Productivity and per capita GDP growth: the role of the forgotten factors

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Abstract

Average hourly productivity has often been used to draw conclusions on long run per capita GDP growth, based on the assumption of full utilization of labour resources. In this paper, we argue that a failure to recognize the potentially significant wedges among the two variables – even in the long run - can be misleading. By applying both time series and panel cointegration techniques on data on 19 OECD countries, we fail to reject the hypothesis of absence of a long run common stochastic trend among the two variables in the period 1980-2005. Furthermore, we apply a simple decomposition of GDP growth into five variables, included some related to the supply-side and demographics, so to verify the single contributions to income growth and variance over our period of interest. We conclude that variables that have been so far absent in the growth literature have indeed a non-negligible role in explaining the dynamics of long run per capita GDP growth. In particular, these "forgotten factors" (that we identify with the employment and the activity rates and a demographic ratio) matter more in better performing economies, where we also highlight that productivity has been less important in determining GDP growth than in relatively bad performers.

Keywords: growth accounting, productivity, panel cointegration, demographics.

JEL classification: O40, O47, E01

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1. Introduction

Can we legitimately use average productivity as a proxy for long-run GDP growth? Growth theory and empirical applications have widely used the two variables interchangeably. In this paper we perform an empirical checking of this practice, using annual data from 1980 to 2005 for a sample of 19 OECD countries. We employ a double-step methodology: first we perform a cointegration analysis - both at time series and at panel levels - in order to check the long run properties of the two variables and verify the existence of a common stochastic trend. Subsequently, as supporting evidence, we carry out a simple and straightforward quantitative exercise: we decompose per capita GDP growth into five variables, including some supply side and demographic factors, so to be able to identify and quantify the ex-post contribution of each of them to per capita income growth.

Figure 1 shows the values of real capita GDP and hourly productivity growth rates for the economies under investigation over the period 1980-2005.

Insert Figure 1 about here

Clearly, there are pronounced similarities between the two series, yet there is no perfect matching. The aim of this paper is to look deeper into the wedge between the two variables highlighted by Figure1.

Our findings suggest that those (supply side and demographic) factors usually thought of as irrelevant for long-run GDP growth might actually play a more significant role than it is often assumed. Our tests fail to reject the null hypothesis of no cointegration between hourly productivity and real per capita GDP in our data set, confirming that the role of demographic and labour supply factors cannot be treated as simple statistical noise over the long run. Particularly, we find that in better-performing economies the relative weight of other-than-productivity factors on GDP growth is higher than in countries that experienced lower growth rates. This is confirmed by the cointegration tests run at the time series level, which confirm the absence of a common long-run stochastic trend between GDP and productivity in better performing economies, while rejecting the null in most of the economies whose 25 years GDP growth is below the median. These results might therefore trigger a renewed interest in the determinants of long-run growth and in the growth-enhancing policies.

The reason why the factors we focus on are usually neglected, and various measures of aggregate labour productivity have traditionally been identified as the unique approximations of long run per capita income, has anyway deep roots in economic analysis.[1] In the Solow (1956) model, the diminishing returns hypothesis renders long-run output growth depending exclusively on technological progress, empirically measured by the so-called Solow residual. The empirical validity of this theory has been subsequently checked in a variety of growth accounting exercises. Young (1995) seems to downplay the role of pure technological progress in the rapid growth of newly industrialized East Asian countries in the Nineties, finding that the "growth miracle" of those years was almost entirely due to increasing labour force participation and improved labour quality. On the other hand, Hsieh (2002), examining the same episodes, finds a larger role for technological progress by considering factor returns instead of quantities in growth accounting. Similar exercises have been performed for the analysis of US exceptional growth rates in the mid-Nineties (Oliner and Sichel 2000, Jorgenson and Stiroh 2000, Whelan 2000), but were mainly targeted to the identification of which part of technological progress played the largest role in enhancing growth.

However, the ultimate factor allowing the indistinct use of per-capita GDP and productivity growth rates is the full employment assumption[2]; switching from theory to the real world, this amounts to assuming that employed, labour force, active population and total population coincide. Alternatively, given the focus on growth rates rather than levels, it means that they are assumed to be constant over time. Our contribution aims at challenging this assumption from an empirical point of view, using annual data for 19 OECD countries from 1980 to 2005; although these supply-side variables do show less volatility over time, we argue that they still can play a non-negligible role in explaining long run growth, and therefore should not be completely forgotten in favour of an exclusive focus on average productivity.

While we are certainly far from believing that our analysis exhausts the investigation on long run per capita GDP growth determinants, we still maintain that a more accurate growth accounting can benefit from this methodology. Our results call for a more complete and structural analysis capable of accounting for the interactions and the determinants of the factors under consideration, we believe that they can *per se* constitute a meaningful contribution to a better understanding and identification of policies aimed at increasing long-run GDP growth.

