac{A_{gt}}{A_{st}} \left(\frac{L_{gt}}{L_{st}} \right)^{\theta-1} . \tag{6}$$

Thus relative prices depend both on relative productivities and on relative labours allocated to goods and market services.

Production of public services

The government does not optimises the choice of labour. It chooses a level of public services it wishes to supply, and then raises enough revenues through taxes to pay the wage bill in the public sector. We assume that the government taxes private income at rate τ, but it does not levies taxes on wages in the government sector. In reality public sector workers pay taxes. We only assumed that they are not to simplify the algebra. It would not effect our result in

any meaningful way if we assumed that the government taxes it. Thus, the government budget constraint and resource constraint are characterised by

$$W_t L_{pt} = \tau(P_{gt} Y_{gt} + P_{st} Y_{st}), \tag{7a}$$

$$C_{pt} = A_{pt} L_{pt}^{\theta}. \tag{7b}$$

Using the fact that

$$W_t = \theta \frac{P_{jt} Y_{jt}}{L_{jt}},$$

we can express sector output in current prices as

$$P_{jt} Y_{jt} = \frac{W_t L_{jt}}{\theta}$$

Substituting this into (7a) and rearranging, we obtain

$$W_t L_{pt} = \tau \left(\frac{W_t L_{gt}}{\theta} + \frac{W_t L_{st}}{\theta} \right).$$

After dividing both sides with W_t, using (4b) and rearranging, this equation can be solved for L_{pt}

$$L_{pt} = \frac{\tau}{\tau + \theta}. \tag{8}$$

The expression links the tax rate to the amount of labour in the public sector. Combining this equation with (9) gives us the production of government services as a function of the tax rate

$$C_{pt} = A_{pt} \left(\frac{\tau}{\tau + \theta} \right)^{\theta}. \tag{9}$$

Households

The representative household solves the following problem:

$$\max_{\{C_{gt},C_{st}\}} \left(\omega_g^{\frac{1}{\varepsilon}} C_{gt}^{\frac{\varepsilon-1}{\varepsilon}} + \omega_s^{\frac{1}{\varepsilon}} \left(\phi_g^{\frac{1}{\sigma}} C_{st}^{\frac{\sigma-1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} C_{pt}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{10a}$$

$$\text{s.t} \quad (1-\tau)(P_{gt}Y_{gt} + P_{st}Y_{st}) + W_t L_{pt} = P_{gt}C_{gt} + P_{st}C_{st} \tag{10b}$$

The household takes the income variables in the left hand side, and prices P_{gt} and P_{st} as given.

The optimal decision of the households is characterised by

$$\frac{P_{gt}}{P_t} = \omega_g^{\frac{1}{\varepsilon}} \left(\frac{C_t}{C_{gt}} \right)^{\frac{1}{\varepsilon}} \tag{11a}$$

$$\frac{P_{st}}{P_t} = \omega_s^{\frac{1}{\varepsilon}} \left(\frac{C_t}{\tilde{C}_{st}} \right)^{\frac{1}{\varepsilon}} \phi_g^{\frac{1}{\sigma}} \left(\frac{\tilde{C}_{st}}{C_{st}} \right)^{\frac{1}{\sigma}} \tag{11b}$$

where P_t is the shadow price associated with the household budget constraint, and

$$\tilde{C}_{st} \equiv \left(\phi_g^{\frac{1}{\sigma}} C_{st}^{\frac{\sigma-1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} C_{pt}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{12}$$

Combing the two equations leads to

$$\frac{P_{st}}{P_{gt}} = \phi_g^{\frac{1}{\sigma}} \left(\frac{\omega_s}{\omega_g} \right)^{\frac{1}{\varepsilon}} \left(\frac{\tilde{C}_{st}}{C_{st}} \right)^{\frac{1}{\sigma}} \left(\frac{\tilde{C}_{st}}{C_{gt}} \right)^{-\frac{1}{\varepsilon}}. \tag{13}$$

Given the price of market services relative to goods, the household chooses an optimal C_{gt} and C_{st}, but this choice is also affected by the supply of public services which is included in $\tilde{C}_t$.

