Employment and Productivity: Disentangling Employment Structure and Qualification Effects

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ABSTRACT

Based on a disaggregation of the workforce into three qualification or educational attainment categories, the article estimates the effects on hourly productivity from changes in the employment rate structure and from changes in the qualification structure. 21 OECD countries are then ranked in terms of the potential gains in GDP they could expect from moving to the educational attainment rates and employment rates of the best performing countries.

RÉSUMÉ

S'appuyant sur une désagrégation de la population active en trois catégories de qualifications ou de niveaux d'instruction, cet article estime les effets sur la productivité horaire de changements de la structure du taux d'emploi et de changements de la structure des qualifications. Nous classons ensuite 21 pays de l'OCDE selon les gains potentiels de leur PIB auquel ils pourraient s'attendre s'ils atteignaient les taux de niveaux d'instruction et les taux d'emploi des pays les plus performants.

WHICH EMPLOYMENT-BASED POLICY would lead to the largest GDP per capita gains? Countries can increase either the employment rate, working time or the qualifications of the employed population. GDP per capita levels vary among industrialised countries, and at the same time we observe huge variations in employment rates, working time, and qualifications of the working-age population. For example, GDP per capita, the employment rate and working time are higher in the United States than in Continental Europe. This explains why

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improving the employment rate and the knowledge-based economy across Europe were two of the three pillars of the Lisbon Strategy, the implicit goal being to catch up with the U.S. GDP per capita level.[2] However, given trade-offs between productivity and the employment rate, and between productivity and working time, the differences observed among countries in the employment rate and in working time cannot explain differences in GDP per capita in the same proportion.

A growing amount of economic literature, using country panel data, studies the relationships between productivity and the employment rate, and between productivity and working hours. A number of studies, using different methodologies, find a negative elasticity of hourly productivity with regard to the employment rate and working time.[3] The explanation usually given for this negative elasticity with regard to the employment rate is that the most productive and skilled people are hired first. Concerning working time, it is argued that, beyond a certain number of hours, the effects of fixed costs (which produce increasing returns to hours worked) are outweighed by the effects of fatigue (which produce diminishing returns).

Although the relationship between productivity and employment is often intuitively explained in the literature by skills or demographic structure, few papers look closely at this issue empirically. An attempt is made by Bourlès and Cette (2005) who break down the employment rate into six categories based on three age groups for each gender. They find differences between the age groups: an increase in the employment rate due to an increase in employment among 25 to 54 year-olds reduces productivity by less than an increase in employment for the 15-24 and 55-64 age groups. This may reflect two human capital effects: a lack of experience in the young non-employed population and an erosion of human capital in the older bracket of the non-employed working age population.

Boulhol (2009) and Boulhol and Turner (2009) complete the analysis by integrating different qualification or educational attainment groups.[4] They distinguish 30 categories, crossing three dimensions (two genders x five age groups x three education levels) and show that the effect of the working-age population structure is dominated by the effect of educational composition. However, they use data on relative wages to evaluate productivity changes beyond these 30 categories. This approach has the advantage of distinguishing a specific effect for each country, but has the disadvantages of having to assume a perfectly competitive labour market and to rely on data concerning wages, employment structures and working-age population structures at the limit of their accuracy capacities, or beyond.

The present study aims to distinguish, within the trade-off between productivity and the employment rate, the specific role of the education structure and the specific role of the employment rate. To do so, the working age population is broken down into three categories, according to their education level: less than secondary education, some secondary education and some higher education. Unlike Boulhol and Turner, we rely on econometric methods to evaluate the effect on productivity of a change in the employment rate for each of the three educational attainment groups.

Our empirical analysis is carried out on a panel of 22 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France,

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2 The other pillar was the environment, with the aim of reducing greenhouse gas emissions.