The remainder of this paper is organized as follows. Section 2 presents the main idea of the paper, applying our proposed GDP growth decomposition so to highlight the role of the "forgotten factors".

[1] Temple (1999, 142), in an article about growth, states that "it is clear that in-depth studies are needed to address the links between population growth and macroeconomic outcomes." Our paper is an attempt to take this suggestion to the data.

[2] The exogenous growth models allow an increase in labour force to be a growth-enhancing measure but fail to further disentangle the demographic contribution.

Section 3 analyses the long-run relationship between per capita GDP and hourly productivity in the search for a common stochastic trend using both panel and time series cointegration techniques. Section 4 expands on these results by analyzing each variable of our proposed decomposition. Section 5 concludes.

2. GDP decomposition: the forgotten factors

The main idea of our paper is captured by the decomposition of per-capita income $\left(\frac{Y}{N}\right)$ at time *t* into the components of the following identity:

$$\left(\frac{Y}{N}\right)_t = \left(\frac{Y}{h}\right)_t * \left(\frac{h}{L}\right)_t * \left(\frac{L}{LF}\right)_t * \left(\frac{LF}{TAP}\right)_t * \left(\frac{TAP}{N}\right)_t \qquad (1)$$

where:

Y = GDP

N = total population

h = total hours worked

L = number of employees

LF = labour force (employed and unemployed)

TAP = total active population (aged between 15 and 64)

In other words, equation (1) states that we can decompose the level of per-capita income into the product of five variables: hourly productivity $\left(\frac{Y}{h}\right)$, hours worked per employee $\left(\frac{h}{L}\right)$, employment rate $\left(\frac{L}{LF}\right)$, activity rate $\left(\frac{LF}{TAP}\right)$, and a demographic ratio $\left(\frac{TAP}{N}\right)$.

To the best of our knowledge, a similar decomposition has mainly been used in two specifications.

Piacentini and Sulis (2000) limit their analysis to a two-terms decomposition:

$$\frac{Y}{N} = \frac{Y}{L} * \frac{L}{N} \qquad (2)$$

so to focus their attention on average productivity and a wide measure of employment (employed over total population), which does not allow to fully capture the role of demographic factors. With respect to their analysis, we carry out a more detailed exercise along two dimensions: first, we consider hourly productivity rather than average, so to take into account the role of the hours worked. Second, we further decompose the employment measure into the product of three ratios ("proper" employment rate, activity rate and the demographic ratio), in order to emphasize meaningful issues related to the labour supply and the demographic structure. On the other hand, looking into the reasons behind the decline in hours worked across the Atlantic, Blanchard (2004) uses a decomposition very similar to (1). Our paper departs from his work along two lines: first, we apply the full decomposition to a wider set of countries up to 2005 data; secondly, we investigate the issue in a more systematic way, in a framework where the resulting evidence is fortified by econometric evidence.

Note that this decomposition has the advantage of dispensing us with the need of assuming a specific functional form for the production function (and, consequently, the calibration of the related technical parameters) and the task of choosing an adequate measure of the capital/labour ratio. Equation (2) in fact – which we further decompose according to (1) – can be seen as the Cobb-Douglas production function divided by total population N.

$$\frac{Y}{N} = \frac{AK^{\alpha}L^{1-\alpha}}{N} = \frac{L}{N}A\left(\frac{K}{L}\right)^{\alpha} \tag{3}$$

which is, after considering capital per worker, exactly equation (2). Alternatively, our decomposition is also equivalent to the one used for instance by Hayashi and Prescott (2004):

$$\frac{Y}{N} = A^{\frac{1}{1-\alpha}}\left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}}\frac{h}{L}\frac{L}{N} \tag{4}$$

with the following production function:

$$Y = AK^{\alpha}\left(\frac{h}{L}L\right)^{1-\alpha} \tag{5}$$

where N is total population, h/L is hours worked per employee, and L is aggregate employment. Equation (4) has extensively been used in classic cross-section growth accounting exercises; as our focus is not the investigation of the Solow residual, A, but rather the role of demographic factors on long-run per capita growth, we stick to equation (1), which has also the remarkable advantage of not having to rely on variables or parameters that can be hard to measure/estimate exactly.[3]

Each of the factors in (1) yields different pieces of information about the structure of the economy and the scope of policy intervention. Hourly productivity is informative about the efficiency level of the employed resources, depending on the capital/labour ratio in the short run, and a variety of factors in the long run - commonly regrouped under the definition “total factor productivity” - such as technology, public and social infrastructure, human capital and knowledge accumulation, social capital, property rights protection, political stability, research and development. Average hours worked provide information on households' labour supply. The employment rate indicates the economy's capability to generate a level of aggregate demand such that a given number of individuals can actually have a job; in this regard, an important role is played by labour market features such as centralization of industrial relations, flexibility, trade unions strength and regulation. The activity rate tells us how many persons out of the total active population are willing to supply labour services on the legal job market. This measure is likely to be affected by many relevant factors: the labour tax burden and the level of children care services (which may discourage the supply of labour in families where one component is already part of the work force), the presence of long-term unemployment (which takes discouraged people out of the work force), the presence of a black market, and even some residual cultural factors which tend to privilege domestic work. Finally, the demographic ratio can be affected by policy considerations if we think about immigration regulatory regimes, an issue that is much debated in these years in developed countries, or fertility and birth incentive issues.

