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Convergence Patterns at the Industrial Level: the Dynamics of Comparative Advantage

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Contents

List of Tables and Figures

Abstract

Although there exists a vast literature on convergence and divergence issue at the aggregate level, there is only little work on convergence and/or divergence processes of productivity and wage levels at the more disaggregated industrial level. These are especially important in the context of international trade regarding the dynamics of comparative advantages and resulting trade structures between developing and developed countries. In the first theoretical part, we discuss briefly some theoretical aspects of uneven sectoral productivity and wage catching-up processes, which determines patterns of dynamic comparative advantages and trade structures. Second, we present in *Part A* an econometric study of catching-up processes of wage rates and productivity levels and in *Part B* of export unit values (a measure of product quality); the analysis is conducted at the industrial level (ISIC 3-digit) over the period 1965-95 for a set of catching-up and more advanced economies. We use a large international sample of OECD, other European and Asian economies and undertake a cross-section and time-series analysis of convergence processes. In a separate exercise we examine the catching-up patterns of Central and Eastern European economies.

Keywords: industrial catching up, wages and productivity, international patterns of comparative advantage, vertical product differentiation in international trade

JEL classification: C21, C23, F14, J31, L6, O47

Executive Summary

Part A of this paper first looks at catching-up processes in productivity and wage levels for a large international country sample (36 countries) over the period 1963 to 1995 and then compares the quantitative features found for such longer-term catching-up patterns with the growth patterns found for the CEECs from 1993 onwards. Part B then applies a similar methodology to study catching-up patterns for export unit values which can be interpreted as indicators for product quality.

In the first section of Part A in this paper we discuss the effects of uneven sectoral productivity and wage catching-up for the dynamics of international comparative advantage. This is first done by reviewing some of the theoretical literature on this issue, but the main part of this paper is devoted to study the empirical patterns of catching-up processes. For this purpose a large international comparative database has been constructed (from UNIDO industrial statistics) comprising the range of OECD economies, Asian and Latin American economies. Industry level productivity and wage levels were expressed in current PPPs and relative to a 'lead economy' (the USA). The emphasis is on studying so-called 'convergence' patterns (i.e. reductions in the global spreads of productivity and wage levels between the lead and the follower economies). A number of methodological procedures are applied: from a simple statistical analysis using coefficients of variation to cross-country and time series econometric studies. We started with the analysis of catching-up patterns for total manufacturing before moving on to industry-level estimates. The cross-country studies on convergence show that on average 2.5% of the technology (productivity) gap is closed per year. After controlling for the effects of individual countries we found more or less the same speed of convergence for wage levels. These econometric cross-country results are well confirmed in the time series analysis (we use Dickey-Fuller tests here). The use of the full yearly time series (as compared to using trend estimates in the cross-country analysis above) allows the examination of country specific catching-up patterns. The country with the fastest catching-up parameters estimated over the period is Japan with a half-time of about 8.3 years (i.e. the number of years necessary to close half of the gap). The average half time estimated over the whole country sample is 20 to 25 years. Further, with the exception of Japan and the Eastern Asian countries (NICs2) all countries show higher wage than productivity convergence.

As mentioned above, the dynamics of comparative advantage of leader and follower countries are driven by the catching-up processes at the detailed industrial level and also by the relative movements of productivity, product quality and wage catching-up (see also Landesmann and Stehrer, 1999 for a theoretical model on this issue). To study the disaggregated pattern we chose a range of medium-to-high tech (mechanical and electrical engineering) and low tech sectors (textiles, clothing and leather products). Applying the same range of methods as introduced for aggregate manufacturing above, we found some

striking differences between the lower tech and the medium/high tech sectors: Productivity convergence is higher in the medium/high-tech industries, whereas wage catching-up is more or less the same in both types of industries. This is an indication for a wage drift across industries and an indication that catching-up countries are losing (over time) comparative unit cost advantages in the low tech sectors. This pattern is again confirmed by applying the time series methodology. We then consider the evolution of the productivity and wage catching up of CEEC economies since 1993 (i.e. after the transformational recessions). The statistical database is rather small here and we are forced to use a somewhat different approach, but the above derived pattern also emerges: Broadly, there is evidence that also the CEECs are gaining comparative cost advantages in the medium-/ high-tech sectors and losing comparative advantages in the low-tech sectors.

Part B of the paper then considers convergence/catching-up patterns in export unit values which are taken as indicators for product quality. These indicators are calculated from a very large, product level database (at the 8-digit product level from the Eurostat's COMEX database) on EU imports. Six industries were included in our analysis (three engineering industries and textiles, clothing and leather products) and as 'lead' economies served 6 EU economies and the US; all other countries export price gaps were expressed as ratios of their export unit values relative to those of the lead economies. For the sample as a whole, a graphical inspection of the data shows that convergence processes in product quality do not seem to occur quickly. Applying cross-country econometric analysis to the data yields estimates of a half time of about 33 years when all industries are included. Convergence, furthermore, is faster in the low tech industries. Including only the CEECs from 1991 onwards, however, shows much higher rates of convergence for the higher tech industries (half time of about 10 years!). Although there are some drawbacks in applying the time series analysis in this case, due to short time series and high volatility of the data, the time series tests also broadly confirm these results. Hence, we find that for export prices which are used as indicators for product quality, the countries from Central and Eastern Europe (this result is, as we show, driven by the quality catching-up processes of the more advanced 'Western' CEECs) witnessed relatively fast product quality catching-up in the more advanced engineering industries over the period 1991-96, while for the large international country sample (over the longer time span 1975 to 1996) there was more product quality catching-up in the more labour-intensive, lower-tech industries. (More detailed product quality/export unit value analysis is available in the paper by Burgstaller and Landesmann, 1999).

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Convergence Patterns at the Industrial Level: the Dynamics of Comparative Advantage

1 Introduction

A number of the CEE countries have started a catching-up process with Western Europe in terms of income per capita, productivity and wages, although maybe at a lower speed than expected. This catching-up process at the aggregate level is seen in general to be advantageous for the Eastern as well as the Western European countries. On the other hand, catching-up processes in the tradable goods sectors may also affect the industrial and trade structures, the employment and the specialization structures in both the Eastern and Western European countries. This is seen as a matter of concern in the political debate on integration and trade liberalization.

There arise two questions: Firstly, what drives the process of aggregate catching-up? For example, Bernard and Jones (1996) show in a study of 14 OECD countries that aggregate convergence results (in labour productivity or total factor productivity) are driven mainly by the services sector or by compositional changes, and that the manufacturing sector by itself shows little evidence of convergence. Furthermore, the particular sample of countries included determines the result on convergence; on this issue see especially De Long (1988). Secondly, the politically more sensitive issue are the catching-up processes in the tradable goods sectors. In fact, a similar argument as by Bernard and Jones (1996) at the aggregate level, can be stated for the tradable goods sector (manufacturing): sufficient conditions for convergence at the aggregate level are, first, convergence in output shares and, second, sector-specific convergence in levels. But for the tradable goods sector things are more complicated, as specialization structures and hence output shares are influenced by the evolution of relative cost and price structures and thus depend on the relative movements of productivity, wage levels and product quality. Uneven catching-up processes and thus changes in the structure of comparative advantages change via international trade the industrial and employment structures in open economies and thus are a matter of political concern.

This chapter mainly focuses on this latter point, i.e. the uneven catching-up dynamics of productivity and wage levels as well as of export prices (a measure of product quality) and the resulting structure and dynamics of comparative advantages. We examine here the convergence in levels. The paper goes as follows: First, in section 2, we present some theoretical considerations on the effects of uneven sectoral catching-up and its potential impact on structure and trade specialization. Part A then is concerned with productivity and

* The calculations in Part B of this paper were carried out by Johann Burgstaller.

wage catching-up. We first provide in section 3 some evidence on convergence at the level of total manufacturing where we also introduce the methodology for our empirical analysis. These methods are then in section 4 also applied at the more disaggregated/industrial level. We restrict our analysis to four manufacturing industries, two of which can be characterized as low-tech and the other two as technologically more sophisticated industries. In sections 3 and 4 we use time series from 1965 onwards for a large country sample. Section 5 then compares these results with the catching-up patterns of the Central and Eastern European (CEE) countries and derives some conclusions concerning the evolution of changes in comparative advantages. Section 6 of Part B uses the same methodology (together with some panel estimations) to study catching-up processes in export prices, which are interpreted as product quality indicators, again for a large country sample but especially with respect to the catching-up processes of the CEECs.

PART A Productivity and Wage Catching-up

2 The effects of uneven sectoral productivity and wage catching-up – theoretical considerations

In a simple comparative-static model based on Dornbusch et al. (1977), Krugman (1986) discusses the effects of technological catching-up processes and the emerging patterns of trade. The rates of progress g_z (the labour productivity growth rates in a one factor model) for each good z are an index of the technology intensity of the goods, where g_z is higher for more technology-intensive goods. Wage rates are assumed to be the same in all sectors, but not between countries, where the wage is higher in the more developed country. The productivity gap is larger in technology-intensive goods. In equilibrium, each country has a 'specialization niche' in the range of goods, where the developed country has a comparative advantage in the more technology-intensive goods; this determines the pattern of trade specialization. In the continuum of goods, the less developed country has comparative advantages in the goods ranging from 0 to z*.

If a country is catching up at an equal rate in all sectors (modelled as reducing the lag behind the technological frontier), the productivity gains are relatively larger in the more technology-intensive sectors. The range of goods in which the catching-up country shows comparative advantages grows to the range of products 0 to z**, z** > z*. It can be shown that the wage differential falls, but by less than the productivity gains at the marginal good z*. Thus in this model, the catching-up countries are gaining comparative advantages in their most technology-intensive products, whereas the leading countries are losing comparative advantages in their least technology-intensive industries.[1]

[1] This result is similar to the model by Feenstra and Hanson (1996) using a general-equilibrium framework with capital transfers.

For our purposes the model can be reinterpreted in the following way: First, we assume that there are two different sectors (call them 'high-tech' and 'low-tech' sectors respectively, i = 1, 2), each producing a range of goods from $z_i = 0, ..., Z_i$. Again, we assume that g_{zi} (the rate of technological progress) is higher the higher the technology intensity and thus can be used as an index of technology intensity. Although the high-tech sector has higher productivity growth rates (and thus is more technology-intensive) on average, the most technology-intensive goods in the low-tech sector can be more technology-intensive than the least technology-intensive goods in the high-tech sector. Second, we assume that wages are determined exogenously and are equalized across sectors.[2] Within each sector, the range of goods in which a country has comparative advantages depends on the wage and productivity differentials in this sector.

Before discussing the 2-sector model, let us discuss shortly the assumption of exogenously given (or sticky) wages. This assumption implies, first, that labour markets need not to be cleared (or there can arise unemployment) and, second, that there can arise temporary balance of payments disequilibria.[3] As wages are set exogenously, a country can gain comparative advantages by lowering the wage rate (and thus widening the wage differential).

A lowering of the technology gap can then be discussed for two limiting cases: First, if the wage gap remains constant, the catching-up country gains a larger share, the range of production grows from z* to a level z*** which is larger than in the Krugman version (z**), where wages adjust to the new equilibrium as explained above. Second, if the productivity gain at the marginal product is fully compensated by closure of the wage differential, the pattern of specialization remains constant at z*. The equilibrium model analysed in Krugman (1986) lies between these two limiting cases.

We shall now move to discuss the case of the model with two sectors. The formulation of technology and the assumptions of the catching-up process imply that technological catching-up is higher on average in the high-tech sectors. We further assume that wages are equal across sectors. A catching-up country has then some possibilities for wage policy:

(1) Low-wage policy: Wages are increasing so that the marginal good in the low-tech sector remains constant (at z_2* in the low-tech sector). As the gains in comparative advantages are higher in the high-tech sector and wages are sticky, the country is gaining comparative advantages relatively more in this sector.

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2 This assumption can be generalized so that wage rates differ between the high- and the low-tech sectors.

3 See e.g. Dornbusch et al. (1977) who discuss the effects of sticky money wages under the assumptions of fixed and flexible exchange rates. In this paper only effects of exogenously given wage rates on the specialization structures are discussed. A more rigorous analysis of the effects of catching-up under the assumption of sticky money wages on aggregate employment levels and exchange rates will be left for a future paper.

(2) High-wage policy: Wages are increasing so that the marginal good in the high-tech sector remains constant (at z_1* in the high-tech sector). Given the above assumptions the country is loosing comparative advantages in the range of goods in the low-tech sector (the marginal good is now below z_2* in this sector).

(3) A wage policy between (1) and (2) would imply that the catching-up country is loosing comparative advantages in the upper range of goods of the low-tech sector and is gaining comparative advantages in their upper range of goods in the high-tech sector.

If we assume that wages can differ between sectors, some more complicated cases would have to be discussed. But empirically we find some evidence for a wage drift between sectors, so that these cases need not be further discussed here.

In a more general theoretical model Landesmann and Stehrer (1999) study dynamic catching-up processes at the sectoral level and their implications on specialization structures and labour markets. In this model the emergence of trade structures depends on the different sectoral catching-up rates and the wage developments in both countries. Two types of catching-up countries are distinguished: the first group which, although catching up, maintain their comparative advantage in the low-tech sector, whereas the second group gains more in the high-tech sector. In this model switchovers in the structure of comparative advantages between advanced and catching-up countries can occur depending on the time-paths of productivity catching-up and wage rate movements.

3 Catching up at the aggregate manufacturing level

3.1 The data sample

In this section we compare the catching-up processes for total manufacturing and for particular industries for 36 countries over the period 1965 to 1995. We distinguish eight country groups. These country groups are Canada (CAN), a group of extended EU-northern countries (EUN: Austria, Denmark, France, Germany West, Italy, Liechtenstein, Luxembourg, Netherlands, Switzerland, and United Kingdom), a group of extended EU-Southern countries (EUS: Greece, Iceland, Ireland, Portugal, Spain, Turkey), Japan (JAP), Australia and New Zealand (OZE), and Scandinavian countries (SCA: Finland, Norway and Sweden). Further two groups of Eastern Asian countries are included: Taiwan, Hong Kong, Korea, and Singapore (denoted by NIC1) and India, Indonesia, Malaysia, Philippines, and Thailand (NIC2). We also include two groups of the CEECs: the first group consists of Hungary, Poland, Czech Republic, Slovenia and the Slovak Republic (CEEC1), the second group of countries is Bulgaria, Croatia, Romania, Russia and the Ukraine (CEEC2).

The data set used is taken from the UNIDO industrial statistics data base at the 3-digit ISIC level, revision 2, which allows comparisons across a big country sample. The period covered by these data is generally 1963-1996, although there are missing values for some countries in some industries. For statistical reasons (especially the time-series analysis) we replaced missing values by linear combinations between two years or long-term trends. We expect that this procedure may influence the results quantitatively only slightly and not qualitatively. The UNIDO industrial statistics provide data for output, value added, and employment (among others) for 28 industries which allows comparative analysis between different countries (industrialized and developing countries).[4] Of course there are some limitations concerning the quality of the data. More or less the same difficulties as in the growth literature must be addressed (for an overview see Heston, 1994 and Temple, 1999). The main reasons are that countries report at times only combinations of two or more 3-digit ISIC codes; further, output data can be based on factor values or producer's prices and the reported employment data can either be the number of persons engaged (employees plus self-employed) or the number of employees. Additionally, there are no data available (especially for the developing countries) to account for the effect of differing working hours (see e.g. Wolf, 1994 for a discussion of the implications for the convergence literature).

The following variables are considered: Output per employee (output productivity or OUTPROD), Value added per employee (value added productivity or VALPROD)[5], and wages per employee (WAGEMP). The UNIDO data are expressed in current national currencies. We express all values at current PPP-rates taken either from the Summers-Heston data set or OECD-statistics. For Eastern European countries PPP-rates are provided by the statistical database of the Vienna Institute for International Economic Studies (WIIW) based in turn on the International Comparison Project (ICP). For the effects of using domestic prices, exchange rates or PPP-rates on convergence results see Nuxoll (1994), who discusses the effects pointed out by Gerschenkron (1952). In fact, Nuxoll (1994) shows that using international prices instead of using domestic prices (e.g. the Penn World Tables) leads to very different growth rates. He argues in favour of using national accounts data for growth rates and Penn World Table numbers for levels. Further Bernard and Jones (1996) report different results dependent on the benchmark year used in the regression analysis. Finally, it must be taken into account that the PPP-rates used are based on GDP measures; ideally one should use sectoral level PPP rates and based on sectoral producer prices. Using PPP rates based on GDP measures may introduce some distortions, especially if the non-trading sector is very inefficient and thus shows high relative prices compared to other countries. But data are hardly available for a larger group

[4] We plan to include in the near future also Latin American and African countries.