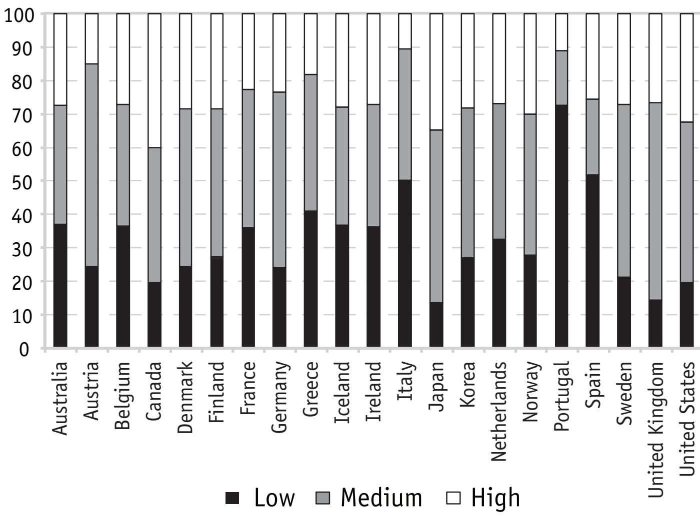
3 See Gust and Marquez (2004), Belorgey *et al.* (2006), Bourlès and Cette (2005, 2007), McGuckin and van Ark (2005), Aghion *et al.* (2009), Dew-Becker and Gordon (2008), and Cette, Chang and Konte (2011).

4 The term qualification is used in this paper in the sense of educational attainment, not skill level.

Chart 1

Educational Attainment in OECD Countries (15-64), 2005

Share, as a per cent, of each of the three education groups



Source: OECD.

Germany, Greece, Ireland, Iceland, Italy, Japan, Korea, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. The macroeconomic data span the 1980-2007 period. The main data sources are the OECD databases. Data sources are detailed in Appendix A.

Our estimates show that the negative effect on hourly productivity growth of an increase in the employment rate is greater (in absolute terms) if coming from an increase in the employment of the two first educational attainment groups than of the population with higher education. Turning to policy implications, it appears that the mechanical (simulated) gains on GDP of a catch-up with the best performing country or with the United States in employment or education structure differ significantly among countries.

The article is organized in four parts. Section one examines differences between countries in the employment rate and the education structure of the workforce and population. Section two presents the model and provides estimation results. Section three discusses policy implications. Section four concludes.

Employment and Qualification Structures

There are significant differences across countries in the educational attainment and employment rate structure of the working-age population. We highlight some important differences in 2005.

As stated in the introduction, we distinguish three levels of qualification (or educational attainment) in the working-age population (i.e. population aged 15 to 64 years): below secondary education, secondary education (completed or not) and higher education (completed or not). This educational attainment or qualification structure differs significantly among countries (Chart 1).

In 2005, the proportion of the working age population with higher education exceeded 30 per cent in only four countries: Canada (40 per cent), Japan (35 per cent), the United States (33 per cent), and Norway (30 per cent). Conversely, this proportion was below 20 per cent in four countries: Greece (18 per cent), Austria (15 per cent), Italy (11 per cent), and Portugal (11 per cent). Similarly, the proportion of the working age population with the lowest education level is very sparse. It is below 20 per cent in four countries: Japan (13 per cent), the United Kingdom (14 per cent), Canada (19 per cent), and the United States (19 per cent). Conversely, it is above 40 per cent in four countries: Greece (41 per cent), Italy (50 per cent), Spain (52 per cent), and Portugal (72 per cent).

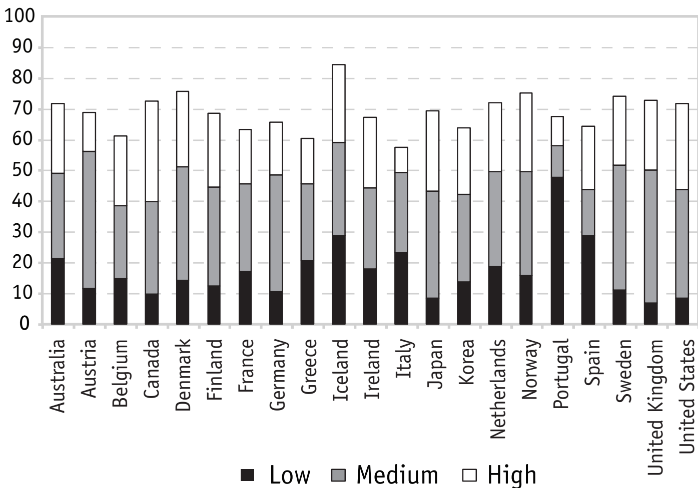
Still, from the various proportions of the population with secondary education, it appears that the differences in the proportions of the population with the lowest level of education do not necessarily reflect similar differences in that with the highest level.