Standard growth models assume:

$$\left(\frac{L}{LF}\right)=\left(\frac{LF}{TAP}\right)=\left(\frac{TAP}{N}\right)=k \ , \ \ k\in\left[0,1\right] \qquad (6)$$

This is the reason why the terms “output per worker” and “output per capita” can be used as syonyms when utilizing constant returns to scale aggregate production functions. Thanks to our decomposition, see equation (1),we can make the following remarks.

The emphasis on productivity growth as ultimate determinant of long-run growth is still justified: no other increase in any of the components on the RHS of (1) is able to determine *per se* a rise in per-capita income. In fact, proceeding from right to left, an increase in the numerator is also a decrease in the denominator of the term next to the left, thereby offsetting the positive effect. Thus, an increase in the effectiveness of labour supply (i.e. productivity) is the only necessary and sufficient condition for per-capita growth. Nevertheless, the relationship between productivity and per-capita output can be

[3] For instance, Young (1995) noted that the estimation of TFP growth change once other factors (rising participation rates among the others) are taken into account.

"wedged" by the employment rate, the activity rate and the demographic ratio. That is, a sustained growth in productivity can result in a less than proportionate per-capita income growth according to the dynamics of the other factors in (1).

To see this formally, let us turn to growth rates, leading (1) one period forward, taking logs and then subtracting the values of the preceding period, so to obtain:

$$\log\left(\frac{Y}{N}\right)_{t+1}-\log\left(\frac{Y}{N}\right)_{t}=\left[\log\left(\frac{Y}{h}\right)_{t+1}-\log\left(\frac{Y}{h}\right)_{t}\right]+\left[\log\left(\frac{h}{L}\right)_{t+1}-\log\left(\frac{h}{L}\right)_{t}\right]+\left[\log\left(\frac{L}{LF}\right)_{t+1}-\log\left(\frac{L}{LF}\right)_{t}\right]+$$
$$+\left[\log\left(\frac{LF}{TAP}\right)_{t+1}-\log\left(\frac{LF}{TAP}\right)_{t}\right]+\left[\log\left(\frac{TAP}{N}\right)_{t+1}-\log\left(\frac{TAP}{N}\right)_{t}\right] \quad (7)$$

The economic interpretation of equation (7) is straightforward: per-capita GDP growth can be seen as the algebraic sum of growth in hourly productivity, in the intensive and the extensive margins, in the activity ratio and in active population. This relation does not allow any full counterfactual reasoning, as the partial derivative with respect to *h, L, LF, TAP* is zero and nothing can be said without a theory accounting for the determinants of each of the above ratios; however, it is informative about how much of productivity growth is “eaten up” by growth in other factors and about the magnitude of each contribution to per capita income growth.

Before applying equation (7) to our dataset, in the following section we check the existence of cointegration between GDP and hourly productivity. We do so because, if the indistinct use of per capita GDP and hourly productivity is to be justified, we should at least be able to detect the presence of a common stochastic trend in the data over the long run.

3. Data and cointegration analysis

The main source of our data is the World Development Indicators produced by the World Bank. In particular, we use purchasing power parity GDP expressed in US dollars and we calculate the various ratios of equation (1) with the following series: the age dependency ratio (dependents to working-age population), labour force (total), population (total, ages 0-14, 15-64, 65 and above) and unemployment (total, percentage of labour force). We integrate these series with the OECD average annual hours actually worked per worker, available from the OECD Labour Database.

Using this dataset, we look for a cointegrating relationship among per capita GDP and hourly productivity. The use of cointegration tests to verify a steady long run relationship between any two economic variable is common in the empirical literature: it has been used when investigating the link between consumption spending and disposable income (Davidson et al 1978), public debt and GDP (Kremers 1989) and actual holding of the purchasing power parity condition. (Baillie and Selover 1987, Corbae and Ouliaris 1988). Here, we first run the test over the whole sample using panel cointegration techniques (subsection 3.1); then we do the same for each time series at the national level, to verify whether the existence of a common trend can be found in a specific sub-sample of countries featured by the same performances (subsection 3.2).