3 Equilibrium: Putings Things Together

We are ready now to combine the various equilibrium conditions. Substituting (13) and (12)

into (13) yield

$$\frac{P_{st}}{P_{gt}} = \phi_g^{\frac{1}{\sigma}} \left(\frac{\omega_s}{\omega_g}\right)^{\frac{1}{\varepsilon}} \left(\phi_g^{\frac{1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} \left(\frac{C_{pt}}{C_{st}}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}} \left(\phi_g^{\frac{1}{\sigma}} \left(\frac{C_{st}}{C_{gt}}\right)^{\frac{\sigma-1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} \left(\frac{C_{pt}}{C_{gt}}\right)^{\frac{\sigma-1}{\sigma}}\right)^{-\frac{\sigma}{\sigma-1}\frac{1}{\varepsilon}}. \tag{14}$$

Next we substitute out the consumption levels with the supplies (4a) which gives us

$$\left(\frac{A_{gt}}{A_{st}}\right)^{\varepsilon} \left(\frac{L_{gt}}{L_{st}}\right)^{\varepsilon(\theta-1)} = \phi_g^{\frac{1}{\sigma}} \left(\frac{\omega_s}{\omega_g}\right)^{\frac{1}{\varepsilon}} \left(\phi_g^{\frac{1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} \left(\frac{A_{pt}L_{pt}^{\theta}}{A_{st}L_{st}^{\theta}}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\varepsilon}{\sigma-1}} \left(\phi_g^{\frac{1}{\sigma}} \left(\frac{A_{st}L_{st}^{\theta}}{A_{gt}L_{gt}^{\theta}}\right)^{\frac{\sigma-1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} \left(\frac{A_{pt}L_{pt}^{\theta}}{A_{gt}L_{gt}^{\theta}}\right)^{\frac{\sigma-1}{\sigma}}\right)^{-\frac{\sigma}{\sigma-1}}$$

which we can rearrange as

$$\left(\frac{A_{st}}{A_{gt}}\right)^{1-\varepsilon} \left(\frac{L_{st}}{L_{gt}}\right)^{\varepsilon+(1-\varepsilon)\theta} = \phi_g^{\frac{1}{\sigma}} \left(\frac{\omega_s}{\omega_g}\right)^{\frac{1}{\varepsilon}} \left(\phi_g^{\frac{1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} \left(\frac{A_{pt}}{A_{st}} \left(\frac{L_{pt}}{L_{st}}\right)^{\theta}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\varepsilon-\sigma}{\sigma-1}}$$

The labour market clearing condition (4b), and the relationship between income tax and labour imply

$$\frac{L_{st}}{L_{gt}} = \frac{(\tau+\theta)L_{st}}{\theta-(\tau+\theta)L_{st}} \tag{15a}$$

$$\frac{L_{pt}}{L_{st}} = \frac{\tau}{(\tau+\theta)L_{st}} \tag{15b}$$

If we use these two relationships to substitute out L_{st}/L_{gt} and L_{pt}/L_{st} from the previous equilibrium condition we obtain

$$\left(\frac{A_{st}}{A_{gt}}\right)^{1-\varepsilon} \left(\frac{(\tau+\theta)L_{st}}{\theta-(\tau+\theta)L_{st}}\right)^{\varepsilon+(1-\varepsilon)\theta} = \phi_g^{\frac{1}{\sigma}} \left(\frac{\omega_s}{\omega_g}\right)^{\frac{1}{\varepsilon}} \left(\phi_g^{\frac{1}{\sigma}} + \phi_s^{\frac{1}{\sigma}} \left(\frac{A_{pt}}{A_{st}} \left(\frac{\tau}{(\tau+\theta)L_{st}}\right)^{\theta}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\varepsilon-\sigma}{\sigma-1}}. \tag{16}$$

This expression contains only one endogenous variable, namely, L_{st}, hence this condition determines the equilibrium in the services sector.

The left hand side is increasing in L_{st} with the left hand side equaling to zero if $L_{st} = 0$, and it is infinity as $L_{st} \to \theta/(\tau+\theta)$. Suppose that $\varepsilon > \sigma$, then the right hand side is is decreasing in

L_{st} with with the left hand side approaching infinity as $L_{st} \to 0$, and it is some finite constant for $L_{st} \to \theta/(\tau + \theta)$. Hence there is a unique L_{st} that satisfies this equilibrium condition. Hence the equilibrium exists and it is unique.

4 Net wages and government services in general equilibrium

The data suggest that there is a *negative correlation* between net wages and public services at purchasing power parities. This can be interpreted as a correlation between variables while holding relative prices constant. In our case net wages in terms of manufacturing output can be expressed as

$$w_t \equiv (1 - \tau)W_t = (1 - \tau)\theta A_{gt} L_{gt}^{\theta - 1}$$

which implies

$$L_{st} = \frac{\theta}{\tau + \theta} - L_{gt} = \frac{\theta}{\tau + \theta} - \left(\frac{(1 - \tau)\theta A_{gt}}{w_t} \right)^{\frac{1}{1-\theta}}.$$

Substituting this back into (16), one obtains an expression that is implicitly expresses w_t a a function of τ. Since τ is the only determinant of the level of public services, the derivative of w_t with respect to τ shows as how net wages change as public services change. After tedious algebra one can show that

$$\frac{dw_t}{d\tau} < 0, \tag{17}$$

hence higher level of public services indeed is associated with lower wages. A more precise quantitative exercise can tell whether the size of this effect is in line with the empirical evidence.