In all countries, the employment rate for the working age population with the lowest education level is below that of the population with secondary education, which is lower than that of the population with higher education. Overall, the employment rate in 2005 was very diverse across OECD countries. It is particularly high (75 per cent or more) in three countries: Norway (75 per cent), Denmark (76 per cent), and Iceland (84 per cent). It was low (below 65per cent) in five countries: Italy (57 per cent), Greece (60 per cent), France (63 per cent), Korea (64 per cent), and Spain (64 per cent). The employment rate is higher in Anglo-Saxon and Nordic countries and Japan compared to Continental European countries.

The contributions of the different education groups towards the overall employment rate (defined as the ratio between the number of employed in the education group and the total working-age population) depend both on the education structure of the working-age population and on the employment rate of each group.[5] Chart 2 shows that the contribution of the population with higher education is very low (below 15 percentage points) in four countries: Italy (8 points), Portugal (10 points), Austria (13 points), and Greece (14 points). It is on the contrary particularly high (over 25 percentage points) in six countries: Denmark (26 points), Iceland (26 points), Japan (26 points), Norway (26 points), the United States (28 points), and Canada (33 points).

The contribution to the overall employment rate of the population with the lowest level of education is very small (below 10 percentage points) in four countries: the United Kingdom (7 points), Japan (8 points), the United States (8 points), and Canada (9 points). It is on the contrary particularly large (over 25 percentage points) in three countries: Iceland (29 points), Spain (29 points), and Portugal (48 points).

Chart 2
Employment Rate (in per cent) and Contribution of each Education Group (in percentage points), OECD Countries, 2005



Source: OECD.

From these observations, we may already guess that for some countries, GDP gains from moving to the education structure and employment rate of the best performing country can be significant. In order to evaluate these gains, it is necessary to first estimate the potential GDP gains from an increase in the employment rate or from a shift upwards in the qualification structure.

Model and Estimation Results[6]

Before trying to break down the respective effects of changes in qualification level and in employment structure on productivity (effects on GDP follow immediately), let us first analyse the overall effect on hourly productivity growth of an increase in the employment rate. In the following, variables in lower case correspond to logs, Δ corresponds to first order differences and

5 The contribution of an education group to the employment rate is therefore different from the employment rate of this education group (that is the ratio between the number of employed in the education group and the number of working-age individuals in this group).

6 More estimation results are available upon request to the authors.

a subscript -i indicates that the variable is lagged by i period(s).

This first model aims to characterize the effect of changes in the employment rate (ΔER) on changes in the logarithm of hourly labour productivity (Δlp). Based on previous empirical studies (e.g. Gust and Marquez (2004), Bourlès and Cette (2005 and 2007), and Belorgey *et al.* (2006)) and according to economic theory, we also control in the estimates (i) for changes in the logarithm of hours worked (Δh) to control for the decreasing returns of this variable on hourly productivity and (ii) for changes in the capacity utilisation rate (ΔCUR), to reflect the effects of the business cycle. Finally, we test for many other controls (X_i). In the following, the only additional control variable presented in our results that we use will be the share of ICT production in total value added (IPTR). This is consistent with previous studies (e.g. Bourlès and Cette, 2005, 2007) that indicate this variable as the only other significant one among all alternative explanatory variables (investment rate, R&D spending, rate of self-employment, share of part time in employment, etc.). Therefore, the estimated relationship is the following:

$$\Delta lp = \beta.\Delta ER + \gamma.\Delta h + \varphi.\Delta CUR + \eta.ITPR + cte + u \quad (1)$$

The expected signs are negative for the coefficient of the changes in employment rate (ΔER) and for the changes in hours worked (Δh) and positive for the changes in the capacity utilisation rate (ΔCUR) and for the share of ICT production in total value added (IPTR).