3.1. Panel cointegration tests

Our first step is to apply panel unit root test to check the order of integration of the two series. In order to ensure the robustness of the results, we carry out three different tests: the first two were proposed – respectively - by Levin et al. (2002) (LLC) and Hadri (2000) (H) and test the existence of a common root in the panel; the third one was built by Im et al. (2003) (IPS), and allows the existence of heterogeneous individual roots. All tests are carried out in two different model specifications: one assuming an individual intercept and the other with an individual intercept and a time trend. Results are reported in Table 1:

Insert Table 1 about here

Looking at the LLC and the IPS tests, we fail to reject the null hypothesis of non-stationarity at conventional significance levels for both Y/N and Y/H (in three of the four different specifications).
The Hadri test seems to over-reject the null hypothesis of stationarity (especially in the case of Y/H). However, due to the results of the other tests, it can be concluded that the two variables of interest appear to be integrated of order 1 in our dataset (this is also confirmed by the results of the tests for the first differences of the two series). Among the variables that appear to be integrated of the same order, it is necessary to look for a cointegrating relationship. We accomplish this task by implementing the methodology proposed by Pedroni (1999). Table 2 reports the relevant statistics:

Insert Table 2 about here

The first three rows report within-dimension-based tests (panel v, panel ρ and the non-parametric panel PP test), while the last two lines show parametric between-dimension-based statistics (group ρ and group t), which are just the group mean approach extensions of the within-based ones. The group ρ test is particularly important, as it has been proven to have the best power among the Pedroni statistics (Gutierrez, 2003). Finally, we choose to use the non-weighted statistics – instead of weighted – because of their better performances in small samples. Most tests point to the non-rejection of the null hypothesis in a pretty robust fashion: only the panel v statistics, in the specification with an individual intercept, indicate the presence of a cointegrating relationship. Thus, we conclude that there is no evidence of a cointegrating relationship between the two variables of interest.

3.2 Time series cointegration tests

While the previous subsection confirms the absence of a well-defined cointegrating relationship at panel level, in this subsection we perform the same test on single countries' time series by using the well-known Johansen cointegration test. Our objective is to verify whether the existence of a common stochastic trend between GDP and productivity – ruled out at the panel level – can indeed be found in any particular subset of countries. Table 3 reports the results country by country:

Insert Table 3 about here

Based on the above statistics, there is evidence in favour of the existence of a cointegrating relationship in 11 countries (Australia, Belgium, Canada, Denmark, Finland, France, Japan, Korea, New Zealand, Sweden, USA), whereas the tests indicate no cointegration in the remaining 8 (Greece, Ireland, Italy, Netherland, Norway, Portugal, Spain, UK). In the next section we further investigate the panel and time series cointegration results.

4. Exploring the "wedge": GDP decomposition

In section 3 we have established the absence of cointegration between per capita GDP and hourly productivity at panel level, while there is evidence of cointegration in a specific subset of countries. This result calls for further investigation. In this section we attempt to answer the following questions:

(i) if productivity and GDP do not share – in general – the same stochastic trend, what is the quantitative impact of the other factors creating the wedge between the two? (ii) if evidence of cointegration can be found in a given subset of countries, what is the common feature they share, and are the quantitative results of the GDP decomposition in line with that? (iii) are the results on the relative importance of decomposing factor confirmed by the analysis of time series volatility? Subsection 4.1 is concerned with (i) and (ii), whereas subsection 4.2 looks at (iii). Finally, in subsection 4.3 we verify the intensity of convergence of each variable.

4.1. Growth rate decomposition

In this subsection we investigate how much of the per-capita income growth in the period 1980-2005 is explained by growth in each factor of the RHS of equation (4).
Table 4 reports the 25-year growth rates country-by-country:

Insert Table 4 about here

A visual inspection of Table 4 confirms that, while productivity dynamics is no doubt leading GDP growth, the two growth rates do not always match perfectly. As a general trend, we can notice that the decrease in hours worked is approximately offset by the increase in the activity ratio, whereas the increase in employment ratio and demography accounts for the positive differential between GDP and hourly productivity growth rates. In some cases, this differential is remarkable: in Japan and France a sharp decline in hours worked (almost 8%) made GDP grow substantially less than productivity; on the other hand, in Ireland (one of the most successful experiences) and Netherlands, active population and labour force growth are responsible for a noteworthy positive differential.
Figure 2 orders countries growth rates over the period 1980-2005, helping us to individuate meaningful subsamples:

Insert Figure 2 about here

Median growth rate is 21.21% (Greece); we can thus distinguish between nine relatively good performers (high-growth countries: Korea, Ireland, Portugal, Norway, UK, Spain, Netherlands, Finland, USA) and nine relatively bad performers (low-growth countries: Japan, Australia, Belgium, Denmark, Sweden, Canada, Italy, France, New Zealand). Searching for interesting common patterns, a useful piece of information is provided, after having divided countries according to relative growth performances, by computing for each group a variable capturing the relative weight of each of the RHS component of equation (7) in determining the 25-year GDP growth:

$$m_i = \frac{g_i}{g_{Y/N}} \qquad (8)$$

where *i* indicates each of the factor on the RHS of equation (1) and g_i the corresponding growth rate over the 1980-2005 time span. Table 5 shows the average values of this weight variable for countries above and below the median growth rate ("HIGH" and "LOW") and for the total sample:

Insert Table 5 about here

We can observe that, while the negative role of hours worked is similar in the two groups, the relative weight of other components is different: in countries below the median growth rate, hourly productivity has grown even more than real per-capita income, with a less pronounced role for the remaining factors. In better-performing economies, on the other hand, the role played by growth in employment rate, activity rate and (to a lesser extent) active population ratio is non-negligible.