Appendix 2: Supplementary tables to section 3.1

Table A.1

Variables and sources

Abbreviation	Source	Variable
gdpo (or gdp_c_cpps)	Eurostat	GDP per capita, current PPS
gdp_gr	Eurostat	GDP volume index
pl_gdp	Eurostat	Relative price level of GDP
gdp_vh	AMECO	GDP per hours worked
eduv	World Bank	WB Gross enrolment ratio. Secondary. All programmes. Total
life	World Bank	WB Life expectancy at birth, total (years)
fiscal	Eurostat	General government Net lending (+) /net borrowing (-), % of GDP
gov_gdp	Eurostat	Final consumption expenditure of general government
infl	Eurostat	HICP (2005 = 100) Annual average rate of change
efw	Fraser Institute	Economic Freedom of the World index
inv_gdp	Eurostat	Fixed capital formation, % of GDP
tot	Eurostat	Terms of trade (P_Export/P_import)

Table A2.

The effect of misalignment estimated by per capita GDP; detailed results

VARIABLES	(1) UC1	(2) C1	(3) UC2	(4) C2
L.lgdpo	-6.472***	-15.658***	-3.717**	-12.679***
	(2.037)	(3.271)	(1.719)	(3.015)
misal	-0.142***	-0.117***		
	(0.046)	(0.040)		
life		-0.976		-0.986
		(0.668)		(0.677)
fiscal		0.103		0.107
		(0.078)		(0.078)
gov_gdp		-0.614**		-0.476*
		(0.251)		(0.231)
infl		-0.163***		-0.122**
		(0.041)		(0.050)
efw		0.144		-0.019
		(0.882)		(0.842)
inv_gdp		0.249**		0.303**
		(0.102)		(0.110)
tot		0.006		0.016
		(0.031)		(0.035)
educ		0.009		0.007
		(0.024)		(0.020)
2001.year	-1.028**	0.016	-1.173***	-0.155
	(0.376)	(0.479)	(0.390)	(0.440)
2002.year	-0.922*	0.920	-1.188**	0.700
	(0.529)	(0.741)	(0.565)	(0.763)
2003.year	-0.475	2.209**	-0.889	1.810
	(0.611)	(1.043)	(0.637)	(1.098)
2004.year	0.772	3.832***	0.291	3.397**
	(0.674)	(1.274)	(0.637)	(1.380)
2005.year	0.878	4.101***	0.202	3.474**
	(0.773)	(1.388)	(0.721)	(1.506)
2006.year	2.341**	5.989***	1.529*	5.149***
	(0.916)	(1.635)	(0.825)	(1.725)
2007.year	2.532**	6.411***	1.534	5.373**
	(1.050)	(1.925)	(0.947)	(1.999)
2008.year	-0.577	5.622**	-1.775*	4.241*
	(1.005)	(2.275)	(0.875)	(2.347)
2009.year	-7.328***	0.807	-8.573***	-0.528
	(0.907)	(2.336)	(0.782)	(2.398)
2010.year	-0.490	7.171***	-1.539*	6.200**
	(0.817)	(2.403)	(0.811)	(2.530)
2011.year	0.301	8.537***	-0.867	7.483**
	(1.123)	(2.981)	(1.078)	(3.200)
2012.year	-1.704	6.851**	-2.954**	5.785*
	(1.154)	(3.041)	(1.118)	(3.288)
2013.year	-0.999		-2.306**	
	(1.103)		(1.057)	
D.misal			-0.188***	-0.137***
			(0.040)	(0.029)
Constant	66.405***	233.281***	39.962**	201.695***
	(19.683)	(64.253)	(16.579)	(69.024)
Observations	358	320	358	320
R-squared	0.663	0.761	0.655	0.751
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A3.