The empirical analysis is carried out with annual data across a panel of 22 countries in the OECD, for the period 1986-2006 using instrumental variables (to correct for some of the measurement errors and simultaneity issues present in the model). Two tests are used to evaluate adjustment quality: the Sargan test (1958), which assesses the overall quality of the adjustment and the relevance of the instruments, and the Durbin-Wu-Hausman test (Durbin, 1954; Wu, 1973; Hausman, 1978) to check the exogeneity of the instruments.

The first column of Table 1 presents the results of the estimates of regression (1) using the "best" set of instruments (that is the smallest set that satisfies both tests). In this specification, ΔER and ITPR are instrumented. The choice of the instruments, ΔER lags, ΔGDP lags and the investment rate is consistent with both theoretical and empirical theory. The lags of the employment rate tend to reduce the bias due to measurement errors whereas the biases due to co-linearity driven by cycles can be reduced by the introduction of ΔGDP as an instrumental variable.

The estimates of column [1] give the following results: (i) a one percentage point increase in the employment rate changes hourly productivity by -0.51 per cent; (ii) a 1 per cent increase in hours worked changes hourly productivity by -0.50 per cent; (iii) a one percentage point increase in the capacity utilisation rate raises hourly productivity by 0.22 per cent; (iv) a one percentage point increase in ICT production as a share of GDP raises the growth in hourly productivity by 1.49 per cent.

As pointed out by Boulhol (2009), the above analysis (and its interpretation in terms of productivity changes due to overall employment rate variations) is silent on a key aspect of productivity: qualifications. Indeed, depending on the structure of the non-employed (who become employed after an increase in the employment rate) in terms of qualifications, the change in productivity caused by an increase in the employment rate could be very different.

Here, we choose to split the workforce into three groups according to qualification level: 1) less than secondary education, 2) some secondary education and 3) some higher education. This allows us to split the previous effect of the employment rate into two parts: the effect of the qualification structure in the workforce (for a

Table 1
Relation (2) estimates
Explained Variable: Δlp

	[1]	[2]	[3]	[4]	[5]
Relationship	**(1)**	**(1)**	**(2)**	**(2)**	**(2)**
ΔER	-0.509** (0.238)	-0.529*** (0.177)			
ΔER_1			-0.600*** (0.200)		
ΔER_2			-0.589*** (0.181)		
$ER_{1,2}$				-0.594*** (0.163)	-0.594** (0.262)
ΔER_3			-0.112 (0.294)	-0.108 (0.285)	-0.108 (0.328)
Δh	-0.503*** (0.177)	-0.583*** (0.170)	-0.555*** (0.158)	-0.555*** (0.158)	-0.555*** (0.188)
ΔCUR	0.219*** (0.064)	0.200*** (0.062)	0.189*** (0.057)	0.188*** (0.056)	0.188*** (0.049)
$\Delta ITPR$	1.492*** (0.448)	0.930*** (0.261)	0.770*** (0.214)	0.773*** (0.206)	0.773*** (0.201)
Constant	-0.064** (0.025)	-0.038** (0.016)	-0.030** (0.013)	-0.031** (0.013)	-0.031** (0.012)
Clustered standard errors	No	No	No	No	Yes
Number of observations	400	163	163	163	163
Sargan-Hansen stat.	12.675	3.565	6.396	6.377	7.548
P-value	0.1779	0.6136	0.3803	0.4965	0.3741
Durbin-Wu- Hausman stat.	28.46148	14.64888	13.23244	12.05782	
P-value	0.00000	0.00066	0.01019	0.00719	