This result can be combined with the statistical analysis of section 3. We found no evidence of time series cointegration in 8 countries, which correspond almost perfectly to the group of good performers (with the only exception of Italy). Conversely, we found evidence of cointegration in 11 countries, which can approximately[4] be identified with the sub-sample of bad performers.

Thus, it seems that economies which performed relatively good in the period 2005-1980 are characterized by a non-negligible role of the "forgotten factors": in those countries we do not find evidence of cointegration between GDP and productivity even at the time-series level, and the quantitative weight of the "wedge" (i.e. the "forgotten factors") in our growth accounting exercise is large. On the other hand, in relatively bad performer economies, there is evidence of cointegration among hourly productivity and per capita GDP, and the forgotten factors seem to play a more negligible role. How do we interpret this result? Since our analysis is based on long-run dynamics, we

[4] 8 countries out of 11 belong to the bad-performers group.

abstract from heterogeneity in short run aggregate demand policies across countries in the sample and focus on long-run supply-side determinants of income growth. Our double empirical evidence reveals a new growth theory stylized fact: within OECD area, a relatively higher trend in economic activity is not accounted for by a corresponding higher productivity growth trend; instead, better performances in widening the overall participation into the labour market have played a significant role. The remarkable decrease in hours worked is a common feature; however, the most successful countries are not those who managed to counterbalance that decrease with higher productivity but, indeed, those who improved the utilization of labour input. Failing to do so results in lower income growth, regardless of the dynamics of hourly productivity. The example of France is particularly illuminating: one of the best performances in the sample in terms of productivity growth has not only been offset by a sharp decrease in hours worked (probably emphasized by the reduction to thirty five working hours per week in 2000[5]), but also by a lack of increase in labour market participation.

4.2. Variance decomposition

We turn now to the examination of the variance of the series. The logarithmic version of equation (1) is a summation, thus we can decompose the variance of real per capita GDP as follows:

$$\sigma^2_{Y/N} = \sigma^2_{Y/H} + \sigma^2_{H/N} + \sigma^2_{N/FL} + \sigma^2_{FL/TAP} + \sigma^2_{TAP/N} + W_t \tag{9}$$

where the term W_t indicates the sum of the covariances:

$$W_t = 2\sum \sigma_{ij} \qquad \text{with } i \neq j \tag{10}$$

In a five-terms equation like the one we use, the analysis of the covariances would be complicated and hard to interpret, so we limit ourselves to the decomposition of $\sigma^2_{Y/N}$ into the five direct effects, by building the following weight variable:

$$q_i = \frac{\sigma^2_i}{\sigma^2_{Y/N}} \tag{11}$$

[5] The reduction was then abolished in 2005.

where *i* indicates each of the factors on the RHS of (1).

Table 6 reports GDP variance and the q_i's according to the growth-performance criterion:

Insert Table 6 about here

This result is harder to comment, for the above-mentioned reason: we can not tell the whole story since we chose not to take covariances into account (that is the reason why the q_i's do not sum up to 100%). However, there is also a bright side for that: by ignoring the cross-effects (which might be cumbersome to interpret economically), we can focus on the directly-interpretable percentage of GDP variance attributable to the variation in the underlying factors. Table 6 shows that – although in this case the differential in demographic factors' quotas is negligible – the role played by hourly productivity is again lighter (i.e. lower than in the whole sample) in better-performing economies, whereas its variance is even higher than GDP variance in relatively bad performers.

4.3. Convergence analysis

A complementary and further piece of evidence supporting our findings can be given by verifying the convergence in the variables of our decomposition among the countries of our sample. The literature has reached a certain consensus on the fact that there has been convergence of economic growth among developed countries (Islam, 2003). The convergence is tested by running the following regression, based on the technique firstly used by Baumol (1986):

$$X_{2005} - X_{1980} = \alpha + \beta X_{1980} \qquad (12)$$

with the sign of coefficient β indicating convergence (if negative) or divergence (if positive) of the variable X_i which in each of the regressions take the form of one of the variables in equation (1). Table 7 shows the results of the six different regressions:

Insert Table 7 about here

According to the previous literature, over the period 1980-2005, we observe convergence of GDP growth among developed countries. Additionally, there is evidence of convergence for all the RHS variables of equation (1). A particular feature is noteworthy: the intensity of per capita income convergence (-0.394) is much higher than the corresponding value for hourly productivity convergence (-0.298). We interpret this result as a further confirmation of the role played by the remaining factors: the higher intensity of convergence in employment rate, activity rate and total active population helped to fill the gap between intensities in GDP and productivity convergence processes.