[5] In this paper only labour productivity is analysed. Of course, one has to take into account that labour productivity levels are heavily influenced by the input of other factors, especially capital. For further research total factor productivity should by analysed, depending on the availability of data.

of countries; for a comparison of Eastern Asian countries see e.g. Timmer and Szirmai (1997). Further, for the most part of the analysis data are smoothed by 5-year moving averages. All variables are expressed in percentages or in the form of a gap (see below) relative to the US level, which is assumed to be the technology leader over the whole period and in all industries.[6]

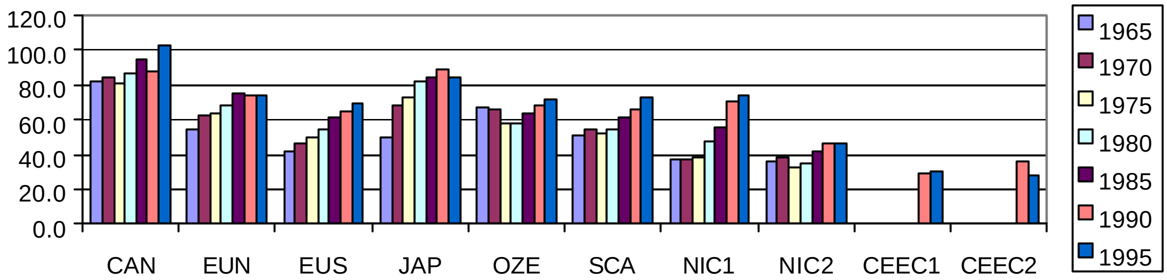
3.2 Descriptive analysis

First we present the results on convergence for manufacturing industry as a whole and introduce the methodologies used in the subsequent analysis at a more disaggregated level. Figure 1 presents the productivity (OUTPROD and VALPROD) levels relative to the US for the 8country groups over the period 1965 to 1995 at 5-year intervals (for the CEECs only for 1990 and 1995).

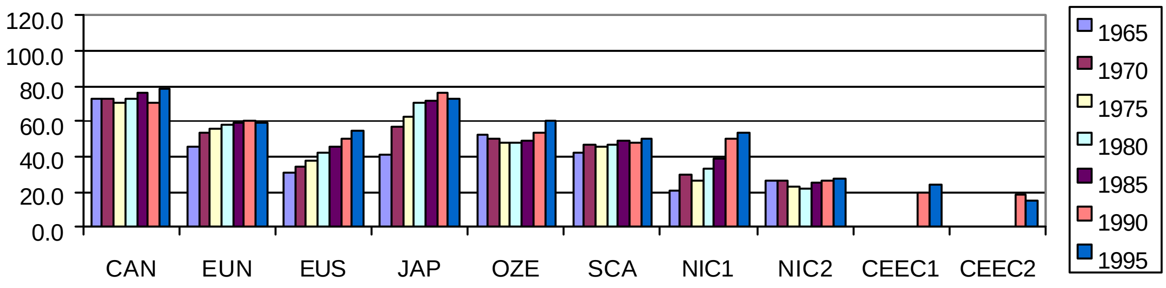
Figure 1

Dynamics of relative productivity levels – Total manufacturing

OUTPROD



VALPROD



6 Although this is not the case for all industries over the time period considered, we see this as a reasonable first approximation.

In 1965 Canada started with an output productivity level of 80% of the US and was thus the second best performing country in 1965; it then also reached the US-level in the 1990's. Australia and New Zealand (OZE) started with almost 70% of the US-level in 1965, but did not manage to catch-up to the US-level and their gaps to the US remained. EUN, JAP, and SCA were at about 50-60% of the US level in 1965 and experienced a catching-up to almost 80% of the US-level in 1995; Japan reached about 90% from a starting level of about 50% and can thus be seen as the most successful catching-up country. The country groups EUS, NIC1, and NIC2 had more or less the same starting position at about 40%. EUS and NIC1 converged to the productivity level of the US (70%), but the time path was different. Whereas the EUS countries showed a steady increase from 1965 onwards, the NIC1 group started catching up only from 1975-1980 onwards, but then experienced very high growth rates in productivity. The NIC2 group also started at about 40% of the US-level. The countries in this group have not yet managed to catch up to the extent of the other countries, but seem to be on a growth path in productivity levels from 1985 onwards; this growth path may now be disrupted due to the economic and financial crises in the region. Finally, the two groups of Central and Eastern European countries are included in this graph. These two groups show a level of about 35-40% (CEEC1) and 25-30% (CEEC2) and thus had a lower level in 1990 than all other country groups in 1965. The level is slightly lower than that of the NIC2 group. This could be interpreted to mean that the potential for catching up is very high and thus that these countries will potentially embark upon a very rapid catching-up process; on the other hand, the backwardness could also be an impediment to growth. If the gap is too large there could also be a 'falling behind', if one takes other factors (e.g. education, infrastructure, etc.) into account.[7] Further there could also be a non-linear relationship between growth rates and backwardness: countries lagging very far behind catch up very slowly, when they reach a certain level they start to catch up with high convergence rates, and finally they reach a level close to the leader from where it becomes increasingly hard to reach the leader. This would imply a sigmoid-shaped path of convergence; this path of catching-up is emphasized in technology diffusion models (for an overview see Karshenas and Stoneman, 1995).

Similar comparisons can be made for the wages per employee (WAGEMP). In our analysis the wage rates are also measured at current PPP rates. Thus we are comparing the purchasing power (or standard of living) of employees in the manufacturing sector.[8]

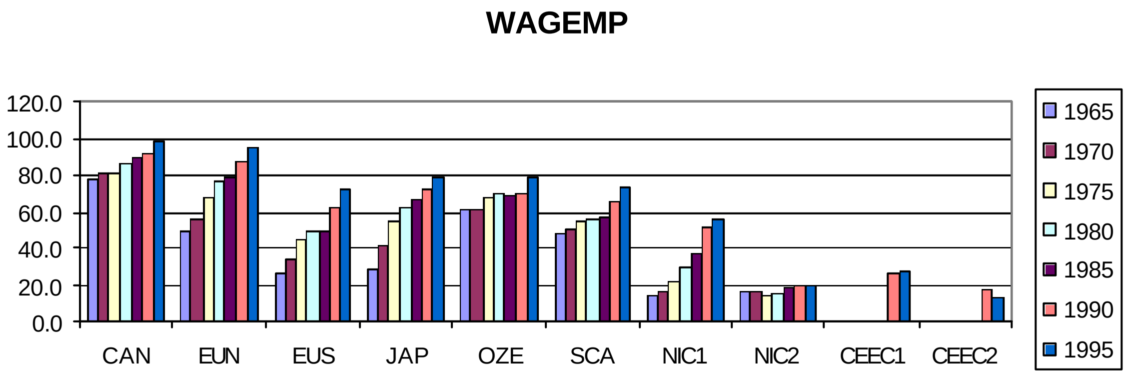
[7] See Abramovitz (1986) and Verspagen (1992) for a non-linear model of catching up or falling behind of countries, where the latter develops the ideas by Abramovitz more formally.

[8] There are two reasons why we chose to analyse the catching-up processes of wages in PPP rates rather than at current exchange rates: one is to avoid the much higher degree of volatility which calculations in current exchange rates would imply and, second, catching-up processes imply a convergence also in relative price structures (particularly between tradables and non-tradables) which implies an erosion of the relative under-valuation of a country's exchange rate at the beginning of a catching-up process. Particularly in the case of CEECs the sharp differences and adjustments in the relative price structures in the early phases of transition have led to a high degree of under-valuation of their currencies which we would like to abstract from as they should constitute a transitory phenomenon.

Figure 2 presents the comparisons and catching-up processes of the wage rates for the ten country groups.

Figure 2

Dynamics of wage levels – Total manufacturing



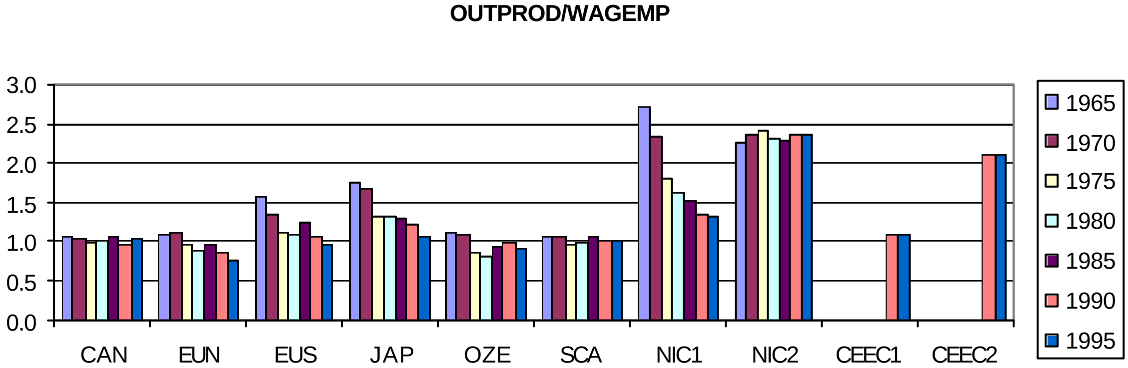
Again, Canada shows the highest level relative to the US and reaches the US level in 1995. OZE starts at a level of about 60%, which corresponds to the relative productivity level, but catches up to a level of about 80%, whereas productivity remains at the 60% level. The situation is different for the country groups EUN, JAP and SCA, which – as shown above – behaved rather similarly with respect to productivity levels. Whereas EUN and SCA started with a wage level of about 50% of the US, Japan only had a level of 25%. The convergence of the Japanese wage level was stronger, reaching 80% (more or less that of the productivity level), while EUN reached about 95% of the US level; thus wage growth (in PPPs) was outstripping productivity growth. SCA shows a wage catching-up more or less in line with the productivity catching-up. The NICs started at a level of about 15-20% of the US-wage level. But whereas the NIC1 countries also experienced relatively high growth rates of the wage rates (even higher than productivity growth rates), the NIC2 countries remained at the 20% level. Finally, the CEECs show wage levels of about 30% (CEEC1) and 15-20% (CEEC2) of the US-level, which is lower than their relative productivity levels (both measured in PPPs).

The relative movements of productivity (OUTPROD) and wages (WAGEMP) can be seen from Figure 3.

Figure 3 shows the ratio of OUTPROD to WAGEMP (the inverse of unit labour costs) over the period. A ratio of 1 describes the situation where the productivity level relative to the US corresponds exactly to the wage level relative to the US; a ratio larger than 1 means that the productivity gap relative to the US is smaller than the wage gap relative to the US, thus

Figure 3

Relative movement of productivity and wage levels



giving a cost advantage to this country or country group. It can easily be seen that the country groups are all converging to the ratio of 1 (with exception of NIC2 and CEEC2, see below). For a country starting of with lower labour unit costs relative to the US, this means that wages are catching up faster than productivity. Such a pattern could be seen as typical for catching-up processes in which losses in labour unit cost advantages are compensated by (relative) improvements in product quality, a variable which will be analysed in section 6 of this paper. The more rapid catching-up in wage rates than in productivity levels is particularly remarkable for EUS, JAP, and NIC1. EUN end up with a coefficient less than 1, which means an absolute gap in labour unit cost advantage relative to the US. Further the difference between NIC1 and NIC2 is striking. Whereas NIC1 experienced high growth rates of their relative productivity levels, wage growth was even higher; NIC2 remained more or less at the same level. The positions of the CEECs in 1990 and 1995 can be compared to the EUS group and/or Japan in 1975 for CEEC1 and the NIC1 in the 1970s for CEEC2.

In the light of this analysis – only regarding the aspect of relative wage and productivity levels – the position for the CEEC1 seems not to be as favourable as compared to the NICs in the 1960's or 1970's. Their productivity levels were lower at the starting point, whereas their wage levels at the starting point were higher or equal relative to the NICs. This means that the longer-term prospects for export driven growth based on very low relative labour unit costs seem to be less accessible to these countries. (Remember, however, that all our variables are expressed in PPPs; see footnote 8.) On the other hand, there are a lot of factors which can counteract this disadvantage, mainly factor endowment structures, skill-structures and human capital levels, FDI, learning capabilities, etc, all factors which might show up in a potential to absorb new technologies quickly and improve product quality.

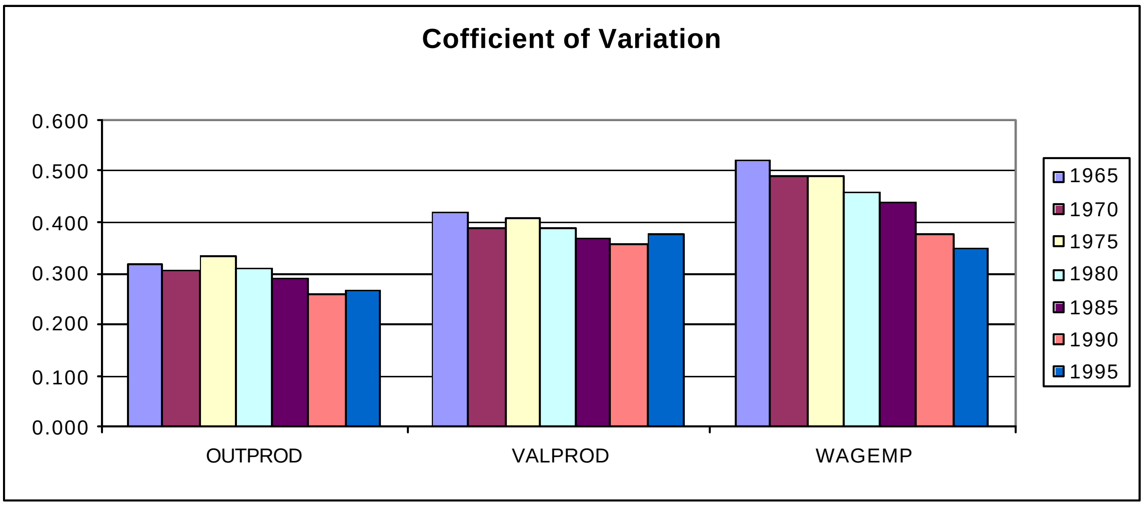
3.3 Convergence and divergence – econometric results

We shall now try to use some more elaborate statistical and econometric analysis to tackle the problem of convergence and especially the expected speed of convergence processes. In the aggregate growth literature there is a debate on the right measures of convergence, which cannot be summarized here. In this paper we use three different methods: the coefficient of variation (CoV) used e.g. by Dollar and Wolff (1993), an econometric analysis which looks at the impact of the initial technology gap on the growth rate in a cross section analysis (similar to the model used by Verspagen (1992) which in turn can be compared to the analysis on technology diffusion and convergence by Barro and Sala-i-Martin, 1997), and, finally, a time-series approach using a Dickey-Fuller test which also provides a measure on the speed of convergence (see e.g. Ben-David, 1993 and 1996). Thus, we use the same methodology as in the aggregate empirical growth literature, but we shall also apply this methodology at the disaggregated/industrial level.[9] We shall not fully flesh out the underlying theoretical model for the disaggregated case but refer to the paper by Landesmann and Stehrer (1999) where the implications of uneven catching-up are studied in the context of a multi-sectoral model.

The Coefficient of Variation

Figure 4 shows the coefficient of variation (the ratio of the standard deviation to the mean) for the three variables over the period 1965-95 for all countries with the exception of the CEECs. There is little convergence for OUTPROD and VALPROD and much higher convergence for wages starting at 0.5 and falling to 0.35 around the level of the CoV for VALPROD.

Figure 4



[9] Further, also a simple growth-accounting approach (which is not necessarily based on theoretical reasoning) might be useful at the disaggregated level. But this approach is not adopted here.