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%.
List of instruments:
Column 1: Δh; ΔCUR; ΔER_{-1}; ΔER_{-2}; ΔER_{-3}; ΔER_{-4}; ΔER_{-5}; Δgdp_{-1}; Δgdp_{-2}; Δgdp_{-3}; Δgdp_{-4}; INVR
Column 2: Δlp_{-1}; Δh; ΔCUR; ΔER_{-1}; ΔER_{-2}; ΔER_{-3}; Δgdp_{-1}; Δgdp_{-2}; Δgdp_{-3}; Δgdp_{-4}
Column 3: Δlp_{-1}; Δh; ΔCUR; $\Delta ER_{1,-1}$; $\Delta ER_{2,-1}$; $\Delta ER_{3,-1}$; ΔER_{-2}; $\Delta ER_{2,1}$; $\Delta ER_{2,2}$; $\Delta ER_{2,3}$; Δgdp_{-2}; Δh_{-2}
Column 4: Δlp_{-1}; Δh; ΔCUR; $\Delta ER_{1,-1}$; $\Delta ER_{2,-1}$; $\Delta ER_{3,-1}$; ΔER_{-2}; $\Delta ER_{2,1}$; $\Delta ER_{2,2}$; $\Delta ER_{2,3}$; Δgdp_{-2}; Δh_{-2}
Column 5: Δlp_{-1}; Δh; ΔCUR; $\Delta ER_{1,-1}$; $\Delta ER_{2,-1}$; $\Delta ER_{3,-1}$; ΔER_{-2}; $\Delta ER_{2,1}$; $\Delta ER_{2,2}$; $\Delta ER_{2,3}$; Δgdp_{-2}; Δh_{-2}

constant employment structure) and the effect of employment structure (for a given qualification structure). This methodology differs from the one used by Boulhol and Turner (2009) who estimate the same effects using the wages differential as a proxy for the productivity differential between qualification groups.

Instead, here we break down the employment rate into three contributions: $\frac{E}{P} = \frac{E_1}{P} + \frac{E_2}{P} + \frac{E_3}{P}$ where E_i represents the number of employed with a level of qualification i and P represents the working-age population. In the following, we will note: $ER_i = \frac{E_i}{P}$ where ER_i is the contribution in percentage points of the education group to the overall employment rate. This is not the employment rate of the education group i, which would be E_i/P_i.

Given this breakdown, the relationship (1) becomes:

$\Delta lp = \Sigma i \beta_i . \Delta ER_i + \gamma . \Delta h + \varphi . \Delta CUR + \eta . ITPR + cte + u$ (2)

As employment data by qualification level are available for fewer observations than total employment (for most of the countries, data are only available from 1996 to 2005), this relationship is performed on 163 observations, concerning 21 countries (Switzerland disappears from our dataset).

In column [2] of Table 1, we first reproduce the estimates of the previous section on this reduced sample. It then appears that our main results are preserved and that this outcome can be obtained with fewer instruments. We are indeed able to obtain estimates close to those of Column [1] without instrumenting by the investment rate and with fewer lags on ER. This may indicate that there is less bias in the reduced sample. The main change between the two samples being the time period covered (due to time availability of employment rate by educational attainment), this could denote fewer measurement errors in the more recent period of our initial sample.

Column [3] of Table 1 is devoted to the estimates of relationship (2) using instrumental variables. Once again, we only present here the specification giving the best results in terms of Sargan and Durbin-Wu-Hansman tests (more estimation results can be found in the working paper version, Bourlès *et al.*, 2010). In this specification, ΔER_i (i=1, 2, 3) and ITPR are instrumented. Regarding the effect of variations in the contribution to the employment rate, it appears that (i) an increase in the employment rate caused by an increase in the employment of workers with less than higher education is significant with an elasticity of around -0.6 (respectively -0.600 for the population with less than secondary education and -0.589 for people with some secondary education); (ii) the difference between these two effects is not significant; (iii) the effect of an increase in the employment rate due to an increase in the contribution of high-skilled workers (with higher education) is negative, non-significantly different from zero and significantly different from the effects of the other categories.

These results allow us to aggregate together (in Column [4]) qualification groups 1 and 2 (that is the part of the population with secondary education and less).

As for the estimates on this aggregated employment rate, the chosen range of instruments groups together lags on productivity growth, on GDP growth on the growth of hours worked and on variations of the three contributions to the change in the employments rate (see Table 2 for the first step estimates).