The effect of misalignment estimated by GDP per hour worked; detailed results

VARIABLES	(1) UC1	(2) C1	(3) UC2	(4) C2
L.lgdpo	-4.783**	-14.392***	-4.584**	-14.487***
	(1.933)	(3.552)	(2.208)	(3.364)
misal_vh	-0.066*	-0.071*		
	(0.035)	(0.039)		
life		-0.965		-0.904
		(0.688)		(0.715)
fiscal		0.122		0.112
		(0.082)		(0.083)
gov_gdp		-0.536**		-0.517*
		(0.260)		(0.256)
infl		-0.142**		-0.157**
		(0.054)		(0.060)
efw		0.114		0.081
		(0.950)		(0.932)
inv_gdp		0.302**		0.328***
		(0.109)		(0.114)
tot		0.019		0.014
		(0.037)		(0.036)
educ		0.005		0.007
		(0.023)		(0.021)
2001.year	-1.134**	-0.033	-1.246***	-0.150
	(0.415)	(0.499)	(0.407)	(0.414)
2002.year	-1.108*	0.863	-1.237**	0.724
	(0.546)	(0.785)	(0.509)	(0.697)
2003.year	-0.736	2.066*	-0.880	1.906*
	(0.631)	(1.091)	(0.572)	(1.029)
2004.year	0.416	3.599**	0.263	3.417**
	(0.672)	(1.316)	(0.588)	(1.298)
2005.year	0.424	3.768**	0.268	3.559**
	(0.787)	(1.427)	(0.734)	(1.432)
2006.year	1.803*	5.534***	1.637*	5.286***
	(0.891)	(1.650)	(0.812)	(1.660)
2007.year	1.880*	5.836***	1.701*	5.588***
	(0.999)	(1.935)	(0.942)	(1.985)
2008.year	-1.352	4.920**	-1.546*	4.667*
	(0.956)	(2.299)	(0.860)	(2.346)
2009.year	-8.131***	0.273	-8.329***	-0.069
	(0.846)	(2.384)	(0.834)	(2.359)
2010.year	-1.173	6.860**	-1.357	6.548**
	(0.841)	(2.463)	(0.885)	(2.505)
2011.year	-0.455	8.167**	-0.647	7.873**
	(1.199)	(3.057)	(1.241)	(3.193)
2012.year	-2.511**	6.497**	-2.709**	6.209*
	(1.213)	(3.123)	(1.229)	(3.268)
2013.year	-1.841		-2.043*	
	(1.159)		(1.136)	
D.misal_vh			-0.036	-0.058*
			(0.036)	(0.031)
Constant	50.230**	216.788***	48.415**	212.764***
	(18.629)	(66.314)	(21.421)	(71.122)
Observations	358	320	357	319
R-squared	0.626	0.742	0.617	0.736
Number of cc	26	26	26	26

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A4.

The non-linear effect of misalignment estimated by per capita GDP; detailed results

VARIABLES	(1) UC1	(2) C1	(3) UC1	(4) C1
L.lgdpo	-7.463***	-16.687***	-6.478***	-16.055***
	(2.057)	(3.183)	(1.742)	(2.998)
misal	-0.151***	-0.124***		
	(0.043)	(0.039)		
misal_sq	-0.003*	-0.003***		
	(0.002)	(0.001)		
life		-0.992		-0.868
		(0.630)		(0.627)
fiscal		0.097		0.111
		(0.074)		(0.072)
gov_gdp		-0.598**		-0.447
		(0.245)		(0.265)
infl		-0.186***		-0.157***
		(0.038)		(0.053)
efw		-0.012		-0.053
		(0.845)		(0.944)
inv_gdp		0.260**		0.328***
		(0.097)		(0.092)
tot		0.004		0.015
		(0.037)		(0.044)
educ		0.012		0.012
		(0.025)		(0.021)
2001.year	-1.003**	0.015	-1.038**	-0.008
	(0.367)	(0.455)	(0.414)	(0.450)
2002.year	-1.026*	0.767	-1.111**	0.735
	(0.508)	(0.685)	(0.511)	(0.675)
2003.year	-0.562	2.080**	-0.746	1.860**
	(0.571)	(0.969)	(0.551)	(0.903)
2004.year	0.654	3.720***	0.309	3.334***
	(0.653)	(1.189)	(0.568)	(1.108)
2005.year	0.883	4.107***	0.434	3.589***
	(0.766)	(1.324)	(0.698)	(1.200)
2006.year	2.351**	5.993***	1.828**	5.302***
	(0.907)	(1.559)	(0.809)	(1.407)
2007.year	2.654**	6.546***	2.028**	5.738***
	(1.055)	(1.835)	(0.957)	(1.690)
2008.year	-0.489	5.745**	-1.201	4.731**
	(1.036)	(2.155)	(0.908)	(2.017)
2009.year	-7.252***	0.780	-8.063***	-0.218
	(0.963)	(2.203)	(0.808)	(2.083)
2010.year	-0.501	7.103***	-1.212	6.332***
	(0.796)	(2.227)	(0.770)	(2.161)
2011.year	0.372	8.618***	-0.321	7.857***
	(1.054)	(2.760)	(1.062)	(2.687)
2012.year	-1.543	7.026**	-2.265*	6.307**
	(1.109)	(2.826)	(1.118)	(2.787)
2013.year	-0.822		-1.580	
	(1.057)		(1.073)	
misal_vh			-0.083**	-0.085**
			(0.035)	(0.037)
misal_vh_sq			-0.004*	-0.004**
			(0.002)	(0.002)
Constant	76.516***	245.502***	67.470***	225.023***
	(19.974)	(59.805)	(16.942)	(58.999)
Observations	358	320	358	320
R-squared	0.674	0.773	0.641	0.759
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A5.