5. Conclusions

The assumption of full utilization of resources have so far made possible to use interchangeably real per capita GDP and (a measure of) average productivity. In this paper we implemented an empirical test of this assumption on a panel of 19 OECD countries using annual data for hourly productivity, hours worked per employee, employment and activity rates and active population over total population for the period 1980-2005. We first verified the long-run properties of GDP and productivity by performing a number of cointegration tests; then, we investigated more adequately the wedge between these two variables, by applying a GDP decomposition capable of disentangling income growth into five variables, included some supply side and demographic factors. We concluded that the indistinct use of GDP and productivity is not always fully justifiable, as we were not able to find cointegration at panel level and our GDP decomposition analysis indicates that the role of other factors is far from being negligible. Particularly, along both dimensions of analysis, we were able to distinguish two groups of countries characterized by different features. In better-performing economies we do not find evidence in favour of the existence of a cointegrating relationship, and we also find that the relative weight of productivity in explaining growth is lower than in countries with a worse 25 year growth rate, thus unveiling a non negligible role of the three supply side and demographic variables, that we labelled as the “forgotten factors”. Our finding suggests that these factors played a larger role than it is usually assigned to them both by standard theory and by the common understanding of long run income dynamics. Consequently, the stylized fact unveiled in this contribution suggests a twofold consideration. On the side of policy implications, while the emphasis on productivity-enhancing policies should obviously never been diminished, a sharp attention should be paid to measures aimed at widening the participation into the labour market. Many mature OECD economies have long begun to suffer from negative demographic pressures, in terms of ageing population and low participation rates, especially for female and young individuals. Particularly, failing to rapidly adapt pension and education systems - along with immigration policies - to the negative demographic trend might turn out to be very costly in terms of income growth, even in presence of sustained productivity dynamics. Our results have also an additional insight for better-performing economies: given their relative success in improving labour market participation, the marginal benefit of productivity-enhancing policies in terms of GDP growth rates is higher since that contribution to income growth is not at risk of being offset by scarce performances on the extensive margin in the labour market.

In terms of theoretical modelling, our contribution indicates that, although our “forgotten factors” are not certainly new in growth theory (they are rather embedded in standard growth accounting), a specific effort should probably be made in terms of disentangling them in order to be properly accounted for in a more formal context. Even before the theoretical effort, more detailed econometric evidence is certainly needed. A further research step would have to deepen the analysis into the determinants of cross-country differences in our five factors. For example, a fully equipped panel econometric analysis could look at the role played by factors such as payroll taxation, the provision of childcare services and immigration patterns in economic growth dynamics through their effects on the five variables that we used in the present exercise.