The estimates give the following results: (i) an increase of one percentage point in the contribution of groups 1 and 2 significantly reduces productivity by 0.594 per cent when an increase in the contribution of high-skilled workers does not have a significant impact;[7] (ii) a 1 per cent increase in hours worked changes hourly productivity by -0.55 per cent; (iii) a one percentage point increase in the capacity utilisation rate raises hourly productivity by 0.188 per cent; (iv) a one-point increase in ICT production as a share of GDP raises the growth in hourly pro-

7 These effects cannot however be directly interpreted as information on the productivity of that particular education group. The differences between categories should not be directly interpreted as productivity gaps between persons in different education groups but rather as productivity gaps between persons in each education category who are currently not employed but would be the first to move into employment.

ductivity by 0.77 per cent. These results are totally consistent, when the comparison is possible, with the ones of the literature previously cited. The last column of Table 1 (column [5]) provides the results of the same specification with clustered standard errors of the country level.[8] The clustering method has little effect on the level of statistical significance of our results.

Policy Implications

Using the estimated results from the previous section, we now calculate for each country the mechanical (simulated) impact on the GDP level from moving to: (i) the educational attainment structure or (ii) the employment rate structure by education level of the United States or of the country shown to be the best performing. These mechanical impacts correspond to the permanent increase of the GDP per capita level (and not to the GDP per capita permanent growth rate) that countries could enjoy from moving to the education structure or the employment rate level of the best performing countries.

Using the previous notations, the impact on the GDP level in country j as a result of adopting the education level (MIES) and the employment rate structure (MIER) of a reference country r is calculated as follows:

$$MIES = \sum_i \beta_i \cdot \frac{E_{ij}}{P_{ij}} \cdot \left(\frac{P_{ir}}{P_r} - \frac{P_{ij}}{P_j}\right)$$

and

$$MIER = \sum_i (1+\beta_i) \cdot \frac{P_{ij}}{P_j} \cdot \left(\frac{E_{ir}}{P_{ir}} - \frac{E_{ij}}{P_{ij}}\right)$$

Concerning the impact of a change in the population's education structure, we assume the observed employment rates are constant per education level. The mechanical impact on the GDP level stems from the change in the employment structure by education group.

Table 2
First Stage Regressions for Relation (2) Estimates (column [4] of Table 1)

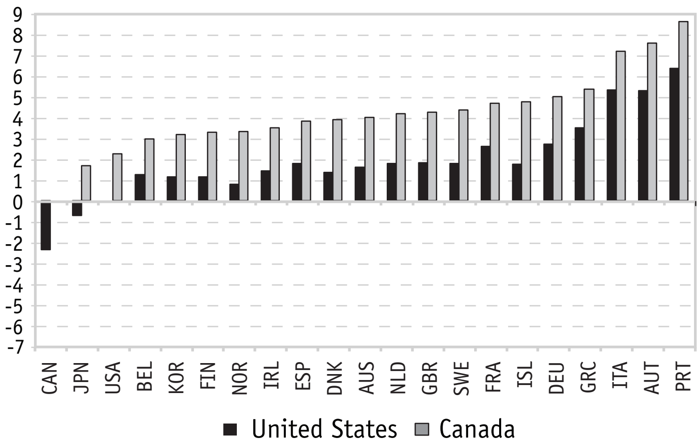
	(1)	(2)	(3)
Explained variable	$ER_{1,2}$	ER_3	ITPR
Δh	0.045	-0.045	-0.174
	(0.039)	(0.039)	(0.155)
ΔCUR	-0.006	0.006	0.028
	(0.015)	(0.015)	(0.061)
ΔER_{-2}	-0.926***	-0.074	-0.117
	(0.076)	(0.076)	(0.303)
$\Delta ER_{1,-1}$	1.888***	0.112	-0.294
	(0.096)	(0.096)	(0.382)
$\Delta ER_{2,-1}$	1.840***	0.160*	0.179
	(0.093)	(0.093)	(0.369)
$\Delta ER_{3,-1}$	0.814***	1.186***	-0.567
	(0.124)	(0.124)	(0.493)
$\Delta_2 ER_1$	0.927***	0.073	-0.150
	(0.047)	(0.047)	(0.188)
$\Delta_2 ER_2$	0.898***	0.102**	0.038
	(0.046)	(0.046)	(0.182)
$\Delta_2 ER_3$	0.374***	0.626***	-0.274
	(0.057)	(0.057)	(0.227)
Δh_{-2}	-0.008	0.008	-0.310**
	(0.035)	(0.035)	(0.140)
Δlp_{-1}	0.009	-0.009	0.251***
	(0.022)	(0.022)	(0.0885)
Δgdp_{-2}	0.009	-0.009	0.121
	(0.024)	(0.024)	(0.095)
Constant	0.000	0.000	0.053***
	(0.001)	(0.001)	(0.003)
Number of observations	163	163	163
R-squared	0.82	0.62	0.15