Cross-country analysis

For the second measure we use the methodology presented in Verspagen (1992) at the manufacturing level. For this we define the technology or wage gap as

$$G^c_t = \ln(v_t^c/v_t^{US}) = \ln(v_t^c)-\ln(v_t^{US}) \tag{1}$$

where v denotes the considered variables (OUTPROD, VALPROD, and WAGEMP), c is the country index and t represents time. The long run motion of the technology (either for OUTPROD or VALPROD) or wage gap G is estimated by OLS regression on a constant and a time trend t.

$$G^c_t = \alpha_0 + \Phi^c\, t + \varepsilon \tag{2}$$

This estimator uses the whole time series information on G^c_t and not just the first and last point. Thus the OLS estimator is robust with respect to short term effects of shocks and cycles. Φ^c denotes the growth rate of the gap in country c over the period. The last step is to regress the growth rate on the initial technology gap:

$$\Phi^c = \beta_0 + \beta^c_1\; G^c_0 + \varepsilon \tag{3}$$

Similarly, Barro and Sala-i-Martin (1997) present a model of catching up to the technology leader, where the growth rate of output per worker in the catching-up country depends on the growth rate of the leading country, the gap, and the steady-state level of the gap. This result differs from the conjecture in their book on economic growth (Barro and Sala-i-Martin (1995)), which turned out to be wrong. If the steady-state gap is 0, this model collapses to the formulation of the Verspagen model.[10]

Further, Verspagen (1992) proposes a non-linear form of equation (3), namely:

$$\Phi^c = \beta_0 + \beta_1 P + \beta^c_2 G^c_0 \exp^{\beta 3(G0/E)} + \varepsilon \tag{3a}$$

β_1 estimates the effect of an exogenous rate of knowledge growth in the backward country (proxied for example by patent data, R&D expenditures, etc. and represented by variable P in 3a). The third term introduces a non-linear relationship between the initial gap and a parameter E measuring endowment with human capital, education, infrastructure, etc.

[10] Barro/Sala-i-Martin (1995) proposes to run non-linear least squares regressions of the form

$$\Phi = \beta_0 + [(1\text{-}\exp(\beta_1\, T)/T]\; G_0 + \varepsilon$$

to average over the time span. The results are very similar to the linear regressions and thus we report only the latter ones.

Table 1 reports the results of regression (3) for the three variables.

Table 1

Cross-country regression[1)]

Total manufacturing – 300

	OUTPROD	VALPROD	WAGEMP
Coeff.	-0.024	-0.018	-0.016
t-value	-4.940	-3.575	-4.171
Std.Dev.	0.005	0.005	0.004
R squ.	0.449	0.299	0.367
R squ. adj.	0.430	0.275	0.346
F-value	24.410	12.780	17.400

1) Estimated over the whole period 1965-95.

Table 2

Cross-country regression – subperiods

Total manufacturing – 300

Periods		OUTPROD	VALPROD	WAGEMP
1965-95[1)]	Coeff.	-0.024	-0.021	-0.015
	t-value	-4.332	-3.849	-3.360
	Std.Dev.	0.006	0.006	0.004
	R squ.	0.190	0.153	0.125
	R squ. adj.	0.180	0.143	0.114
	F-value	18.760	14.820	11.290
1965-75	Coeff.	-0.029	-0.025	-0.014
	t-value	-2.457	-2.502	-1.571
	Std.Dev.	0.012	0.010	0.009
	R squ.	0.215	0.222	0.105
	R squ. adj.	0.180	0.186	0.063
	F-value	6.040	6.260	2.470
1975-85	Coeff.	-0.021	-0.014	-0.020
	t-value	-2.975	-1.809	-3.358
	Std.Dev.	0.007	0.008	0.006
	R squ.	0.247	0.105	0.295
	R squ. adj.	0.219	0.073	0.268
	F-value	8.850	3.270	11.280
1985-95	Coeff.	-0.029	-0.028	-0.015
	t-value	-2.454	-2.428	-1.728
	Std.Dev.	0.012	0.012	0.008
	R squ.	0.182	0.174	0.100
	R squ. adj.	0.152	0.144	0.066
	F-value	6.020	5.890	2.990

1) Three ten-year periods (1965-75, 1975-85, 1985-95) pooled together.

All coefficients have the expected negative sign, i.e. showing evidence for convergence, and are significant at least at the 5% level. These results confirm the above descriptive analysis of convergence between the countries. The speed of convergence of the technology gap can be computed from the estimated coefficients β_1. A coefficient of 0.024 implies that 2.4% of the gap vanishes in one year. The average half life would then be $\ln(0.5)/\ \beta_1 = \ln(0.5)/(-0.024) \approx 28$ years. The coefficient for wage convergence is much lower, $\beta_1 = -0.016$, and thus predicts a half life time of about 43 years. This contrasts with the description above which mentioned that wages relative to the US are growing faster than productivity. But this effect is mainly due to the inclusion of the NIC2 country group. Running the regression without this group gives a coefficient of –0.026 and a R^2 of 0.76. Dividing the period 1965 to 1995 into 3 10-year intervals (1965-75, 1975-85, 1985-95) and running the same OLS-regression on the pooled data gives very similar results (see Table 2). The results for the different subperiods are quite similar to the other results, too. Only the second subperiod (1975-1985) shows a slowdown in productivity catching-up.

Time series analysis

The type of cross-country study used above has been criticized for statistical reasons, known as Galton's fallacy (see e.g. Quah, 1993a and 1993b, and Friedman, 1992). Instead, time series methods are proposed to test for convergence and/or divergence. Here we use a simple unit-root test proposed by Ben-David (1993 and 1996) to study the relationship between trade and growth between countries. This test is in fact a Dickey-Fuller test which can also be applied to our data set. Thus we test for convergence of the above mentioned country groups (in fact, each individual country could also be used). For this test we define the technology and wage gap as above

$$G^c_t = \ln(v_t^c/v_t^{US}) = \ln(v_t^c)-\ln(v_t^{US}) \qquad (1)$$

and use a simple unit root test

$$G^c_{t+1} = \Phi\ G^c_t$$

Defining $G^c_{t+1} = \Delta\ G^c_{t+1} + G^c_t$ one gets

$$\Delta\ G^c_{t+1} = (\Phi\text{-}1)\ G^c_t \equiv \kappa\ G^c_t \qquad (4)$$

which is known as Dickey-Fuller test. The lower the κ the faster is the convergence process. $\kappa < 0$ means convergence, $\kappa > 0$ divergence. The half-life time can easily be computed by $\ln(0.5)/\kappa$ in case of convergence, the double-life time by $\ln(2)/\kappa$. Table 3 presents the results for eight country groups (excluding CEECs).

Table 3

Results of the Dickey-Fuller test

Total manufacturing – 300

	OUTPROD			VALPROD			WAGEMP		
	Coefficient	**t-value**	**Half-time**	**Coefficient**	**t-value**	**Half-time**	**Coefficient**	**t-value**	**Half-time**
CAN	-0.050	-1.424	14.0	-0.012	-0.669	59.4	-0.043	-2.569 **	16.0
EUN	-0.032	-2.470 **	22.0	-0.018	-2.112 **	38.4	-0.052	-5.418 ***	13.3
EUS	-0.027	-2.858 ***	25.7	-0.022	-3.105 ***	31.7	-0.040	-5.537 ***	17.4
SCA	-0.022	-2.290 **	31.9	-0.010	-1.153	71.4	-0.024	-3.381 ***	28.9
JAP	-0.086	-3.825 ***	8.1	-0.057	-3.712 ***	12.1	-0.058	-10.219 ***	12.0
OZE	-0.005	-0.396	138.3	-0.006	-0.707	111.5	-0.022	-1.438	31.5
NIC1	-0.020	-1.817 *	35.5	-0.027	-2.643 **	25.8	-0.030	-4.521 ***	23.3
NIC2	-0.020	-1.416	34.4	-0.019	-1.181	36.2	-0.005	-1.123	134.6

The estimated coefficient κ for OUTPROD is negative in all cases but not significant for CAN and OZE and only significant at the 5% level for NIC2. The average half-time is about 27 years (including only country groups with significant coefficients), which is equal to the half-time from the cross-section analysis above. The fastest catching-up country is JAP with a half-time of about 8.3 years. All other countries exhibit half-times of about 20-25 years. (The speed of convergence would change if one alters the time-period; especially for NIC1 the catching-up process would be much faster starting e.g. with the year 1975).

The results for the catching-up process for WAGEMP again shows negative signs in all cases and are higher for all countries with the exception of JAP and NIC2. Thus the half-time in almost all countries is lower (with the above mentioned exceptions), the average half-time is about 20 years and thus lower than that for productivity growth. With the exceptions of CAN, JAP, and NIC2 wages are converging faster than output productivity.

4 Caching up at the disaggregated/industrial level

After looking at the convergence patterns at the aggregate manufacturing level, we now present evidence on the convergence patterns at a more disaggregated level (3-digit ISIC, rev. 2) to show differences between higher-tech and lower tech sectors. In this section we only include two typical low-tech sectors (textiles ISIC321 and wearing apparel ISIC322) and two typical high- or medium-tech sectors (non-electrical machinery ISIC381 and electrical machinery ISIC383).

We use the same methodology introduced above and compare the two sectors in its prospect and performance of convergence and catching-up.

4.1 Econometric results

The Coefficient of Variation

As first indicator of convergence we discuss the development of the coefficient of variation (CoV) in the four industries. The CoVs for both types of industries are presented in Table 4.

Table 4

Coefficient of Variation

	1965	1970	1975	1980	1985	1990	1995
Textiles - 321							
OUTPROD	0.388	0.051	0.371	0.412	0.380	0.363	0.461
VALPROD	0.417	0.486	0.430	0.551	0.433	0.475	0.703
WAGEMP	0.508	0.595	0.514	0.466	0.440	0.385	0.405
Wearing apparel - 322							
OUTPROD	0.360	0.402	0.361	0.362	0.397	0.363	0.401
VALPROD	0.434	0.452	0.433	0.410	0.381	0.360	0.455
WAGEMP	0.512	0.502	0.487	0.464	0.446	0.418	0.411
Machinery (except electric) - 382							
OUTPROD	0.433	0.421	0.422	0.386	0.456	0.427	0.477
VALPROD	0.482	0.465	0.464	0.436	0.513	0.510	0.536
WAGEMP	0.514	0.496	0.490	0.450	0.444	0.401	0.390
Machinery electric - 383							
OUTPROD	0.345	0.309	0.284	0.241	0.230	0.219	0.265
VALPROD	0.417	0.380	0.385	0.367	0.350	0.364	0.432
WAGEMP	0.483	0.464	0.476	0.449	0.435	0.381	0.356

In the two lower tech industries (textiles and wearing apparel) the coefficient of variation for OUTPROD is rather stable over the longer period at a level of about 0.4 and is only slightly decreasing for the value-added productivity variable in industry ISIC322 (wearing apparel). Wages per employee show a more dynamic pattern. In industry ISIC321 (textiles) the CoV is decreasing from a level of 0.6 in 1970 to about 0.4 and similarly in industry ISIC322 falling from 0.5 in 1965 to also 0.4 in 1995. The higher tech sectors show a somewhat different picture. Whereas the coefficient in industry ISIC382 (non-electrical machinery) is starting at a level of about 0.45 there is a tendency to rise over time to 0.5 in 1995. The coefficient of variation for wages in this industry is again falling from 0.5 at the beginning to 0.4 in 1995. Sector ISIC383 (electrical machinery) differs somewhat. First, the starting level with 0.35 is lower than in the other sectors and is falling to 0.2 in 1990. The CoV for VALPROD, starting at 0.4, is falling slightly over time. On the other hand, wage dispersion shows more or less the same picture as in the other industries and is falling from a level of about 0.5 to 0.35 in 1995. This shows that productivity levels behave more diversely between countries in the different industries than wage levels. It points towards a wage drift across countries which – combined with differences in productivity catching-up patterns across industries – generates a dynamic in the structure of comparative cost advantages. If – in a particular industry – productivity increases are not fully captured by (relative) wage increases a comparative advantage emerges. These results must be seen as a partial picture, as we only use data on labour productivity and hence differences and/or changes in total factor productivities (across industries and countries) are not accounted for.

Cross-country analysis

The same cross-country methodology as above was then applied to each of the four sectors. (Especially, the application of the general non-linear approach represented by equation (3a) would be interesting, if one had some data on P and E at the sectoral level, which is on the agenda for future research.) Table 5 presents the results of the cross-country analysis of convergence patterns (equation 3) at the industrial 3-digit level for the four industries.

Again, all the coefficients have a negative sign and are significant thus indicating convergence. Further, the coefficients for the productivity measures (OUTPROD and VALPROD) are higher than the coefficients for wages (WAGEMP). The striking difference is if one compares the two types of sectors. The coefficients for the two low-tech sectors (textiles and wearing apparel) are much lower than for the high-tech sectors. The half time of convergence in the low-tech sectors is 27 years in textiles and about 46 years in wearing apparel, whereas the half time in non-electrical machinery and in electrical machinery is about 20 years. (One has to keep in mind, though, that not all differences in coefficients are statistically significant.) This indicates faster convergence in the higher-tech sectors. On the other hand, the coefficients for wage catching-up are quite similar across the sectors, which indicates again that a wage drift exists, as discussed above. Hence, catching-up countries are losing comparative advantages in the low-tech sectors.

The results described above are confirmed by a second analysis where we divided the period 1965-95 into three subperiods 1965-75, 1975-85, and 1985-95. The same cross-country estimations can be run for each subperiod and the joint subperiods. Annex Table A/2 gives the results of the regression analysis. The two main results can be summarized as follows: First, the two higher tech sectors (non-electric machinery ISIC382 and electrical machinery, ISIC383) show higher coefficients for the productivity variables OUTPROD and VALPROD (although not statistically different from the other sectors in most cases) than the other two sectors, which indicates faster catching up in these sectors. Second, the estimated coefficient for the wage variable WAGEMP is very similar in all sectors with a minimum of 0.15 and a maximum of 0.22.

Table 5

Results of cross-country regressions – selected industries[1)]

	OUTPROD	VALPROD	WAGEMP
Textiles 321			
Coeff.	-0.025	-0.024	-0.017
t-value	-5.131	-3.707	-3.697
Std.Dev.	0.005	0.006	0.005
R squ.	0.467	0.314	0.336
R squ. adj.	0.450	0.291	0.311
F-value	26.330	13.740	13.670
Wearing apparel 322			
Coeff.	-0.015	-0.016	-0.018
t-value	-1.624	-2.638	-4.466
Std.Dev.	0.009	0.006	0.004
R squ.	0.081	0.188	0.408
R squ. adj.	0.050	0.161	0.387
F-value	2.634	6.960	19.950
Machinery (except electric) 382			
Coeff.	-0.035	-0.030	-0.018
t-value	-5.440	-5.557	-4.799
Std.Dev.	0.006	0.005	0.004
R squ.	0.505	0.516	0.451
R squ. adj.	0.488	0.499	0.432
F-value	29.600	30.880	23.030
Machinery electric 383			
Coeff.	-0.033	-0.029	-0.016
t-value	-5.190	-3.898	-3.832
Std.Dev.	0.006	0.008	0.004
R squ.	0.473	0.336	0.336
R squ. adj.	0.456	0.314	0.313
F-value	26.930	15.190	14.690

1) Estimated over the period 1965-95.

There are differences between the subperiods but this pattern between the sectors can be seen in all subperiods. Especially sector ISIC383 (electrical machinery) shows higher coefficients in all subperiods against all other sectors for the productivity variables and very similar catching-up coefficients for wages as in the other sectors.

Time series evidence

The time series analysis confirms the results above. Table 6 shows the results for the 8 country groups (unweighted averages).[11]

[11] The results for individual countries are reported in Annex Table A/3.