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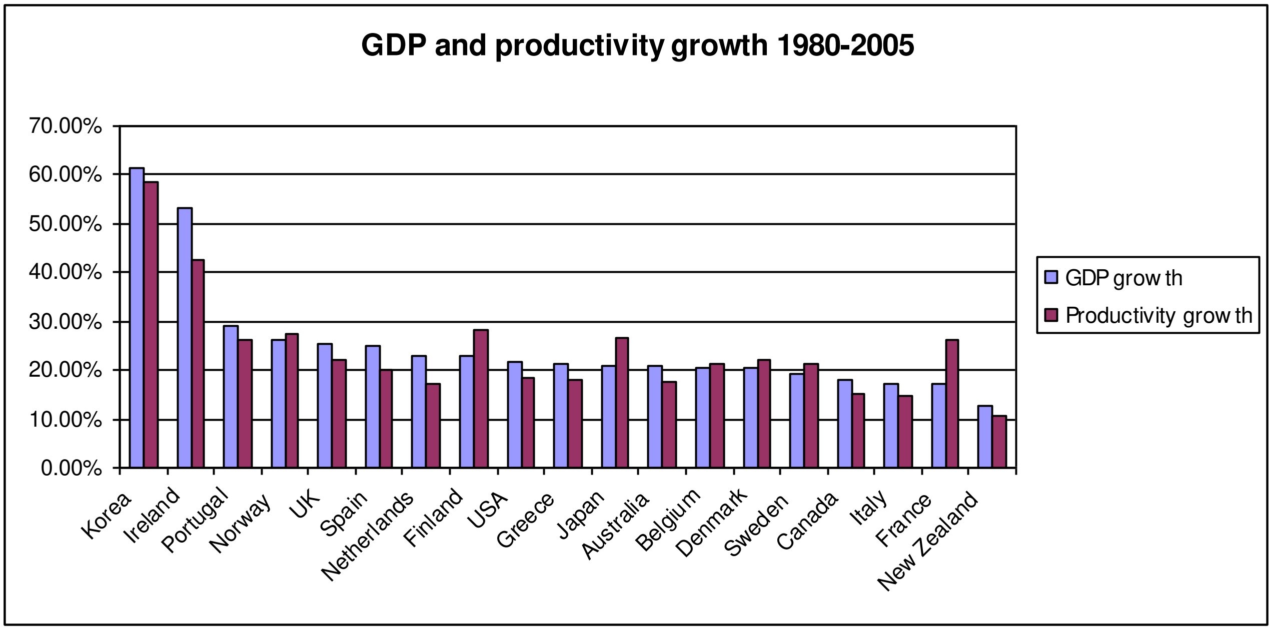
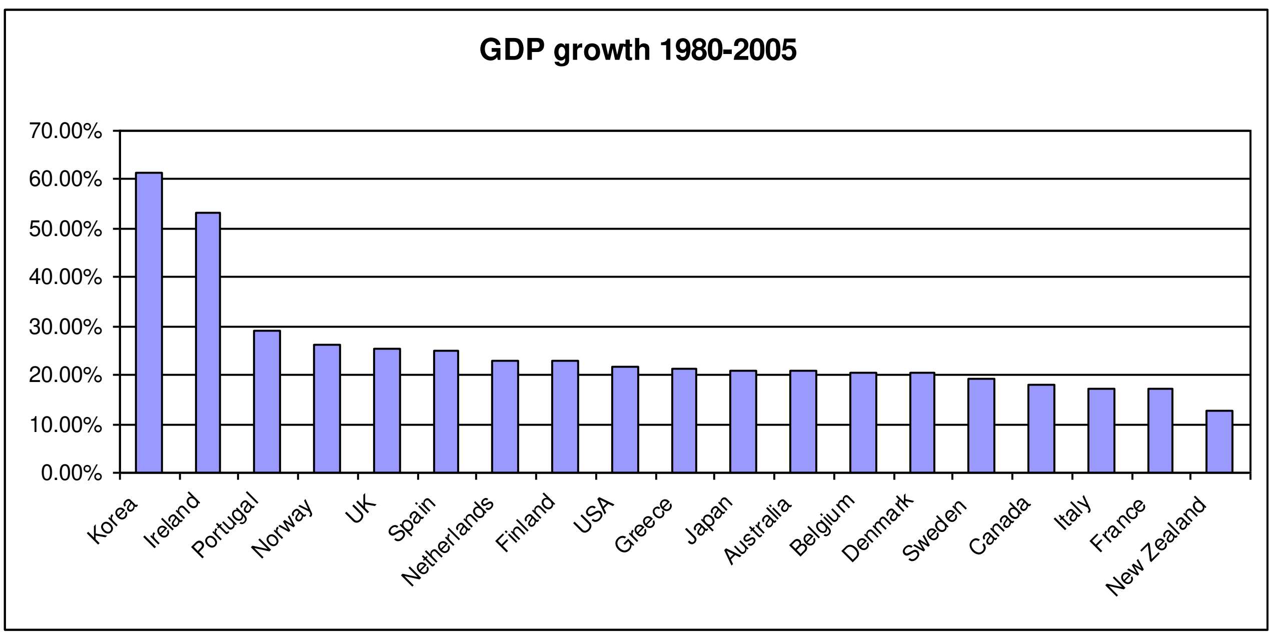
Figures

Figure 1: GDP and productivity growth



Source: WDI and OECD, own computations.

Figure 2: per capita GDP growth, 1980-2005



Source: WDI, own computations.

Tables

Table 1: panel unit root tests

Variable	**LLC**		**IPS**		**H~**	
	Individual intercept	*Ind. intercept and trend*	*Individual intercept*	*Ind. intercept and trend*	*Individual intercept*	*Ind. intercept and trend*
Y/N	-1.117	1.643	4.731	-1.820	16.651	4.948
	(0.132)	(0.950)	(1.000)	(0.034)*	(0.000)**	(0.000)**
D(Y/N)	-8.8164	-7.18885	-9.56876	-7.227	0.19459	1.71427
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.423)	(0.043)*
Y/H	-2.379	0.901	3.831	2.776	17.105	7.986
	(0.009)**	(0.816)	(0.999)	(0.997)	(0.000)**	(0.000)**
D(Y/H)	-14.671	-14.482	-13.123	-12.586	2.308	7.015
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.011)*	(0.000)**
~ Null hypothesis here is No Unit root; p-values in parenthesis						
*, ** significant at 5 and 1% respectively						

Table 2: Panel cointegration tests

	Individual intercept	*Ind.intercept and trend*
Panel v	2.43** (0.007)	1.61 (0.052)
Panel ρ	1.40 (0.919)	3.69 (0.991)
Panel PP	-1.20 (0.113)	-0.003 (0.490)
Group ρ	2.79 (0.990)	4.74 (1.000)
Group *t*	-1.28 (0.09)	0.29 (0.614)

The null hypothesis here is No Cointegration; p-values in parenthesis
*, ** significant at 5 and 1% respectively