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

The mechanical gains in GDP resulting from moving to the U.S. education structure are above 5 per cent for three countries–Austria, Italy and Portugal–and above 2.5 per cent for three additional countries–France, Germany

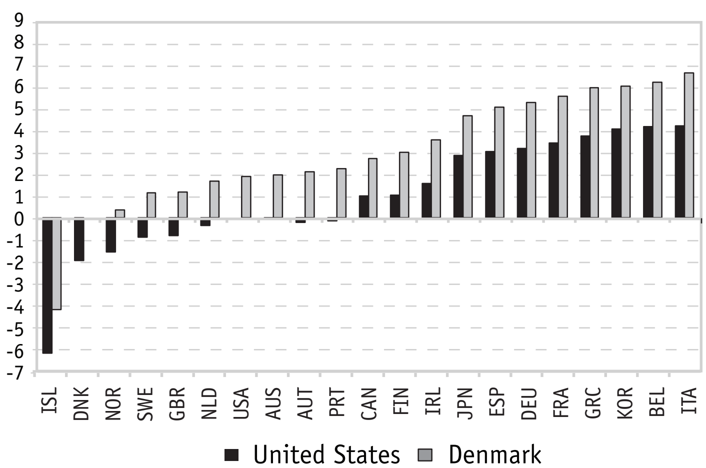
8 Notice here that our variables (including the explained variable) are taken in differences, and from this possible country fixed effects in level disappear in our specification. Moreover, the small number of years used for each country (in average about eight but less for some countries) prevents us from using fixed effects in differences.

Chart 3
Mechanical Effect on the GDP Level by Adopting the Education Structure of the Working-age Population of the United States and Canada, 2005
(in per cent)



Source: Authors' calculations.

Chart 4
Mechanical Effect on the GDP Level by Adopting the Employment Rate Structure of the Working-age population of the United States and Denmark, 2005
(in per cent)



Source: Authors' calculations.

and Greece (Chart 3). Portugal has the highest potential gains: 6.3 per cent. Gains are negative in two countries where the education level of the working-age population is already higher than in the United States: Canada and Japan.

As a whole, the gains are lower than calculated by Boulhol and Turner (2009, Figure 8.4.A) for two reasons. First, Boulhol and Turner distinguish 30 groups, crossing three dimensions (two genders x five age classes x three education levels), whereas we distinguish only two or three groups in one dimension, the education level. Second, we estimate the productivity–education elasticity, assuming that the elasticity is constant over all countries, whereas Boulhol and Turner (2009) allow it to vary across countries by the wage costs, under the assumption of a perfectly competitive and efficient labour market. This assumption may lead to an overestimation of the productivity of high-skilled workers who may extract rent from the employer and are paid more than their marginal productivity.

Canada is the country with the highest proportion of its working age population with higher education, at 40 per cent in 2005.[9] GDP gains are therefore higher when adopting Canada's education structure than when adopting that of the United States.

Let us now turn to the impact of a change in the employment rate structure while keeping the population's education level constant. Due to decreasing returns of the employment rates, a general increase in the employment rate mechanically decreases the productivity level, which reduces itself the positive impact on the GDP level of the increase in the employment rate.