Table 6

Results of the Dickey-Fuller test – industry level

	OUTPROD			VALPROD			WAGEMP		
	Coefficient	t-value	Half-time	Coefficient	t-value	Half-time	Coefficient	t-value	Half-time
Textiles - 321									
CAN	-0.046	-1.158	15.1	-0.055	-1.062	12.6	-0.025	-0.610	27.9
EUN	-0.076	-1.982 ***	9.1	-0.069	-2.010 **	10.1	-0.080	-2.546 **	8.6
EUS	-0.022	-1.618 *	31.1	-0.020	-1.517	34.9	-0.048	-3.720 ***	14.4
SCA	-0.018	-1.642 *	37.7	-0.012	-1.086	56.0	-0.028	-2.905 ***	24.8
JAP	-0.049	-2.176 **	14.1	-0.058	-3.175 ***	11.9	-0.064	-7.995 ***	10.9
OZE	-0.042	-0.825	16.6	-0.036	-1.010	19.4	-0.046	-1.566	14.9
NIC1	-0.046	-2.769 ***	15.2	-0.029	-2.411 **	23.7	-0.034	-2.983 ***	20.3
NIC2	-0.013	-1.180	52.6	-0.008	-0.725	91.5	-0.004	-0.899	157.8
Wearing apparel - 322									
CAN	-0.072	-1.579	9.6	-0.031	-1.076	22.3	-0.037	-0.804	18.9
EUN	-0.055	-2.375 **	12.7	-0.032	-2.340 **	21.5	-0.050	-2.676 ***	13.9
EUS	-0.017	-1.113	40.0	-0.013	-0.967	52.2	-0.046	-4.247 ***	15.2
SCA	-0.025	-1.662 *	27.3	-0.017	-1.118	40.0	-0.045	-3.853 ***	15.3
JAP	-0.017	-1.903	41.3	-0.030	-2.213 **	22.7	-0.060	-8.192 ***	11.5
OZE	-0.042	-1.254	16.4	-0.030	-1.145	23.0	-0.024	-0.606	28.3
NIC1	-0.036	-1.562	19.3	-0.045	-2.743 ***	15.5	-0.040	-3.269 ***	17.5
NIC2	-0.018	-1.429	39.2	-0.018	-1.308	39.2	-0.015	-1.614 *	46.0
Machinery (except electric) - 382									
CAN	-0.019	-0.565	35.6	-0.004	-0.143	197.5	-0.020	-1.038	34.4
EUN	-0.027	-1.353	25.5	-0.013	-0.950	54.6	-0.048	-3.930 ***	14.5
EUS	-0.044	-2.835 ***	15.9	-0.043	-3.312 ***	16.0	-0.033	-3.798 ***	21.2
SCA	-0.027	-1.388	26.0	-0.008	-0.682	86.4	-0.022	-2.410 **	31.9
JAP	-0.114	-2.990 ***	6.1	-0.067	-2.629 **	10.3	-0.059	-7.253 ***	11.8
OZE	-0.039	-1.097	17.8	-0.025	-1.043	27.8	-0.032	-1.205	21.9
NIC1	-0.041	-3.345 ***	16.8	-0.033	-3.786 ***	20.8	-0.031	-5.032 ***	22.6
NIC2	-0.019	-0.673	37.1	-0.007	-0.235	103.5	-0.006	-0.931	115.2
Machinery electric - 383									
CAN	-0.052	-1.031	13.3	-0.012	-0.051	60.1	-0.041	-1.439	17.0
EUN	-0.024	-1.902 *	28.3	-0.009	-0.861	78.4	-0.052	-4.925 ***	13.3
EUS	-0.038	-2.136 **	18.2	-0.028	-2.127 *	25.1	-0.041	-3.418 ***	16.9
SCA	-0.024	-1.650 *	29.2	-0.006	-0.535	107.6	-0.028	-2.459 ***	24.4
JAP	-0.106	-2.658 ***	6.5	-0.028	-1.508	25.1	-0.049	-6.505 ***	14.3
OZE	0.000	-0.018	1671.0	-0.010	-0.596	68.4	-0.015	-1.105	46.9
NIC1	-0.037	-2.835 ***	18.8	-0.020	-2.189 **	34.3	-0.021	-2.679 ***	33.1
NIC2	-0.022	-0.841	32.2	-0.019	-0.785	36.1	-0.006	-0.925	109.0

First we discuss the results of convergence for the different country groups for output productivity (OUTPROD). Canada does not show convergence in any industry, which can be explained by the fact, that this country started already close to the leader country USA, where catching up is becoming more and more difficult. The country group EUN converged relatively fast in the low-tech sectors (textiles and wearing apparel) with a half-time of 9.1 and 12.7 years, but does not show convergence in the non-electrical machinery sector (ISIC382) and only slow convergence in the electric machinery sector with a half-time of about 28 years and significantly only at the 10% level. The EUS group shows another pattern: convergence is faster and more significant in the high-tech sectors (half time of 15.9 and 18.2 years) than in the two low-tech sectors (with a half time of 31.1 and 40.0 years). The Scandinavian countries have only very low coefficients of convergence and are only significant at the 10% level in three industries. The results with respect to the more advanced economies (EUN and SCA) point to the importance of product quality competition rather than focussing on the narrow issue of relative productivity and wage convergence; on this see the analysis in section 6. Japan converges especially in the high-tech sectors at very high rates (half time of about 6 years) and relatively slowly (although faster than other countries) in the textiles sector. The NIC1 group shows convergence in the textiles and the two machinery sectors with similar rates of convergence (about 15 to 19 years half-time), whereas the NIC2 do not show convergence in any sector.

These results can be compared to the convergence of sectoral wage rates WAGEMP. The overall picture is that there is a catching-up of wage rates. The coefficients are significant for more countries and show higher significance levels. This is especially true for the high-tech sectors. On the other hand productivity catching-up takes place faster than wage catching-up, especially in the high-tech sectors, but the results between country groups seem to be rather mixed.

As mentioned above, the time horizon examined can have an important influence on the results one obtains from either cross-section or time-series analysis. Thus, for example, we can see from Table 6 that the results are not significant for the NIC2 group. However, if one argues that the catching-up process for these countries started later (for whatever reasons), say in the mid 1970s, the parameters characterizing the catching-up process should be estimated for the period 1975-1995. Table 7 shows the results for this time-period and the NIC2 group.

This pattern of the catching-up process can be compared with that of Japan in Table 6. The NIC2 group shows rapid catching-up in the low-tech sectors whereas in the high-tech sectors the coefficients are not significant. In Japan this process was different in the sense that the high-tech sectors were catching up much faster than the low-tech sectors. Further it can be seen that wage catching-up is slower than productivity catching-up and also takes place in the high-tech sectors (wage drift). This means that this country group is gaining comparative advantages in the low-tech sectors, whereas Japan was gaining comparative advantages especially in the high-tech sectors (productivity growth faster than wage growth). Further, in all sectors wage catching-up is slower than productivity catching-up,

Table 7

Results of the Dickey-Fuller test for NIC2 in the period 1975-1995

	OUTPROD				VALPROD				WAGEMP			
	Coefficient	t-value		Half-time	Coefficient	t-value		Half-time	Coefficient	t-value		Half-time
Textiles - 321												
NIC2	-0.033	-2.881	***	20.9	-0.019	-1.542		35.8	-0.018	-1.390	***	38.2
Wearing apparel - 322												
NIC2	-0.055	-3.377	***	12.5	-0.047	-2.447	**	14.8	-0.024	-2.563	**	28.3
Machinery (except electric) - 382												
NIC2	-0.017	-0.396		40.8	-0.013	-0.291		53.7	-0.016	-3.346	***	42.4
Machinery electric - 383												
NIC2	-0.054	-1.570		12.9	-0.041	-1.212		16.8	-0.016	-1.728	*	43.7

meaning that these countries are gaining absolute cost advantages in all sectors. We should remind the reader, however, that our analysis is conducted in PPP rates so that movements in the nominal exchange rate relative to PPP rate (nominal appreciation) may counteract these effects in nominal terms.

5 Catching-up patterns of CEECs

5.1 Some descriptive analysis

We shall now restrict our analysis to a discussion of the catching-up experiences of the CEECs over the 1990s. We first present a short descriptive analysis of the catching-up patterns in seven CEECs (Czech Republic, Slovak Republic, Hungary, Poland, Slovenia, Bulgaria, and Romania). Further we restrict this part to 5 industries (NACE 2-digit, rev. 1), namely textiles (DB), leather (DC), machinery (DK), electrical equipment (DL), and transport (DM). Figure 5 shows the evolution of wage and productivity levels and the unit labour costs relative to Austria for the period 1991 to 1997. Productivity levels are expressed at constant prices for 1996; wage levels are expressed at current exchange rates. Here also total manufacturing is included.

For total manufacturing wages and productivity levels are growing relative to Austria in the Czech Republic, the Slovak Republic, Poland and Slovenia. Wages are relatively stable in Hungary, Romania, and Bulgaria. On average the countries reach a wage level 10 to 15% relative to Austria; exceptions are Slovenia with a level of almost 30% and, on the other side, Bulgaria and Romania with less than 5%.

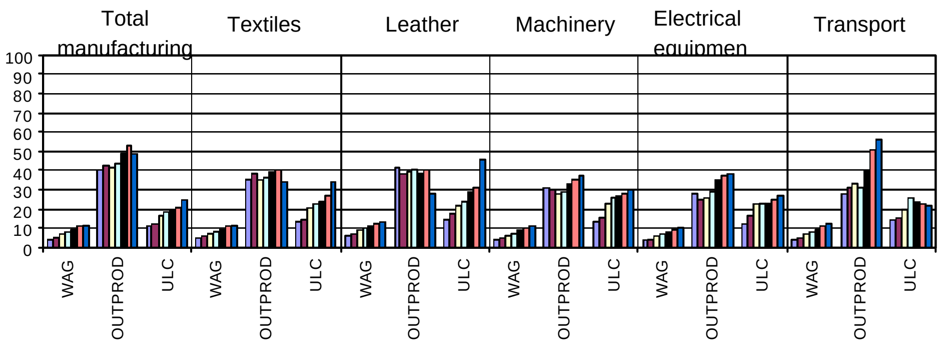
Productivity levels have grown in all countries since 1991 and are at a higher level than wages (relative to Austria, fixed at 1996 levels). The Czech Republic, the Slovak Republic, Poland, and Slovenia have a productivity level in total manufacturing of about 50% of the Austrian level. The highest relative level is reached by Hungary with about 65%. The performance of Bulgaria and Romania is worse at a level of 30 to 35%.

Figure 5

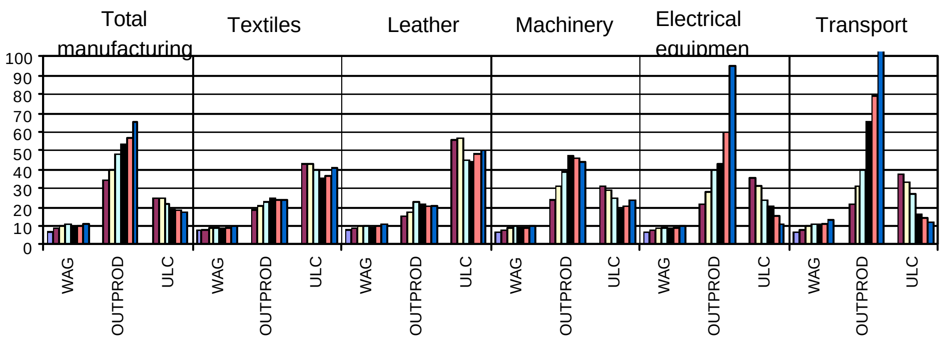
Dynamics of wages, output and Unit Labour Costs in CEECs, 1991-97

relative to Austria 1996 (= 100)

CZECH REPUBLIC



HUNGARY



POLAND

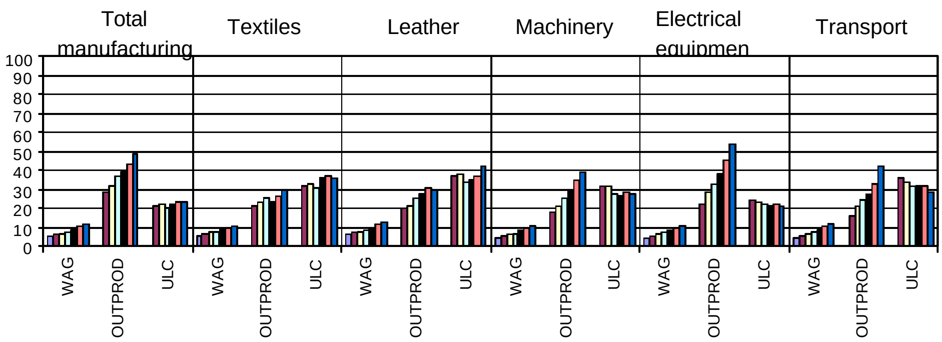
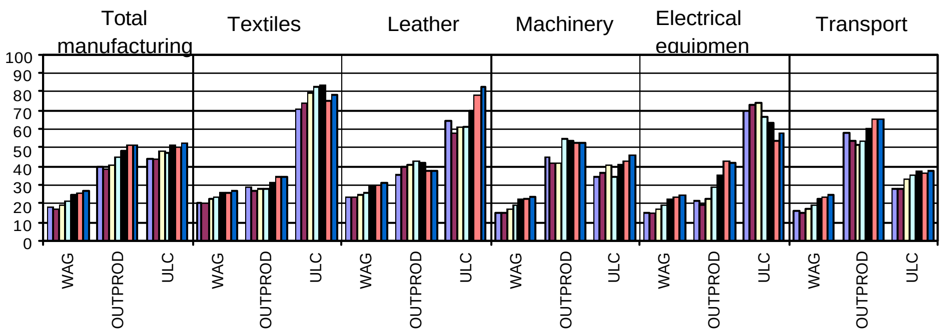
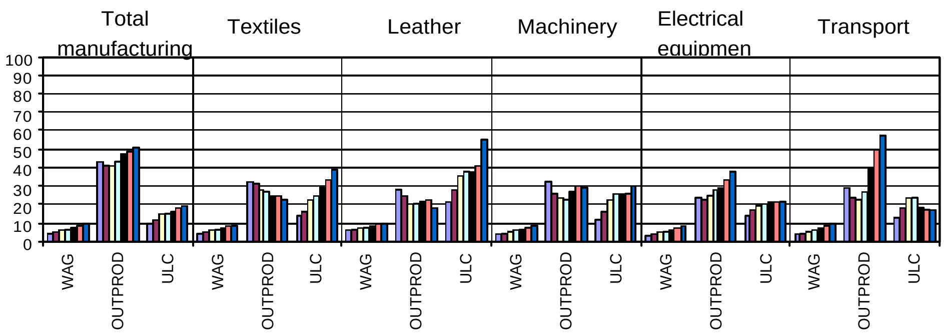


Figure 5 ctd.

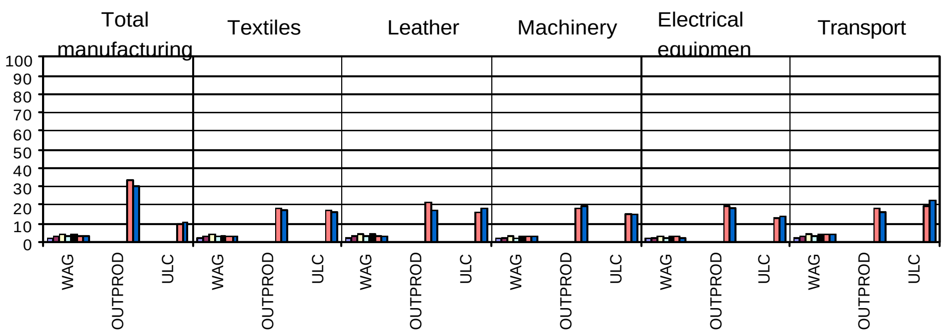
SLOVENIA



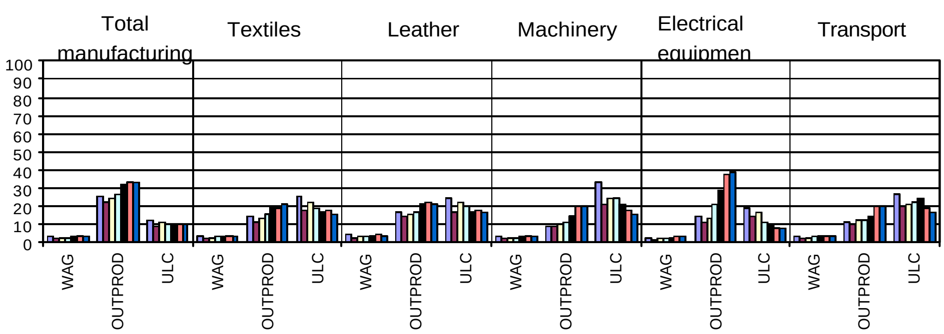
SLOVAK REPUBLIC



BULGARIA



ROMANIA



The evolution of the unit labour costs (ULC) results from the growth of wage levels versus the growth of productivity levels. The ULC have grown most rapidly in the Czech Republic from a level of about 10% in 1991 to about 25% in 1997 and in the Slovak Republic again from 10% to about 20%, meaning that wages were growing much faster than productivity. In the other countries the ULC are rather constant (Poland and Romania) or even falling (e.g. in Hungary). In Slovenia the ULC are the highest relative to the other CEECs at a level of about 50%.