The effect of misalignment according to country estimated by per capita GDP, groups; *detailed results*

VARIABLES	(1) gdp_gr	(2) gdp_gr	(3) gdp_gr	(4) gdp_gr
L.lgdp0	-6.453***	-15.69***	-3.722**	-12.71***
	(2.016)	(3.205)	(1.728)	(3.062)
missal	-0.158**	-0.130**		
	(0.0623)	(0.0593)		
ob.ceeu#co.underval	0	0		
	(0)	(0)		
1.ceeu#c.underval	0.0287	0.0260		
	(0.0800)	(0.0829)		
life		-0.963		-0.983
		(0.669)		(0.678)
fiscal		0.0990		0.106
		(0.0783)		(0.0784)
gov_gdp		-0.619**		-0.479*
		(0.252)		(0.236)
infl		-0.166***		-0.121**
		(0.0395)		(0.0503)
efw		0.115		-0.0174
		(0.892)		(0.841)
inv_gdp		0.254**		0.304**
		(0.103)		(0.111)
tot		0.00435		0.0156
		(0.0329)		(0.0350)
educ		0.00917		0.00695
		(0.0242)		(0.0203)
2001.year	-1.037**	0.00398	-1.170***	-0.152
	(0.378)	(0.482)	(0.389)	(0.442)
2002.year	-0.940*	0.902	-1.183**	0.707
	(0.531)	(0.744)	(0.566)	(0.768)
2003.year	-0.490	2.198**	-0.891	1.814
	(0.606)	(1.043)	(0.638)	(1.100)
2004.year	0.756	3.819***	0.291	3.401**
	(0.679)	(1.275)	(0.636)	(1.386)
2005.year	0.864	4.083***	0.201	3.478**
	(0.784)	(1.385)	(0.718)	(1.515)
2006.year	2.322**	5.961***	1.532*	5.155***
	(0.921)	(1.629)	(0.827)	(1.736)
2007.year	2.515**	6.384***	1.534	5.375**
	(1.056)	(1.918)	(0.946)	(2.008)
2008.year	-0.617	5.573**	-1.760*	4.257*
	(1.004)	(2.272)	(0.889)	(2.372)
2009.year	-7.377***	0.746	-8.566***	-0.518
	(0.924)	(2.352)	(0.787)	(2.420)
2010.year	-0.530	7.110***	-1.542*	6.202**
	(0.852)	(2.428)	(0.809)	(2.539)
2011.year	0.278	8.497***	-0.877	7.477**
	(1.144)	(2.988)	(1.059)	(3.202)
2012.year	-1.720	6.820**	-2.957**	5.786*
	(1.167)	(3.038)	(1.112)	(3.299)
2013.year	-1.011		-2.307**	
	(1.108)		(1.058)	
D.misal			-0.179***	-0.129***
			(0.0530)	(0.0331)
ob.ceeu#coD.misal			0	0
			(0)	(0)
1.ceeu#cD.misal			-0.0174	-0.0140
			(0.0709)	(0.0570)
Constant	66.26***	233.0***	40.00**	201.7***
	(19.43)	(63.45)	(16.66)	(69.37)
Observations	358	320	358	320
R-squared	0.664	0.762	0.655	0.751
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A6.