Table 3: Johansen cointegration test

Country	test	null	p-value
Australia	Max.eig.	None	0.003**
		At most 1	0.598
Belgium	Max.eig.	None	0.004**
		At most 1	0.586
Canada	Max.eig.	None	0.041*
		At most 1	0.270
Denmark	Max.eig	None	0.009**
		At most 1	0.932
Finland	Max eig.	None	0.000**
		At most 1	0.736
France	Max.eig.	None	0.000**
		At most 1	0.464
Greece	Max.eig.	None	0.222
		At most 1	0.166
Ireland	Max.eig.	None	0.110
		At most 1	0.450
Italy	Max eig.	None	0.125
		At most 1	0.970
Japan	Max eig.	None	0.006**
		At most 1	0.087
Korea	Max.eig.	None	0.006**
		At most 1	0.532
Netherlands	Max. eig.	None	0.355
		At most 1	0.622
New Zealand	Max. eig.	None	0.022*
		At most 1	0.202
Norway	Max. eig.	None	0.059
		At most 1	0.970
Portugal	Max eig.	None	0.105
		At most 1	0.581
Spain	Max. eig.	None	0.086
		At most 1	0.230
Sweden	Max.eig.	None	0.027*
		At most 1	0.891
UK	Max.eig.	None	0.107
		At most 1	0.719
USA	Max.eig.	None	0.002**
		At most 1	0.544

The null hypothesis are indicated by "None" and "At most 1 cointegrating relationship". *, ** significant at 5 and 1% respectively.

Table 4: 25 year growth decomposition

country / growth rates	$g_{Y/N}$	$g_{Y/H}$	$g_{H/L}$	$g_{L/LF}$	$g_{LF/TAP}$	$g_{TAP/N}$
Korea	61.38%	58.46%	-8.70%	0.68%	4.63%	6.31%
Ireland	53.03%	42.40%	-8.90%	5.27%	7.37%	6.87%
Portugal	28.89%	26.24%	-5.92%	0.62%	5.64%	2.30%
Norway	26.01%	27.27%	-4.63%	-1.34%	2.92%	1.80%
UK	25.31%	21.95%	-1.72%	4.06%	0.62%	0.42%
Spain	24.98%	20.13%	-5.84%	0.92%	5.88%	3.89%
Netherlands	22.95%	17.20%	-6.84%	2.80%	11.05%	-1.26%
Finland	22.80%	28.23%	-3.21%	-1.72%	0.14%	-0.65%
USA	21.57%	18.48%	-0.36%	0.93%	2.13%	0.40%
Greece	21.21%	18.18%	-2.32%	-0.97%	4.32%	2.00%
Japan	21.08%	26.54%	-7.73%	-1.08%	4.02%	-0.67%
Australia	20.95%	17.57%	-1.64%	0.46%	3.08%	1.48%
Belgium	20.55%	21.42%	-6.02%	1.97%	3.89%	-0.71%
Denmark	20.48%	22.08%	-1.13%	-0.01%	-1.36%	0.90%
Sweden	19.27%	21.37%	2.51%	-2.51%	-2.93%	0.84%
Canada	18.17%	15.20%	-1.81%	0.33%	3.57%	0.87%
Italy	17.03%	14.76%	-0.95%	-0.05%	2.14%	1.13%
France	17.02%	26.15%	-7.50%	-1.75%	-0.93%	1.04%
New Zealand	12.87%	10.51%	-0.75%	0.24%	1.96%	0.91%
MEAN	**25.03%**	**23.90%**	**-3.87%**	**0.47%**	**3.06%**	**1.47%**
MEDIAN	**21.21%**	**21.42%**	**-3.21%**	**0.33%**	**3.08%**	**0.91%**

Table 5: relative weights in "good" and "bad" performers

	$m_{Y/H}$	$m_{H/N}$	$m_{L/LF}$	$m_{LF/TAP}$	$m_{TAP/N}$
HIGH	91.40%	-16.10%	4.08%	15.20%	5.42%
TOTAL	97.19%	-15.14%	0.99%	12.11%	4.85%
LOW	104.26%	-14.63%	-1.48%	8.09%	3.76%

Table 6: variance decomposition according to groups

Country/variance	$q_{Y/H}$	$q_{H/N}$	$q_{N/FL}$	$q_{FL/TAP}$	$q_{TAP/N}$
HIGH	88.65%	3.54%	2.78%	4.28%	0.80%
TOTAL	97.75%	4.59%	2.52%	4.04%	0.79%
LOW	110.03%	5.94%	2.41%	3.50%	0.63%

Table 7: convergence regressions

	Y/N	Y/H	H/L	L/LF	LF/TAP	TAP/N
β coefficient	-0.394**	-0.298**	-0.240*	-0.561**	-0.447**	-0.664**
Standard error	0.096	0.084	0.110	0.120	0.098	0.100
t-statistic	(-4.07)	(-3.53)	(-2.17)	(-4.68)	(-4.54)	(-6.63)

*, ** significant at 5 and 1% respectively