But there are quite large differences if one looks at individual branches. Without going into detail and describing the different trajectories for each country and industry we only want to emphasize some general patterns. The productivity levels of the five industries in most CEECs relative to Austria have initially been rather higher in the low-tech sectors. An exception is Slovenia with rather high levels in the machinery and the transport sector. Looking now at the evolution over time the general pattern is that catching-up is stronger and in some cases much stronger in the high-tech (machinery, electrical equipment, transport) than in the low-tech sectors. In the low-tech branches, relative productivity growth is for some countries constant (e.g. Czech Republic and Hungary) or even negative (e.g. in the Slovak Republic). Wage catching-up, on the other hand, is very similar across branches, which again means that there is a wage drift between industries and that these countries are gaining comparative advantages in the high-tech industries. This can also be seen by looking at the ULCs, which in most countries are rising much faster in the low-tech than in the high-tech industries.

5.2 Econometric analysis

In this subsection we analyse the catching-up processes of various Eastern European countries. Although we use more or less the same cross-section methodology, the analysis differs somewhat from the one given above. Here the data set consists of seven CEECs (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovenia and Slovak Republic) and 14 industrial branches at the 2-digit NACE (rev. 1)-classification level. We compare the countries not to the international technology leader (USA) but to Austria as the reference country. Further, the data for productivity levels are expressed at constant prices (1993 as base year) and compared at the PPP rates for 1993. The wage data are again expressed in current PPPs. An important difference to the previous analysis is that due to the small country sample for the CEECs we had to pool the data across countries and across 14 industries. This implies that the convergence hypothesis is tested in relation to relative (initial) technology gaps for different industries as well as countries. In our previous analysis, on the other hand, we only assessed the impact of differences in technology and wage gaps across producers in different countries but within the same industrial branch.

Productivity catching-up

Table 8 shows the results for the cross-section regressions for the total sample and the individual countries. Stacking the data over countries and industries shows that the regression coefficient (in the column 'Total sample') is negative and significant, supporting the hypothesis of convergence. In this context this means that sectors showing a higher initial gap are growing relatively faster. The coefficient is rather high (compared to the cross-section results above), but the explained variance (indicated by the R^2) is rather low. Further Table 8 shows the results for the individual countries; in this case the total variance is derived only from cross-industry variations. (Note that the number of degrees of freedom is here only 12.) For individual countries the evidence is rather mixed. The regressions indicate cross-industry convergence significantly (at 5 or 10% significance level) only for Poland, Slovenia and the Czech Republic. Bulgaria, Romania, and the Slovak Republic show a negative (insignificant) sign, whereas the coefficient of Hungary shows a positive sign, but is insignificant.

In general, this pattern may show that sectors (within countries) lying farther behind are catching up faster, but that specific industrial characteristics (e.g. high- or low-tech industries, FDI involvement, specific skill endowments, etc.) might probably be much more important. The dependency of catching up on such other factors has not yet been explored.

Table 8

Cross-industry regressions
Output productivity

	Total sample	without BUL and RO	BUL	CZR	HUN	POL	ROM	SLO	SKR
Coeff.	-0.116	-0.114	-0.069	-0.223	0.034	-0.146	-0.064	-0.186	-0.113
t-value	-3.335	-3.224	-0.034	-1.957	0.274	-2.377	-0.568	-2.030	-1.513
R squ.	0.104	0.133	0.009	0.242	0.006	0.320	0.026	0.256	0.160
R squ. adj.	0.095	0.120	-0.073	0.179	-0.077	0.263	-0.055	0.194	0.090
F-value	11.120	10.400	0.110	3.830	0.080	5.650	0.320	4.120	2.290

Wage catching-up

The results for the equivalent cross-section regressions on wage convergence are presented in Table 9. The coefficients are negative in all cases and significant in the cases of Hungary, Poland, Romania and the Slovak Republic and insignificant only in the case of Bulgaria.

Table 9

Cross-industry regressions
Wages

	Total sample	without BUL and RO	BUL	CZR	HUN	POL	ROM	SLO	SKR
Coeff.	-0.132	-0.063	-0.019	-0.060	-0.121	-0.194	-0.106	-0.082	-0.101
t-value	-5.183	-4.458	-0.021	-1.501	-2.319	-2.480	-3.041	-1.940	-2.044
R squ.	0.219	0.226	0.004	0.158	0.309	0.339	0.435	0.239	0.258
R squ. adj.	0.211	0.215	-0.080	0.088	0.252	0.284	0.388	-1753.000	0.196
F-value	26.860	19.870	0.040	2.250	5.380	6.150	9.250	3.760	4.180

Some analyses for industry groupings

Another way to look at the catch-up patterns is to divide the 14 industries into three subgroups: a *low-tech group* (including DA (food products, beverages, and tobacco), DB (textiles and textile products), and DC (leather and leather products)); a *high-tech group* (including DK (machinery and equipment), DL (electrical and optical equipment) and DM (transport equipment)), and a *resource- (and scale-) intensive group* (including DD (wood and wood products), DF (coke, refined petroleum products and nuclear fuel), DG (chemicals, chemical products and man-made fibres), and DI (other non-metallic mineral products)). We refer first to Table 10 for initial gaps and growth rates in the productivity levels and wage rates of the three industrial groupings across the whole country sample over the period 1991-97.

As regards productivity catching-up, the high-tech industries experienced the highest average growth rate (0.16) and, compared to the resource-intensive industries, show a rather high initial gap. There is no significant relationship across branches within this group between the initial gap and the growth rate of the gap (for the econometric results on convergence patterns within the groups see Table 11 below). Thus, although these sectors are catching up relatively faster than the other sectors, the size of the initial gaps within the group seems not to be important. The low-tech industries have an initial gap comparable to the high-tech industries, but a very low growth rate in the closure of the gap across branches within this group (0.04). Again there is no significant relationship between the initial gap and the growth rate of the gap within the group. The resource-intensive industries show the lowest initial gap on average (-0.87) and a relatively high growth rate in the gap (0.07); further there is a strong relationship between the initial gap and the growth rate within this industry group, which gives the typical catching-up pattern, i.e. that industries lagging behind are catching up relatively faster than other industries in this group.

Table 10

Average initial gap and growth rate for industry groups

	low-tech		resource-intensive		high-tech	
	productivity	wages	productivity	wages	productivity	wages
gap	0.382	0.337	0.446	0.292	0.343	0.274
growth rate	0.035	0.049	0.070	0.078	0.161	0.079

Table 10 also allows us to make some comparisons between productivity and wage catching-up across the three industrial groupings. (Note, however, that wages are expressed at current PPP's and productivity at constant prices; thus the absolute values for the growth rates are not comparable, but the relative structure is interesting.)

The initial gap in labour productivity levels is highest in the high-tech industries and lowest in the resource-intensive industries, with the low-tech sectors lying in between. The initial gap of wages is higher than that of productivity levels in all three groups and much more similar across industries. This pattern is quite different if one looks at the growth rates of these two variables. Productivity growth is highest on average in the high-tech sectors, medium in the resource-intensive industries and lowest in the low-tech sectors. But the growth rates in wages are much more similar across these industry groups, almost the same in the high-tech and resource-intensive industries, and a little bit lower in the low-tech industries. In the low-tech and resource-intensive industries the wage growth rate is higher

Table 11

Cross-country regressions for industry groups
Productivity

Industry groups	**low-tech**	**resource-intensive**	**high-tech**
Coeff.	-0.027	-0.177	0.058
t-value	-0.686	-3.918	0.909
R squ.	0.024	0.371	0.042
R squ. adj.	-0.027	0.347	-0.009
F-value	0.470	15.350	0.830

without Bulgaria and Romania

	low-tech	**resource-intensive**	**high-tech**
Coeff.	-0.018	-0.205	-0.013
t-value	-0.460	-3.596	-0.131
R squ.	0.016	0.418	0.001
R squ. adj.	-0.060	0.386	-0.076
F-value	0.210	12.930	0.020

low-tech: DA, DB, DC; resource-intensive: DD, DF, DG, DI; high-tech: DK, DL, DM than the productivity growth rate; in the high-tech industry the productivity growth rate is much higher than wage growth. Thus, whereas the comparative cost advantage in 1991 was in the resource based industries for the CEECs, this pattern may have changed. The CEECs are gaining comparative cost advantages in the 'higher-tech' sectors and losing comparative cost advantages in the 'low-tech' industries.

As regards within-group econometric results on wage catching-up, see Table 12. We can see that the within-group convergence coefficients are consistently significant for all but the low-tech industries.

Table 12

Cross-country regressions for industry groups
Wages

Industry groups	low-tech	resource-intensive	high-tech
Coeff.	-0.153	-0.172	-0.130
t-value	-3.163	-3.746	-2.062
R squ.	0.345	0.351	0.183
R squ. adj.	0.311	0.326	0.140
F-value	10.000	14.030	4.250

without Bulgaria and Romania

Industry groups	low-tech	resource-intensive	high-tech
Coeff.	-0.038	-0.058	-0.058
t-value	-1.555	-3.147	-2.064
R squ.	0.157	0.355	0.247
R squ. adj.	0.092	0.319	0.189
F-value	2.420	9.900	4.260

low-tech: DA, DB, DC; resource-intensive: DD, DF, DG, DI; high-tech: DK, DL, DM

Conclusions to Part A

In this part of the paper we analysed productivity and wage catching-up processes at the aggregated manufacturing and the detailed industrial level, first, for a large country sample and, second, compared these results to the CEECs' experiences in the 1990s. The overall pattern is that countries are catching up in productivity levels relatively faster in the technologically more sophisticated industries than in low-tech industries. The reasons for this pattern are not investigated here, but there is some evidence that countries and industries lagging further behind at the beginning are catching up faster. Other factors which are now on the research agenda are the impact of FDI patterns, industry-specific skill endowments and different learning curves across the industrial branches. A second important result is that the catching-up of wages is much more similar across branches within the countries. Although the statistical database for the CEECs is rather small and using a somewhat different approach due to the short time period, this pattern also emerges. As emphasized in the short theoretical discussion at the beginning of the paper: due to the uneven industrial pattern of catching up in productivity levels across industries and, on the other hand, the wage drift across industries, these countries have the potential to increasingly gain comparative advantages in the technologically more sophisticated industries.

Part B

6 Catching up in product quality/export prices

We now apply a similar methodological approach as in Part A to catching-up patterns in product prices or more precisely in export unit values.

6.1 Data and graphical analysis

In particular, we used unit values of products exported to the EU for selected countries and industries to study convergence in export prices. Information on trade values and volumes at the (most detailed) 8-digit CN (Combined Nomenclature, 6-digit NIMEXE before 1988) product level of exports to EU countries (measured f.o.b.) was taken from Eurostat's Detailed Trade Statistics. Trade values were given in 1000 ECU (current exchange rates).

For each industry then the full product level information was used to construct an industry-level (weighted) price gap indicator for country c's exports to the EU, which was arrived at as:

$$Q^c_j = \sum_{i \in I(j)} (p^c_i / p^{EU}_i) \cdot \chi^c_i$$

where

p^c_i is the price (per kg) at which country c sells exports of the product item i on EU markets (refers here to the EU 12 market),

p^{EU}_i is the average price of product item i in total EU 12 imports and

χ^c_i is the share of product item i in country c's exports to the EU 12 market, i.e.

$$\chi^c_i = x^c_i / \sum_{i \in I(j)} x^c_i$$

with

$$\sum_{i \in I(j)} \chi^c_i = 1$$

where

x^c_i is the export value of product i for country c and

$I(j)$ is the set of product items i belonging to industry j.

This indicator was calculated for each year from 1977 up to 1996 except for 1980-82 because data were lacking. We interpolated values for these years assuming constant growth rates. The specific industries (ISIC classification) are 321 (textiles), 322 (wearing apparel), 323 (here leather products and footwear are subsumed), 382 (mechanical engineering), 383 (electrical engineering) and 385 (professional goods).

Afterwards we had to name a technology or (in this case) price leader to whom convergence shall be examined throughout this study since actual price leadership can be changing with industry and time. We decided that a group of countries comprising the six core EU countries (Germany, France, Italy, Belgium, the Netherlands and the United Kingdom) and the USA should play this role (referred to as USAEUN).

The graphs in Figure 6.1 show three-year-averages for the price gap for the following country groups (as well as for China and India individually):

SCAAUT: Scandinavian countries and Austria,

EUS: the Southern European countries Spain, Portugal and Greece,

CEECW: comprising the 'Western' Central and Eastern European countries Hungary, Poland, the Czech Republic (Czechoslovakia and CSFR, respectively) and Slovenia (Yugoslavia before 1993),

CEECE: with the 'Eastern' Central and Eastern European countries Romania, Bulgaria and Russia (Soviet Union before 1993),

ABC: Argentina, Brazil and Chile,

NICS1: Hong Kong, Singapore, Taiwan and South Korea,

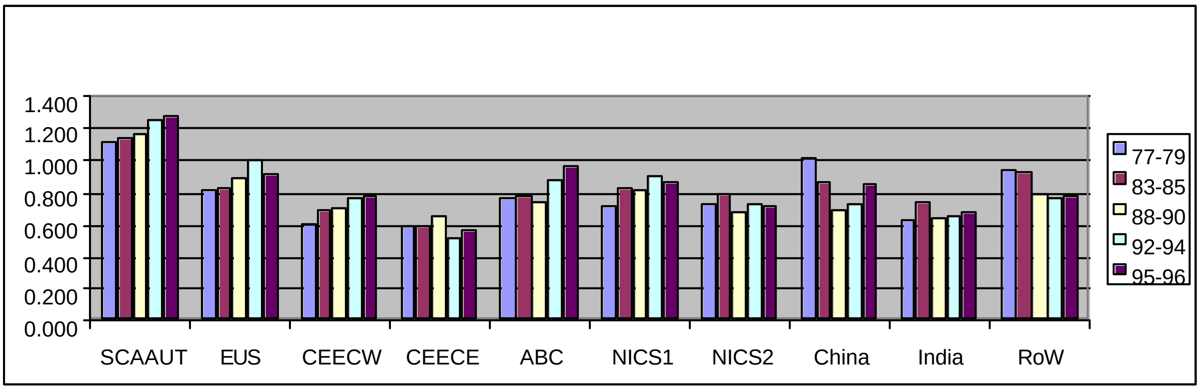
NICS2: Malaysia, Thailand, Indonesia and the Philippines,

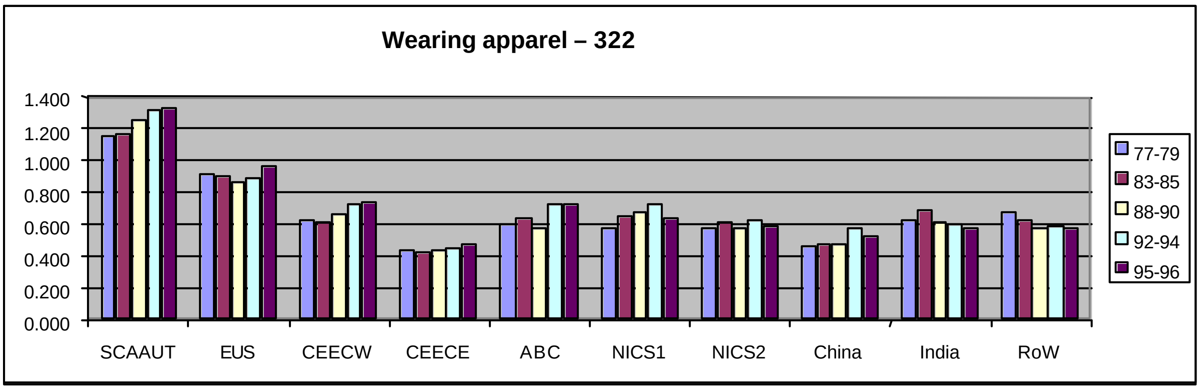
RoW: Rest of the World.