The effect of "under" and "overvaluations" estimated by per capita GDP; detailed results

VARIABLES	(1) gdp_gr	(2) gdp_gr	(3) gdp_gr	(4) gdp_gr
L.lgdpo	-7.298***	-16.65***	-3.827**	-12.64***
	(2.137)	(3.252)	(1.714)	(2.904)
misal	-0.210**	-0.183***		
	(0.0830)	(0.0646)		
0b.uval#co.misal	0	0		
	(0)	(0)		
1.uval#c.misal	0.130	0.131*		
	(0.104)	(0.0748)		
life		-0.919		-1.042
		(0.652)		(0.679)
fiscal		0.103		0.0943
		(0.0767)		(0.0788)
gov_gdp		-0.613**		-0.481**
		(0.252)		(0.228)
infl		-0.175***		-0.120**
		(0.0385)		(0.0484)
efw		0.0625		-0.0815
		(0.851)		(0.796)
inv_gdp		0.260**		0.304**
		(0.0998)		(0.112)
tot		0.00676		0.0144
		(0.0358)		(0.0332)
educ		0.0130		0.0111
		(0.0236)		(0.0201)
2001.year	-1.009**	0.00426	-1.303***	-0.261
	(0.378)	(0.461)	(0.359)	(0.410)
2002.year	-0.941*	0.862	-1.428**	0.517
	(0.513)	(0.706)	(0.517)	(0.727)
2003.year	-0.522	2.131**	-1.109*	1.665
	(0.577)	(1.004)	(0.570)	(1.038)
2004.year	0.689	3.726***	0.123	3.346**
	(0.651)	(1.233)	(0.586)	(1.330)
2005.year	0.877	4.070***	0.231	3.553**
	(0.767)	(1.369)	(0.725)	(1.469)
2006.year	2.368**	5.966***	1.458*	5.181***
	(0.913)	(1.610)	(0.774)	(1.669)
2007.year	2.651**	6.479***	1.537	5.476***
	(1.070)	(1.899)	(0.903)	(1.942)
2008.year	-0.486	5.686**	-1.888**	4.245*
	(1.044)	(2.234)	(0.802)	(2.243)
2009.year	-7.275***	0.759	-8.626***	-0.544
	(0.941)	(2.263)	(0.764)	(2.314)
2010.year	-0.455	7.110***	-1.471*	6.316**
	(0.794)	(2.301)	(0.770)	(2.472)
2011.year	0.399	8.540***	-0.882	7.581**
	(1.089)	(2.859)	(1.009)	(3.111)
2012.year	-1.518	6.943**	-2.918**	5.931*
	(1.158)	(2.935)	(1.077)	(3.206)
2013.year	-0.799		-2.399**	
	(1.099)		(1.002)	
D.misal			-0.287***	-0.211***
			(0.0562)	(0.0308)
0b.uval#coD.misal			0	0
			(0)	(0)
1.uval#cD.misal			0.219***	0.161***
			(0.0625)	(0.0405)
Constant	75.06***	239.1***	41.15**	205.8***
	(20.86)	(61.93)	(16.57)	(67.15)
Observations	358	320	358	320
R-squared	0.670	0.768	0.668	0.759
Number of cc	26	26	26	26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Appendix 3: Charts

Figure A1

The evolution of per capita GDP at current PPP (EU15=100) and the real share of services in the CEE10 countries (1999-2013)