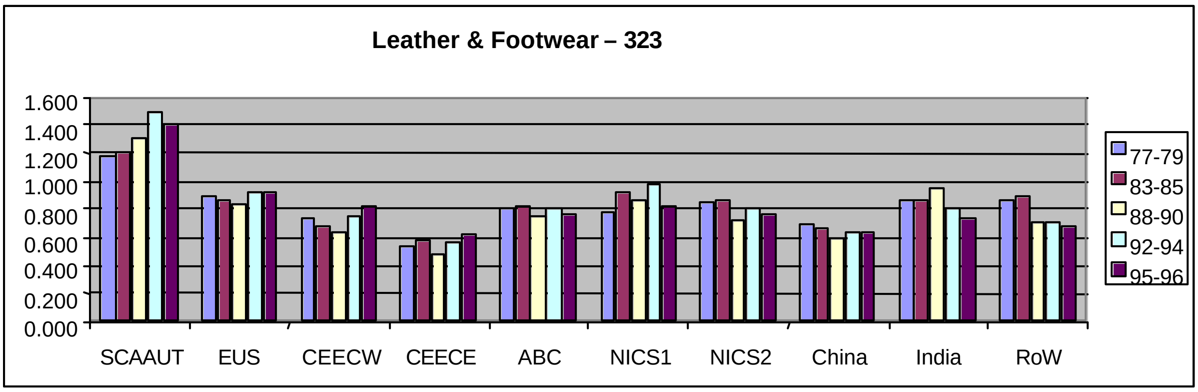
Some movements in the series of the CEECs obviously reflect the structural break at the beginning of the 1990s. We can observe some falling behind towards the end of the communist era and a significant increase in export prices afterwards in most industries, resulting in series looking slightly U-shaped.

Figure 6

Price gaps for country groups (USAEUN = 1.00; averages)



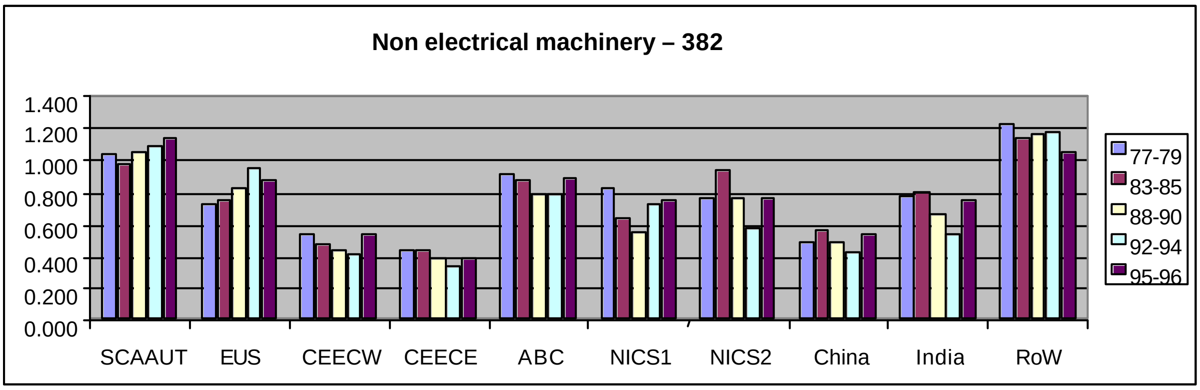


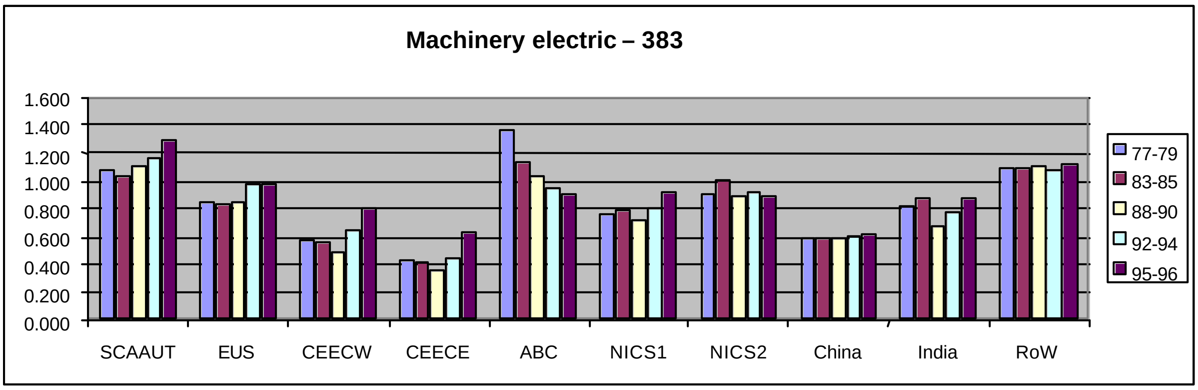


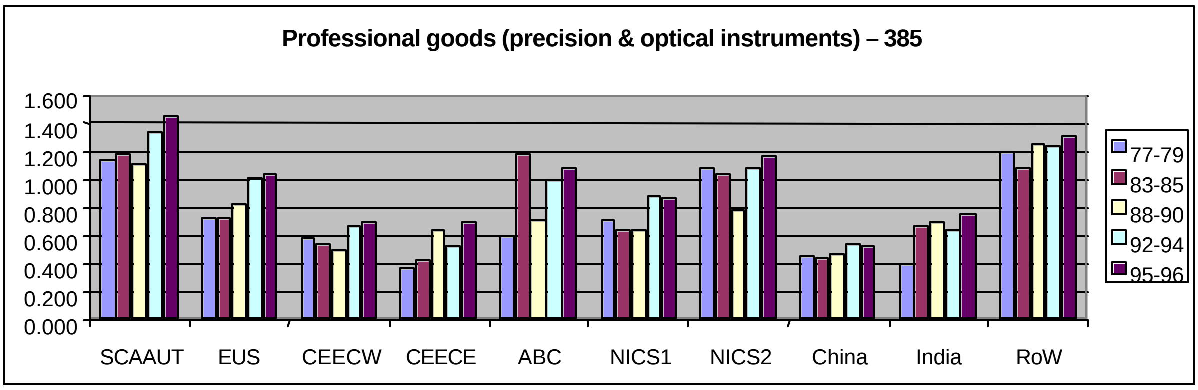
(Figure 6 ctd.)

Figure 6 ctd.

Price gaps for country groups (USAEUN = 1.00; averages)







Sometimes also for the NICs and the Latin American countries (ABC) a similar picture emerges. This may mirror an increasing influence of domestic firms in addition to exports by multinationals, pushing average export prices down in the first place (as their product qualities and prices are below those of the multinational corporations). Then, as they improve their quality, the average price rises again.

Small export values to the EU may be the reason for some volatilities in these gaps (especially for the South American countries) making results somewhat unreliable in light of the fact that one exporting firm or exported product can change price gap values to a considerable extent.

It seems slightly difficult to detect general convergence in export prices from these graphs. The inclusion of the USA, with its prices of exports to the EU increasing over time (relative to the EU countries) for most of the industries examined here in the leader group, surely is one explanation. Convergence, especially for the CEECs, could occur more strongly when using e.g. EU 12 as the benchmark (see the series in Burgstaller and Landesmann, 1999). Strengthened economic integration (lowering transaction costs and market barriers amongst EU member countries) leading to a fall in intra-EU trade prices may also be an influence for this proposition.

Two general statements can be made simply from an inspection of the graphs. First, convergence is not something that has to occur or has to occur quickly and immediately. Looking at EUS, ABC, the NICs and India from the late 1970s onwards, even countries and country groups with a considerable initial gap did not show a convergence process that is instantaneous, continuous or is speeding up. Second, there is no need to assume that all countries that are candidates for catching up in fact do so conforming to a general or average pattern as implied by a great bulk of the literature in this field. Similarly, there are differences across industries and manufacturing sectors.

We now turn to examine the evidence for convergence by means of econometrics.

6.2 Cross-country regressions

The data for the regression analysis were calculated for the individual countries of the above-mentioned groups EUS, ABC, NICS1, NICS2 (plus China and India) in the same way as for the other variables in this report.

We tried to account for differences in convergence between industries by dividing the sample into two groups of industries (engineering comprising ISIC industries 382, 383, 385 and textiles, clothing and leather products comprising ISIC industries 321, 322, 323) and into country groups doing additional analysis for CEECW and CEECE after 1991 and 1993 respectively. From 1993 on, the country groups consist of Hungary, Poland, Czech Republic, Slovenia, Slovak Republic and the Baltic countries (CEECW) and Bulgaria, Romania, Russia, Ukraine and the rest of the CIS nations (CEECE). Unfortunately, the number of industries and years here is too small to dig deeper into differences across countries and country groups.

The results, of linear as well as panel regressions, are given in Table 13. The first case comprises 18 countries from the above-mentioned groups. With linear regressions, the β-coefficients are negative and significant. The average half life can be calculated by $\ln(0,5)/\beta_1$, resulting in approximately 33 years when looking at the equation including all of the six industries. Convergence is found to occur faster in the textiles, clothing and leather pds. industries. The panel regressions show a similar picture. Both models, fixed and random effects, are given and can be technically discriminated by LM and Hausman tests.

In a next step, only the seven CEECs (Hungary, Poland, Czech Republic, Slovenia, Bulgaria, Romania and Russia) are in the sample with data starting in 1991. The estimated parameter for convergence speed is now much higher leading to an average half life of about 10 years (when covering all six industries). Again, the process is faster for textiles etc., and β_1 is insignificant for the engineering industries potentially because of a delayed and slow closure of the gap for some countries within the CEECE group especially for industries 382 and 385. This is confirmed by a highly significant estimate of β_1 of -0,094 (resulting in a half life of 7.37 years!) in the linear regression which includes only the four 'Western' CEECs.

When looking at the period after 1993, it is possible to include more CEE countries (Slovakia, the group of Baltic countries, the Ukraine and a 'Rest of CIS'-group); the estimated parameter rises to -0.149 (estimated average half life is 4.65 years!) in the linear regression including all industries. But now the closure of the gap in export prices seems to be somewhat faster for the engineering industries. Again, the more 'Western' CEE countries seem to be able to reduce their gap faster (see the estimates for only the six countries).

These high values obtained for the convergence parameter from the regressions for the CEECs (with those of panel regressions even higher than the ones obtained from linear regressions) may stem from a nonlinear relationship between the gap and the speed of convergence which we did not incorporate here. The implication of such a nonlinearity would be a slowing down of the convergence speed in the following years.

Some of the results given here are not too reliable in a statistical sense because of the low numbers of degrees of freedom in some panel cases.

Table 13

Regression results (price gap variables)

country group, method and time period as indicated

18 countries: Southern EU, South America, Southeast Asia, China, India

LINEAR REGRESSION

Total (6 industries)			***Textile industries***			***Engineering industries***		
coefficient	-0.021		coefficient	-0.036		coefficient	-0.016	
s. d.	0.005		s. d.	0.008		s. d.	0.007	
t-value	-4.339	***	t-value	-4.642	***	t-value	-2.338	**
R sq.	0.152		R sq.	0.293		R sq.	0.097	
R sq. adj.	0.144		R sq. adj.	0.279		R sq. adj.	0.079	
F-value	18.830	***	F-value	21.540	***	F-value	5.470	**
obs.	107		obs.	54		obs.	53	

FIXED-EFFECTS

Total (6 industries)			***Textile industries***			***Engineering industries***		
coefficient	-0.026		coefficient	-0.030		coefficient	-0.026	
s. d.	0.005		s. d.	0.007		s. d.	0.008	
t-value	-4.860	***	t-value	-4.112	***	t-value	-3.307	***
R sq. within	0.212		R sq. within	0.326		R sq. within	0.243	
R sq. between	0.010		R sq. between	0.286		R sq. between	0.001	
F-value	23.620	***	F-value	16.910	***	F-value	10.940	***
obs.	107		obs.	54		obs.	53	

RANDOM EFFECTS

Total (6 industries)			***Textile industries***			***Engineering industries***		
coefficient	-0.022		coefficient	-0.033		coefficient	-0.017	
s. d.	0.005		s. d.	0.007		s. d.	0.007	
t-value	-4.472	***	t-value	-4.804	***	t-value	-2.607	***
Wald	20.000	***	Wald	23.080	***	Wald	6.800	***
obs.	107		obs.	54		obs.	53	
LM test	0.470		LM test	9.420	***	LM test	0.640	
Hausman	3.650	*	Hausman	0.450		Hausman	4.300	**

7 countries: Hungary, Czech Rep., Poland, Slovenia, Bulgaria, Romania, Russia; since 1991

LINEAR REGRESSION

Total (6 industries)			***Textile industries***			***Engineering industries***		
coefficient	-0.068		coefficient	-0.064		coefficient	-0.052	
s. d.	0.023		s. d.	0.023		s. d.	0.055	
t-value	-2.969	***	t-value	-2.770	**	t-value	-0.940	
R sq.	0.181		R sq.	0.288		R sq.	0.045	
R sq. adj.	0.160		R sq. adj.	0.250		R sq. adj.	-0.006	
F-value	8.810	***	F-value	7.670	**	F-value	0.880	
obs.	42		obs.	21		obs.	21	

FIXED-EFFECTS

Total (6 industries)			***Textile industries***			***Engineering industries***		
coefficient	-0.109		coefficient	-0.128		coefficient	-0.130	
s. d.	0.029		s. d.	0.046		s. d.	0.084	
t-value	-3.793	***	t-value	-2.796	**	t-value	-1.540	
R sq. within	0.297		R sq. within	0.376		R sq. within	0.154	
R sq. between	0.039		R sq. between	0.323		R sq. between	0.026	
F-value	14.390	***	F-value	7.820	**	F-value	2.370	
obs.	42		obs.	21		obs.	21	

RANDOM EFFECTS

Total (6 industries)			***Textile industries***			***Engineering industries***		
coefficient	-0.076		coefficient	-0.075		coefficient	-0.052	
s. d.	0.024		s. d.	0.027		s. d.	0.055	
t-value	-3.203	***	t-value	-2.798	***	t-value	-0.94	
Wald	10.260	***	Wald	7.830	***	Wald	0.880	
obs.	42		obs.	21		obs.	21	
LM test	0.340		LM test	0.430		LM test	1.040	
Hausman	4.140	**	Hausman	2.020		Hausman	1.500	

*** significant at the 1 % level
** significant at the 5 % level
* significant at the 10 % level

Table 13 ctd.

Regression results (price gap variables)

country group, method and time period as indicated

11 countries: Hungary, Czech Rep., Poland, Slovenia, Bulgaria, Romania, Russia, Slovakia, Baltic countries, Ukraine, Rest of GUS; since 1993

LINEAR REGRESSION

Total (6 industries)		*Textile industries*		*Engineering industries*	
coefficient	-0.149	coefficient	-0.133	coefficient	-0.164
s. d.	0.024	s. d.	0.027	s. d.	0.045
t-value	-6.316 ***	t-value	-4.929 ***	t-value	-3.617 ***
R sq.	0.384	R sq.	0.439	R sq.	0.297
R sq. adj.	0.374	R sq. adj.	0.421	R sq. adj.	0.274
F-value	39.890 ***	F-value	24.300 ***	F-value	13.090 ***
obs.	66	obs.	33	obs.	33

FIXED-EFFECTS

Total (6 industries)		*Textile industries*		*Engineering industries*	
coefficient	-0.167	coefficient	-0.161	coefficient	-0.193
s. d.	0.032	s. d.	0.057	s. d.	0.044
t-value	-5.294 ***	t-value	-2.840 **	t-value	-4.386 ***
R sq. within	0.342	R sq. within	0.278	R sq. within	0.399
R sq. between	0.464	R sq. between	0.620	R sq. between	0.006
F-value	28.020 ***	F-value	8.070 ***	F-value	19.240 ***
obs.	66	obs.	33	obs.	33

RANDOM EFFECTS

Total (6 industries)		*Textile industries*		*Engineering industries*	
coefficient	-0.158	coefficient	-0.134	coefficient	-0.188
s. d.	0.026	s. d.	0.028	s. d.	0.043
t-value	-5.99 ***	t-value	-4.793 ***	t-value	-4.39 ***
Wald	35.880 ***	Wald	22.970 ***	Wald	19.270 ***
obs.	66	obs.	33	obs.	33
LM test	6.800 ***	LM test	0.000	LM test	5.610 **
Hausman	0.310	Hausman	0.300	Hausman	0.200

6 countries: Hungary, Czech Rep., Poland, Slovenia, Slovakia, Baltic countries; since 1993

LINEAR REGRESSION

Total (6 industries)		*Textile industries*		*Engineering industries*	
coefficient	-0.193	coefficient	-0.180	coefficient	-0.208
s. d.	0.024	s. d.	0.042	s. d.	0.038
t-value	-8.100 ***	t-value	-4.267 ***	t-value	-5.491 ***
R sq.	0.659	R sq.	0.532	R sq.	0.653
R sq. adj.	0.649	R sq. adj.	0.503	R sq. adj.	0.632
F-value	65.600 ***	F-value	18.210 ***	F-value	30.150 ***
obs.	36	obs.	18	obs.	18

FIXED-EFFECTS

Total (6 industries)		*Textile industries*		*Engineering industries*	
coefficient	-0.183	coefficient	-0.166	coefficient	-0.240
s. d.	0.036	s. d.	0.138	s. d.	0.028
t-value	-5.122 ***	t-value	-1.208	t-value	-8.544 ***
R sq. within	0.475	R sq. within	0.117	R sq. within	0.839
R sq. between	0.908	R sq. between	0.806	R sq. between	0.001
F-value	26.230 ***	F-value	1.460	F-value	72.990 ***
obs.	36	obs.	18	obs.	18

RANDOM EFFECTS

Total (6 industries)		*Textile industries*		*Engineering industries*	
coefficient	-0.193	coefficient	-0.180	coefficient	-0.238
s. d.	0.024	s. d.	0.042	s. d.	0.029
t-value	-8.100 ***	t-value	-4.267 ***	t-value	-8.328 ***
Wald	65.600 ***	Wald	18.210 ***	Wald	69.360 ***
obs.	36	obs.	18	obs.	18
LM test	0.310	LM test	0.280	LM test	8.530 ***
Hausman	0.140	Hausman	0.010	Hausman	0.000

*** significant at the 1 % level
** significant at the 5 % level
* significant at the 10 % level

6.3 Dickey-Fuller unit root tests

For the assessment of convergence in export prices we also applied Dickey-Fuller tests. But in this exercise they have some severe drawbacks.

First, our time series are very short making it impossible to apply this test to time series of CEECs which are reliable only from the early 1990s onwards. The small number of observations also restricted the testing procedure in a way leading us to include a maximum of five lags for augmentation of the test. As a result, we could not fully deal with the problem of autocorrelation and the estimates might be inefficient.

Second, the price gap series are very volatile and the ADF test loses power in case of structural breaks. In fact, the results are then biased towards non-rejection of the null (see Charemza and Deadman, 1997, p. 119 f.). This, in our case, means that convergence will be indicated less often than it might be the case.

Given these weaknesses of applying the procedure to our data set, we found that a great part of the results were unsatisfactory for single countries when comparing them with the individual data series (the test often did not confirm convergence for series for which we expected to produce this result and reported significant results for others for which we did not expect these). We thus only report the results for country group series and give an explanation using the single country results where this seems to be necessary.

The ADF test results can be found in Annex Table A/4. Positive coefficients signal divergence relative to the leader group USAEUN. For industry 321, textiles, CEECW and NICS1 show up with significant statistics. Convergence is not confirmed for EUS (potentially because of a break at the end of the time series), ABC and China (both series show a U-shape). EUS has a high and significant coefficient in 322, wearing apparel, because this group of countries was able to close its small initial gap in export prices successfully. There was no catching-up for other country groups, for which this process started later (e.g. for ABC and CEECW starting in the 1990s). Within the leather and footwear industry group (323), both NIC country groups and India show partly very highly significant coefficients despite of rather volatile time series.

For engineering industry 382 (mechanical engineering), none of the coefficients of the classic catching-up-countries is significant even at the 10%-level. EUS did well in closing the gap for most of the period but fell a little behind again in the mid-1990s. Catching-up in export prices began late for CEECs and the other series show ups and downs. In industry 383, electrical engineering, the NIC2 managed well in closing the gap. The ABC series seem to be influenced by outliers, respectively multinationals' exports, with export prices relative to USAEUN starting from above 1 and falling continuously, resulting in convergence. The series of the CEECs show some U-shape, whereas the coefficient for

EUS are not significant (see figure). Prices of professional goods (ISIC 385) converged for ABC and the NICs and no significant catching-up was found for EUS here. Also China and India have made progress, but, as it seems, not enough so far to yield significant estimates (see again figure).

As stated before, the results are surely biased towards non-convergence here. Some of the single country results, also biased in this sense, can be commented upon here. Significant group test statistics here were driven by Taiwan and Hong Kong (NICS1 for 321), Korea (NICS1 for 323), Indonesia and the Philippines (NICS2 for 323), Chile and Brazil (ABC for 382 and 385), and Malaysia, Indonesia and Thailand (NICS2 in 383 and 385). None of the single-country statistics was found significant for CEECW for industry 321 and NICS1 for industry 385.

Conclusions to Part B

The analysis of catching-up processes in export prices as indicators of product quality complements well the analysis of productivity levels and of wage rates conducted in part A of this chapter. We found generally significant (econometric) evidence for convergence processes in export prices across a wide range of international suppliers. Interestingly, while the estimated catching-up parameters for the wide sample of suppliers to EU markets including those from Southern Europe, South America and South and South-East Asia and over the long estimation period 1977-1996 were bigger for the (more labour-intensive) branches textiles, clothing and leather products than for the technologically more sophisticated engineering branches, the opposite was the case for the parameters estimated for the Central and Eastern European countries over the shorter period 1991-96 and even more so for the group of ‘Western’ CEECs. Hence our conclusion from Part A concerning the potential for relatively fast catching-up processes in the (technologically) more advanced engineering branches in the case of the more advanced group of CEECs is also confirmed here by our analysis of the catching-up processes in export prices as indicators for product quality.

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ANNEX

Table A/1

Results of Dickey-Fuller test for individual countries

Total manufacturing – 300

	OUTPROD			VALPROD			WAGEMP		
	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time
CAN	-0.050	-1.424	14.0	-0.012	-0.669	59.4	-0.043	-2.569 **	16.0
AUT	-0.025	-2.372 **	27.6	-0.012	-1.952 *	56.6	-0.044	-5.293 ***	15.9
BEL	-0.065	-2.063 **	10.6	-0.031	-3.248 ***	22.7	-0.045	-6.167 ***	15.5
DEN	-0.004	-0.326	177.0	0.000	0.022	-3281.9	-0.037	-2.703 ***	18.7
FRA	-0.061	-4.061 ***	11.4	-0.036	-3.341 ***	19.1	0.022	0.315	-31.3
GWE	-0.030	-2.830 ***	23.4	-0.031	-2.196 **	22.7	-0.066	-6.375 ***	10.5
ITA	-0.095	-2.984 ***	7.3	-0.022	-1.096	31.1	-0.084	-2.315 ***	8.2
LUX	-0.027	-0.923	25.9	-0.008	-0.412	85.2	-0.065	-3.088 ***	10.7
NLD	-0.088	-2.249	7.9	-0.023	-2.047 **	29.5	-0.083	-3.286 ***	8.4
SWI	-0.018	-1.147	39.4	-0.010	-0.801	68.1	n.a.		
UKD	-0.023	-1.915 *	30.4	-0.018	-2.217 **	38.2	-0.030	-3.725 ***	22.8
GRC	-0.037	-3.854 ***	18.5	-0.026	-3.121 ***	26.5	-0.037	-7.462 ***	18.8
ICE	-0.031	-1.929 *	22.7	-0.018	-1.405	37.8	-0.058	-2.170 ***	11.9
IRE	-0.040	-2.151 **	17.3	-0.043	-3.156 ***	16.3	-0.039	-3.520 ***	17.7
POR	-0.002	-0.181	434.3	0.006	0.957	-120.4	-0.026	-2.013 **	26.2
ESP	-0.043	-2.885 ***	16.2	-0.021	-1.691 *	33.1	-0.047	-5.656 ***	14.6
TUR	-0.034	-1.282	20.2	-0.040	-1.631 **	17.4	-0.017	-1.184	41.4
JAP	-0.086	-3.825 ***	8.1	-0.057	-3.712 ***	12.1	-0.058	-10.219 ***	12.0
AUS	-0.011	-0.079	65.7	-0.014	-1.177	51.1	-0.024	-2.328 **	28.9
NZL	-0.003	-0.016	236.1	-0.001	-0.075	771.2	-0.024	-0.971	29.1
FIN	-0.030	-2.103 **	23.1	-0.022	-2.103 **	32.1	-0.033	-3.679 ***	20.7
NOR	-0.021	-1.840 *	33.6	-0.005	-0.684	137.9	-0.030	-3.009 ***	23.3
SWE	-0.018	-1.231	38.0	-0.003	-0.255	206.9	-0.009	-0.913	75.2
TAI	-0.034	-2.424 **	20.3	-0.020	-2.340 **	35.0	-0.053	-6.593 ***	13.2
HKO	-0.044	-2.705 ***	15.7	-0.024	-2.233 **	28.3	-0.043	-3.723 ***	15.9
KOR	-0.040	-3.352 ***	17.4	-0.037	-3.196 ***	18.8	-0.034	-4.274 ***	20.6
SIN	-0.020	-0.851	35.0	-0.025	-3.139 ***	27.3	-0.026	-3.310 ***	26.3
INA	-0.016	-1.980 *	43.6	-0.004	-0.935	158.2	-0.007	-1.546	98.8
INO	-0.030	-3.824 ***	23.0	-0.032	-3.236 ***	21.7	-0.016	-3.998 ***	42.6
MAL	-0.021	-1.502	33.6	-0.010	-1.089	72.3	-0.012	-2.211 **	56.8
PHI	0.006	0.363	-125.5	0.003	0.235	-225.7	-0.003	-0.472	269.9
THA	-0.029	-0.067	24.2	-0.008	-0.152	82.7	-0.011	-0.963	60.9

Table A/2

Results of cross-country regressions – subperiods

Periods		Textiles 321 OGR	Textiles 321 VGR	Textiles 321 WGR	Wearing apparel 322 OGR	Wearing apparel 322 VGR	Wearing apparel 322 WGR
1965-95[1)]	Coeff.	-0.024	-0.022	-0.018	-0.023	-0.029	-0.022
	t-value	-3.507	-3.380	-3.639	-3.663	-5.543	-4.801
	Std.Dev.	0.006	0.007	0.005	0.006	0.005	0.005
	R squ.	0.138	0.128	0.152	0.154	0.291	0.245
	R squ. adj.	0.127	0.116	0.140	0.142	0.281	0.234
	F-value	12.300	11.430	13.240	13.420	30.720	23.050
1965-75	Coeff.	-0.035	-0.036	-0.019	-0.034	-0.024	-0.018
	t-value	-3.550	-3.066	-1.576	-2.271	-2.411	-2.191
	Std.Dev.	0.010	0.012	0.012	0.015	0.010	0.008
	R squ.	0.364	0.299	0.106	0.197	0.217	0.194
	R squ. adj.	0.335	0.268	0.063	0.159	0.180	0.153
	F-value	12.610	9.400	2.480	5.160	5.810	4.800
1975-85	Coeff.	-0.007	-0.014	-0.018	-0.026	-0.027	-0.033
	t-value	-0.836	-1.646	-2.701	-3.030	-4.493	-4.324
	Std.Dev.	0.009	0.008	0.007	0.008	0.006	0.008
	R squ.	0.025	0.088	0.213	0.261	0.428	0.418
	R squ. adj.	-0.011	0.056	0.184	0.233	0.407	0.396
	F-value	0.700	2.710	7.290	9.180	20.190	18.700
1985-95	Coeff.	-0.024	-0.027	0.018	-0.021	-0.038	-0.014
	t-value	-1.570	-1.470	-2.071	-1.886	-3.314	-1.569
	Std.Dev.	0.156	0.015	0.009	0.011	0.011	0.009
	R squ.	0.093	0.083	0.163	0.134	0.323	0.105
	R squ. adj.	0.055	0.044	0.125	0.096	0.294	0.063
	F-value	2.470	2.160	4.290	3.560	10.980	2.460

Periods		Machinery (except electric) 382 OGR	Machinery (except electric) 382 VGR	Machinery (except electric) 382 WGR	Machinery electric 383 OGR	Machinery electric 383 VGR	Machinery electric 383 WGR
1965-95[1)]	Coeff.	-0.029	-0.289	-0.015	-0.038	-0.036	-0.016
	t-value	-3.561	-4.168	-2.806	-4.714	-4.523	-2.649
	Std.Dev.	0.008	0.007	0.005	0.008	0.008	0.006
	R squ.	0.145	0.186	0.099	0.233	0.217	0.091
	R squ. adj.	0.133	0.175	0.086	0.223	0.206	0.078
	F-value	12.680	17.370	7.870	22.220	20.460	7.020
1965-75	Coeff.	-0.049	-0.037	-0.018	-0.041	-0.039	-0.014
	t-value	-4.830	-3.713	-1.977	-3.514	-3.706	-1.125
	Std.Dev.	0.010	0.010	0.009	0.012	0.011	0.012
	R squ.	0.526	0.396	0.163	0.370	0.395	0.059
	R squ. adj.	0.504	0.368	0.122	0.340	0.367	0.012
	F-value	23.330	13.790	3.910	12.350	13.730	1.270
1975-85	Coeff.	-0.027	-0.020	-0.018	-0.047	-0.026	-0.024
	t-value	-2.014	-1.814	-2.693	-3.121	-2.200	-3.735
	Std.Dev.	0.014	0.011	0.007	0.015	0.012	0.006
	R squ.	0.140	0.112	0.225	0.280	0.157	0.358
	R squ. adj.	0.105	0.078	0.194	0.252	0.125	0.332
	F-value	4.060	3.290	7.250	9.740	4.840	13.950
1985-95	Coeff.	-0.023	-0.038	-0.016	-0.039	-0.040	-0.011
	t-value	-1.274	-2.718	-1.452	-1.891	-2.157	-0.864
	Std.Dev.	0.018	0.014	0.011	0.021	0.018	0.013
	R squ.	0.061	0.228	0.084	0.135	0.168	0.034
	R squ. adj.	0.023	0.197	0.044	0.097	0.132	-0.012
	F-value	1.620	7.390	2.110	3.580	4.650	0.750

1) The three ten-year periods (1965-75, 1975-85, 1985-95) pooled together.