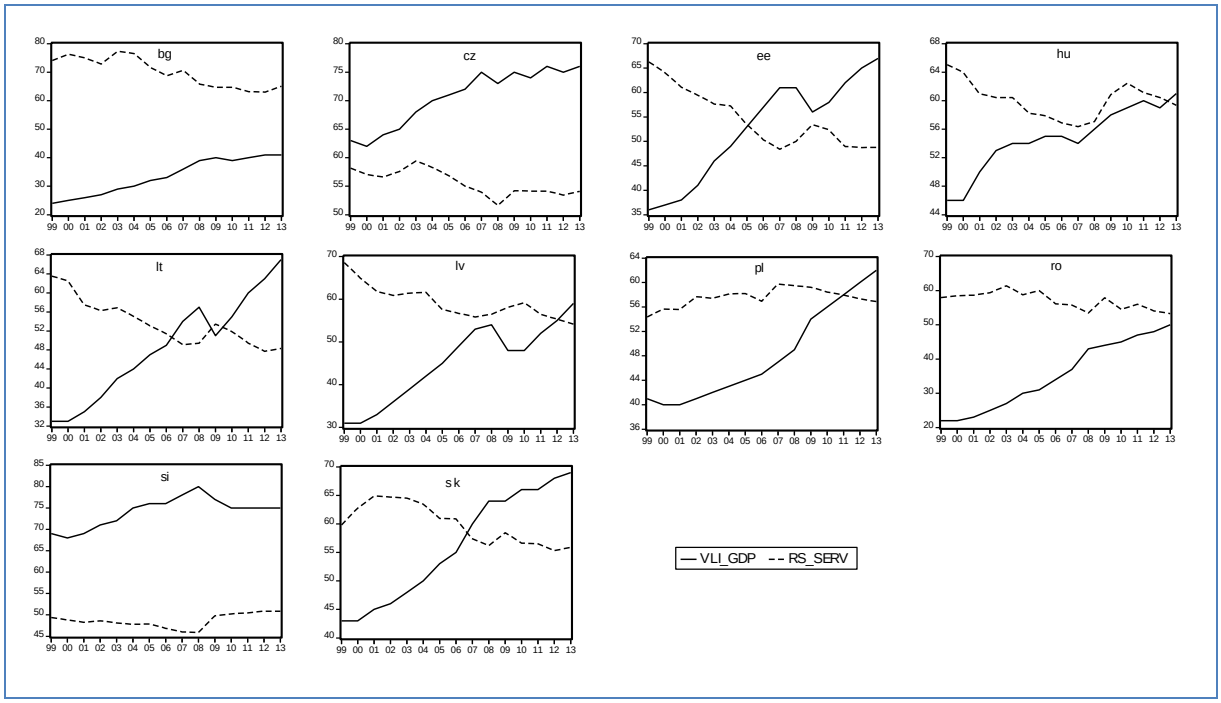
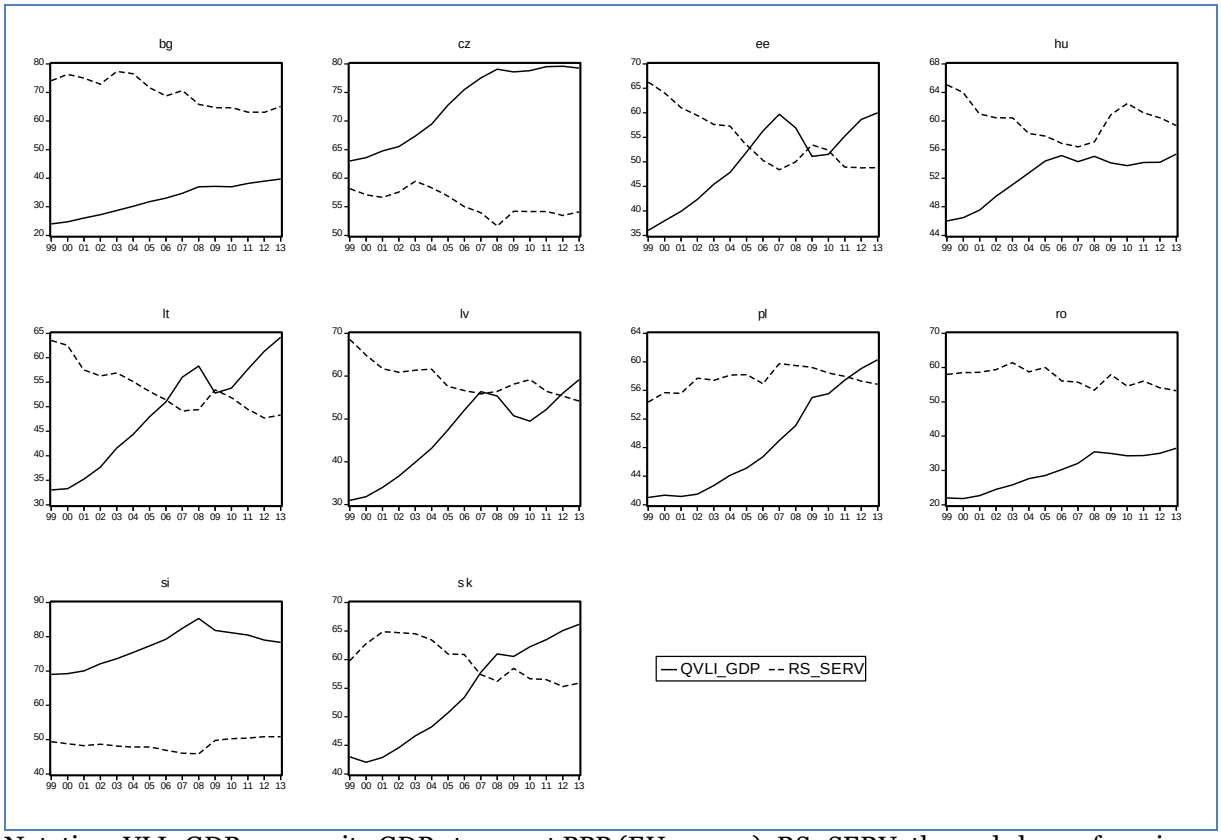