Table A/3

Results of Dickey-Fuller test for individual countries

	Textiles - 321									Wearing apparel - 322								
	OUTPROD			VALPROD			WAGEMP			OUTPROD			VALPROD			WAGEMP		
	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time	Coeff.	t-value	Half-time
CAN	-0.046	-1.158	15.1	-0.055	-1.062	12.6	-0.025	-0.610	27.9	-0.072	-1.579	9.6	-0.031	-1.076	22.3	-0.037	-0.804	18.9
AUT	-0.029	-1.981 **	24.1	-0.021	-1.701 *	32.2	-0.047	-3.181 ***	14.8	-0.020	-0.913	34.3	-0.005	-0.382	127.4	-0.039	-2.948 ***	17.6
BEL	-0.065	-2.068 **	10.7	-0.041	-2.437 **	16.8	-0.043	-3.564 ***	16.2	-0.059	-3.246 ***	11.8	-0.035	-2.643 **	20.0	-0.042	-3.852 ***	16.5
DEN	0.003	0.148	-269.5	0.001	0.042	-775.9	-0.066	-2.658 ***	10.5	-0.006	-0.305	111.8	0.002	0.084	-429.5	-0.086	-1.845 *	8.1
FRA	-0.070	-3.804 ***	9.9	-0.042	-2.683 ***	16.5	0.106	1.458	-6.5	-0.099	-5.253 ***	7.0	-0.100	-4.118 ***	6.9	0.057	3.243 ***	-12.1
GWE	-0.046	-2.820 ***	15.0	-0.055	-1.734 *	12.7	-0.068	-4.466	10.1	-0.046	-1.380	15.2	-0.043	-1.144	15.9	-0.072	-4.208 ***	9.6
ITA	-0.124	-2.422 **	5.6	-0.142	-3.777 ***	4.9	-0.097	-2.391 **	7.2	-0.071	-1.461	9.8	-0.149	-3.439 ***	4.7	-0.102	-2.601 ***	6.8
LUX	-0.060	-0.758	11.6	-0.044	-0.600	15.9	-0.167	-2.016 **	4.2	0.030	1.308	-22.9	-0.010	-0.465	69.0	-0.062	-2.334 **	11.2
NLD	-0.114	-1.683 *	6.1	-0.043	-1.923 *	16.0	-0.065	-1.577	10.7	-0.040	-1.034	17.3	-0.032	-1.558	21.5	-0.045	-1.488	15.3
SWI	-0.018	-0.381	38.1	-0.032	-0.639	21.8	n.a.			-0.045	-0.302	15.3	-0.094	-1.215	7.3	n.a.	n.a.	
UKD	-0.012	-0.973	55.7	-0.023	-1.893 *	29.6	-0.034	-3.206 ***	20.4	-0.026	-1.646 *	26.7	-0.027	-1.874 *	26.0	-0.037	-3.341 ***	18.9
GRC	-0.041	-3.186 ***	16.8	-0.038	-2.551 **	18.1	-0.043	-4.925 ***	16.3	-0.042	-2.897 ***	16.7	-0.034	-2.634 **	20.5	-0.043	-5.136 ***	16.1
ICE	-0.059	-2.377 **	11.7	-0.035	-1.349	20.0	-0.123	-2.552 **	5.6	-0.066	-2.078 **	10.5	-0.038	-1.899 *	18.1	-0.082	-2.059 **	8.5
IRE	-0.021	-1.163	33.8	-0.024	-1.493	29.2	-0.040	-3.005 ***	17.2	-0.020	-1.645 *	35.1	-0.021	-1.938 *	33.8	-0.042	-3.427 ***	16.4
POR	-0.009	-0.656	80.3	-0.006	-0.467	122.3	-0.031	-2.028 **	22.3	0.006	0.292	-117.6	0.000	-0.007	6684.2	-0.062	-2.087 **	11.2
ESP	-0.038	-1.134	18.3	-0.025	-0.965	27.4	-0.048	-2.672 ***	14.3	-0.035	-0.720	19.7	0.002	0.070	-354.5	-0.049	-2.918 ***	14.1
TUR	-0.030	-1.170	23.0	-0.033	-1.507	21.0	-0.010	-0.713	66.5	-0.115	-1.551	6.0	-0.020	-0.770	34.5	-0.002	-0.131	344.2
JAP	-0.049	-2.176 **	14.1	-0.058	-3.175 ***	11.9	-0.064	-7.995 ***	10.9	-0.017	-1.093	41.3	-0.030	-2.213 **	22.7	-0.060	-8.192 ***	11.5
AUS	-0.031	-1.169	22.6	-0.034	-1.091	20.6	-0.048	-1.579	14.5	-0.038	-1.569	18.1	-0.029	-1.248	24.0	-0.050	-1.574	13.9
NZL	-0.021	-0.233	33.4	0.007	0.281	-96.2	-0.030	-0.732	23.4	-0.050	-0.990	13.9	-0.009	-0.040	76.3	-0.010	-0.186	71.0
FIN	-0.039	-2.113 **	17.6	-0.036	-2.041 **	19.5	-0.040	-2.868 ***	17.4	-0.027	-1.619 *	25.4	-0.025	-1.541	27.8	-0.047	-3.036 ***	14.6
NOR	-0.008	-0.735	87.1	-0.002	-0.176	312.6	-0.029	-2.365 **	23.7	-0.028	-1.305	24.9	-0.015	-0.967	45.0	-0.046	-2.533 **	15.0
SWE	-0.015	-0.878	46.4	-0.005	-0.225	128.4	-0.012	-0.724	57.7	-0.025	-0.984	28.1	-0.014	-0.622	47.9	-0.044	-1.910 *	15.7
TAI	-0.061	-2.392 **	11.3	-0.033	-2.018 **	20.9	-0.068	-5.292 ***	10.2	0.041	0.740	-17.1	-0.073	-2.138 **	9.5	-0.077	-6.193 ***	9.0
HKO	-0.094	-2.139 **	7.4	-0.088	-3.787 ***	7.9	-0.068	-2.785 ***	10.2	-0.092	-1.674 *	7.5	-0.024	-1.047	29.2	-0.100	-3.701 ***	6.9
KOR	-0.041	-2.786 ***	16.9	-0.040	-3.225 ***	17.2	-0.036	-3.661 ***	19.4	-0.042	-2.528 **	16.4	-0.030	-2.377 **	22.8	-0.038	-3.392 ***	18.4
SIN	-0.041	-2.829 ***	17.1	-0.020	-1.372	35.1	-0.027	-2.516 ***	25.7	-0.021	-0.970	32.6	-0.028	-3.031 ***	24.5	-0.031	-3.150 ***	22.6
INA	-0.018	-2.086 **	39.2	-0.002	-0.311	381.2	-0.005	-1.039	131.7	-0.033	-1.876 *	20.9	-0.017	-1.702 *	41.1	-0.007	-1.255	104.7
INO	-0.056	-3.785 ***	12.4	-0.050	-3.273	13.9	-0.021	-3.773 ***	32.9	-0.036	-3.159 ***	19.0	-0.022	-1.784	32.2	-0.027	-2.947 ***	26.1
MAL	-0.028	-1.573	24.6	-0.027	-1.939 *	25.5	-0.027	-3.583 ***	25.3	-0.031	-2.120 **	22.3	-0.022	-2.615 **	31.7	-0.035	-4.845 ***	19.7
PHI	0.005	0.482	-127.2	0.003	0.244	-202.0	-0.002	-0.375	315.8	0.001	0.085	-614.3	-0.003	-0.205	252.4	-0.011	-1.751 *	64.9
THA	-0.019	-0.928	36.6	-0.055	-2.516	12.7	-0.015	-1.163	47.8	-0.035	-0.646	19.9	-0.027	-0.556	25.8	-0.058	-2.445 **	12.0

(Table A/3 contd)

(Table A/3 contd)

	Machinery (except electric) - 382									Machinery electric - 383								
	OUTPROD			**VALPROD**			**WAGEMP**			**OUTPROD**			**VALPROD**			**WAGEMP**		
	Coeff.	**t-value**	**Half-time**	**Coeff.**	**t-value**	**Half-time**	**Coeff.**	**t-value**	**Half-time**	**Coeff.**	**t-value**	**Half-time**	**Coeff.**	**t-value**	**Half-time**	**Coeff.**	**t-value**	**Half time**
CAN	-0.019	-0.565	35.6	-0.004	-0.143	197.5	-0.020	-1.038	34.4	-0.052	-1.031	13.3	-0.012	-0.506	60.1	-0.041	-1.439	17.0
AUT	-0.042	-1.787 *	16.4	-0.023	-1.611 *	30.8	-0.032	-2.039 *	22.0	-0.049	-2.396 **	14.1	-0.019	-1.713 *	36.8	-0.054	-5.275 ***	12.9
BEL	-0.133	-1.645 *	5.2	-0.056	-1.640 *	12.5	-0.043	-4.885 ***	16.2	-0.052	-1.793 *	13.3	-0.022	-1.318	31.4	-0.055	-4.986 ***	12.7
DEN	0.009	0.734	-80.1	0.004	0.333	-166.2	-0.038	-2.273 **	18.3	0.000	-0.047	1508.5	0.006	0.622	-122.0	-0.038	-2.156 **	18.1
FRA	-0.068	-2.944 **	10.3	-0.030	-1.830 *	23.0	-0.078	-0.792	8.9	-0.042	-2.822 ***	16.5	-0.025	-2.003 **	28.0	-0.138	-1.922 *	5.0
GWE	-0.030	-2.116 **	23.0	-0.029	-1.502	23.5	-0.064	-6.544 ***	10.8	-0.033	-2.657 ***	21.2	-0.054	-3.439 ***	12.9	-0.065	-7.127 ***	10.7
ITA	-0.174	-2.168 **	4.0	-0.036	-1.212	19.3	-0.091	-1.678 *	7.6	-0.068	-1.855 *	10.3	0.001	0.027	-1100.9	-0.077	-2.255 **	9.0
LUX	0.004	0.130	-181.1	-0.013	-0.697	53.5	-0.054	-2.870 ***	12.8	-0.001	-0.029	1096.8	0.003	0.174	-227.9	-0.023	-1.423	29.6
NLD	-0.026	-1.396	26.4	-0.015	-0.990	47.7	-0.067	-2.509 **	10.3	-0.052	-1.360	13.4	-0.001	-0.060	563.4	-0.100	-3.283 ***	6.9
SWI	0.044	1.534	-15.9	0.016	0.611	-42.9	n.a.			0.003	0.070	-216.2	0.026	-1.257	-26.8	n.a.		
UKD	-0.029	-1.667 *	23.6	-0.018	-1.357	39.3	-0.028	-2.939 ***	24.9	-0.016	-1.269	43.3	-0.004	-0.456	160.2	-0.026	-3.249 ***	26.9
GRC	-0.018	-1.464	38.5	-0.015	-1.737 *	47.3	-0.029	-4.700 ***	23.9	-0.078	-2.587 **	8.9	-0.025	-1.459	27.8	-0.040	-5.082 ***	17.2
ICE	n.a.			n.a.			n.a.			-0.097	-2.300 **	7.1	-0.060	-1.986 **	11.5	-0.074	-1.832 *	9.4
IRE	-0.011	-0.393	63.6	-0.044	-1.624 *	15.6	-0.037	-2.804 ***	18.7	-0.037	-1.410	18.9	-0.046	-2.267 **	15.0	-0.035	-2.758 ***	20.0
POR	-0.012	-0.980	60.2	-0.001	-0.091	620.1	-0.030	-1.477	22.7	-0.015	-0.074	46.0	0.005	0.289	-153.9	-0.047	-1.311	14.7
ESP	-0.046	-2.623 **	15.0	-0.032	-1.945 *	21.8	-0.042	-3.500 ***	16.4	-0.041	-1.621 *	17.0	-0.016	-0.879	42.2	-0.060	-3.440 ***	11.6
TUR	-0.021	-0.596	32.7	-0.011	-0.553	60.4	-0.013	-0.914	52.4	-0.048	-0.083	14.4	-0.021	-0.761	32.9	-0.022	-1.322	32.2
JAP	-0.114	-2.990 ***	6.1	-0.067	-2.629 **	10.3	-0.059	-7.253 ***	11.8	-0.106	-2.658 ***	6.5	-0.028	-1.508	25.1	-0.049	-6.505 **	14.3
AUS	-0.016	-0.757	44.1	-0.019	-1.171	37.4	-0.021	-1.635 *	32.5	-0.007	-0.502	93.6	-0.122	-0.906	5.7	-0.015	-1.385	45.3
NZL	-0.069	-1.211	10.0	-0.035	-0.979	19.9	-0.045	-1.010	15.5	0.002	0.044	-319.2	0.017	0.907	-41.4	-0.018	-0.836	39.3
FIN	-0.026	-1.912 *	26.5	-0.015	-1.459	46.6	-0.031	-3.233 ***	22.7	-0.033	-1.911 *	21.3	-0.019	-1.624 *	36.1	-0.032	-3.267 ***	21.6
NOR	-0.049	-1.228	14.2	-0.005	0.377	140.7	-0.032	-2.472 **	21.4	-0.009	-0.542	79.6	0.007	0.503	-105.0	-0.037	-2.314 **	19.0
SWE	-0.013	-0.743	51.7	-0.006	-0.354	117.8	-0.007	-0.496	96.4	-0.028	-1.166	24.9	-0.011	-0.562	62.0	-0.022	-1.037	31.7
TAI	-0.016	-0.708	42.4	-0.032	-2.844 ***	21.5	-0.048	-4.442 ***	14.4	-0.051	-2.451 **	13.7	-0.005	-0.441	140.7	-0.048	-5.161 ***	14.3
HKO	-0.079	-2.998 ***	8.7	-0.033	-2.546 **	21.3	-0.043	-3.402 ***	16.0	-0.097	-3.335 ***	7.1	-0.017	-1.076	41.4	-0.044	-3.380 ***	15.7
KOR	-0.042	-2.686 ***	16.5	-0.041	-2.872 ***	17.0	-0.035	-3.805 ***	20.0	-0.037	-2.522 **	18.6	-0.034	-2.661 ***	20.5	-0.034	-4.219 ***	20.2
SIN	-0.048	-1.945 *	14.4	-0.042	-2.678 ***	16.5	-0.028	-3.295 ***	25.1	-0.042	-2.364 **	16.5	-0.016	-1.283	43.6	-0.013	-1.930	53.7
INA	-0.024	-1.970 **	29.4	-0.011	-1.096	64.8	-0.011	-2.110 **	63.8	-0.022	-1.555	31.3	-0.005	-0.635	127.2	-0.009	-1.655 *	76.3
INO	-0.072	-3.936 ***	9.7	-0.068	-4.059 ***	10.2	-0.022	-3.623 ***	30.9	-0.144	-4.797 ***	4.8	-0.075	-3.049 ***	9.3	-0.028	-2.343 **	24.5
MAL	-0.056	-2.466 **	12.3	-0.036	-2.849 ***	19.4	-0.018	-2.214 **	37.6	-0.021	-0.645	33.8	0.012	0.888	-59.3	-0.007	-0.808	104.6
PHI	0.007	0.480	-104.4	0.001	0.055	-739.0	0.002	0.326	-292.2	0.006	0.298	-107.8	0.012	0.663	-58.3	-0.001	-0.153	525.8
THA	0.027	0.495	-25.6	0.030	0.605	-23.4	-0.025	-1.334	27.3	0.014	0.285	-49.9	-0.021	-0.401	33.7	-0.022	-1.866 *	31.0

Table A/4

Dickey-Fuller test results (price gap variables

321

country	est. k	t-statistic		lags	half-life
SCAAUT	0.168	1.460		3	-4.13
EUS	-0.062	-1.110		0	11.18
CEECW	-0.074	-2.252	**	1	9.37
CEECE	-0.002	-0.043		0	346.57
ABC	-0.069	-1.475		2	10.05
NICS1	-0.141	-1.990	**	3	4.92
NICS2	-0.022	-0.482		0	31.51
China	-0.094	-1.250		3	7.37
India	-0.031	-0.687		0	22.36
RoW	0.022	0.461		0	-31.51

382

country	est. k	t-statistic		lags	half-life
SCAAUT	-0.496	-4.353	***	0	1.40
EUS	-0.067	-0.817		0	10.35
CEECW	0.001	0.046		0	-693.15
CEECE	0.010	0.384		0	-69.31
ABC	-0.159	-1.518		0	4.36
NICS1	-0.045	-1.159		4	15.40
NICS2	-0.151	-0.969		1	4.59
China	-0.022	-0.408		0	31.51
India	-0.112	-1.125		0	6.19
RoW	-0.392	-2.722		0	1.77

322

country	est. k	t-statistic		lags	half-life
SCAAUT	-0.031	-0.480		0	22.36
EUS	-0.236	-1.625	*	0	2.94
CEECW	-0.010	-0.244		0	69.31
CEECE	0.008	0.400		2	-86.64
ABC	-0.025	-0.417		0	27.73
NICS1	-0.004	-0.074		0	173.29
NICS2	0.005	0.148		0	-138.63
China	-0.006	-0.115		0	115.52
India	0.017	0.699		2	-40.77
RoW	0.021	0.853		0	-33.01

383

country	est. k	t-statistic		lags	half-life
SCAAUT	0.152	1.598		2	-4.56
EUS	-0.098	-1.042		0	7.07
CEECW	-0.012	-0.699		1	57.76
CEECE	-0.021	-0.888		0	33.01
ABC	-0.393	-2.416	**	5	1.76
NICS1	-0.035	-0.790		0	19.80
NICS2	-0.231	-1.665	*	0	3.00
China	-0.023	-0.730		0	30.14
India	-0.102	-0.946		1	6.80
RoW	-0.034	-0.351		3	20.39

323

country	est. k	t-statistic		lags	half-life
SCAAUT	0.018	0.406		4	-38.51
EUS	-0.033	-0.478		0	21.00
CEECW	-0.030	-0.647		0	23.10
CEECE	-0.034	-0.764		0	20.39
ABC	-0.058	-0.776		0	11.95
NICS1	-0.219	-2.207	**	0	3.17
NICS2	-0.129	-1.693	*	0	5.37
China	-0.030	-0.894		0	23.10
India	-0.340	-2.498	**	0	2.04
RoW	-0.110	-1.418		0	6.30

385

country	est. k	t-statistic		lags	half-life
SCAAUT	-0.008	-0.100		0	86.64
EUS	-0.169	-1.301		0	4.10
CEECW	-0.018	-0.355		0	38.51
CEECE	-0.038	-0.616		0	18.24
ABC	-0.396	-2.167	**	0	1.75
NICS1	-0.710	-2.816	***	3	0.98
NICS2	-0.457	-2.334	**	0	1.52
China	-0.010	-0.227		0	69.31
India	-0.098	-0.988		0	7.07
RoW	0.067	0.759		4	-10.35

*** significant at the 1 % level (critical value: -2.66)
** significant at the 5 % level (critical value: -1.95)
* significant at the 10 % level (critical value: -1.60)

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