Figure A2

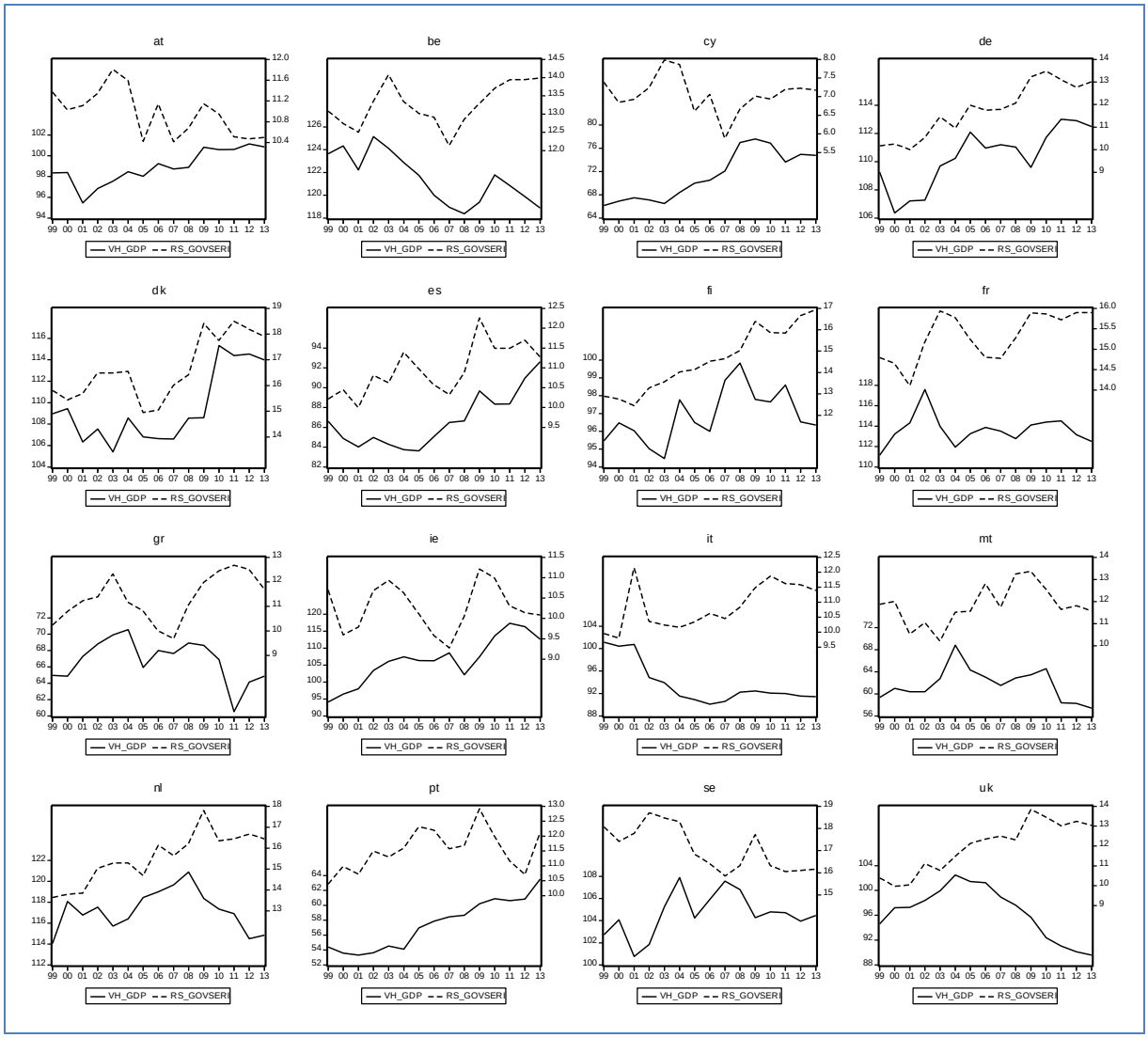
The evolution of per capita GDP at constant (1999) PPP (EU15=100) and the real share of services in the CEE10 countries (1999-2013)



Notation: VLI_GDP: per capita GDP at current PPP (EU15=100); RS_SERV: the real share of services (measured at average EU15 prices); QVLI_GDP: per capita GDP at constant (1999) PPP (EU15=100), Source: Eurostat and own calculations

Figure A3

The evolution of per capita GDP at current PPP (EU15=100) and the real share of services in the EU16 (1999-2013)



Notation and source: see table A 2