The GDP gains obtained by adopting the employment rate structure of the United States

9 It can be noted that many Canadians with post-secondary education have, in fact, a community college qualification and not a university degree. Considering that all countries have particular specificities, and that we are aware for only few of these particularities, we do not take them into account in our analysis. This reinforces the point that our results have to be considered carefully, as in the case for all country panel econometric studies.

are never above 5 per cent (Chart 4). They are above 2.5 per cent for eight countries: Japan, Spain, Germany, France, Greece, Korea, Belgium, and Italy. In Italy, they are the highest at 4.2 per cent. Gains are negative in nine countries, where the employment rate is higher than in the United States: Iceland, Denmark, Norway, Sweden, the United Kingdom, the Netherlands, Australia, Austria, and Portugal. These results are consistent with those of Bourlès and Cette (2005, 2007).

The highest total employment rate was observed in Iceland (84.4 per cent). This cannot however be considered as representative since the country is very small (the working-age population is less than 200 thousand). Denmark, with the second highest employment rate (75.5 per cent), is therefore considered as the best performing country. The GDP gains obtained by moving to Denmark's employment rate structure (for each educational level) are consequently higher than those obtained by moving to that of the United States.

The results demonstrate that increasing the education level or the employment rate of the working-age population are, for many countries, two effective policies to raise GDP.

Conclusion

This analysis should of course be viewed with caution, as it relies on inevitably fragile estimates conducted on a panel of OECD countries. Each country has specific institutions and labour market regulations which can explain specific effects. The estimates, nevertheless, suggest promising gains in GDP, which could be obtained in some industrialised countries after undertaking ambitious reforms to increase the education level or the employment rate of the workforce. A next step in this analysis could be to look at the impact of the interactions between changes to the education structure and rigidities in labour and product markets (in line with Aghion *et al*., 2009). Due to serious measurement errors and endogeneity bias among these variables this however calls for more work, in particular on the instrumentation techniques.

References

Aghion, P., P. Askenazy, R. Bourlès, G. Cette, and N. Dromel. (2009) "Education, market rigidities and growth," *Economics Letters*, Vol. 102.

Belorgey, N., R. Lecat. and T. Maury (2006) "Determinants of productivity per employee: An empirical estimation using panel data," *Economics Letters*, Vol. 91, No. 2.

Boulhol, H. (2009) "The effects of population structure on employment and productivity," OECD Economics Department Working Paper, No. 684.

Boulhol, H. and L. Turner (2009) "Employment - productivity trade-off and labour composition," OECD Economics Department Working Paper, No. 698.

Bourlès, R. and G. Cette (2005) "A comparison of structural productivity levels in the major industrialised countries," *OECD Economic Studies*, 41, 2005/2.

Bourlès, R. and G. Cette (2007) "Trends in Structural Productivity Levels in the Major Industrialised Countries," *Economic Letters*, Vol. 95.

Bourlès, R., G. Cette A. and Cozarenco (2010) "Employment and productivity: disentangling employment structure and qualification effects," GREQAM working paper, 2010-03.

Cette, G., S. Chang, and M. Konte (2011) "The decreasing returns of working time:an empirical analysis on panel country data," *Applied Economics Letters*, Vol. 18, pp. 1677-1682.

Dew-Becker, I. and R. Gordon (2008) "The Role of Labor Market Changes in the Slowdown of European Productivity Growth," NBER Working Paper No. 13840.

Durbin, J. (1954) "Errors in Variables," *Review of the International Statistical Institute*, Vol. 22.

Gust, C. and J. Marquez (2004) "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices," *Labour Economics*, Vol. 11.

Hausman, J. (1978) "Specification Tests in Econometrics,", *Econometrica* Vol. 46, No. 3.

McGuckin, R. and B. van Ark (2005) "Productivity and participation: an international comparison," University of Groningen, GGDC Research Memorandum, No. 2005-78.

Sargan, J. (1958) "The Estimation of Economic Relationships Using Instrumental Variables," *Econometrica*, Vol. 26, No. 3.

Wu, D.M. (1973) "Alternative Tests of Independence between Stochastic Regressors and Disturbance," *Econometrica*, Vol. 42, No.3.

Appendix: Data Sources and Variable Definitions

	Description	Sources	Mean 22 countries* (400 obs)	Standard-deviation 22 countries* (400 obs)	Mean 21 countries* (163 obs)	Standard-deviation 21 countries* (163 obs)
LP	GDP constant prices per hour worked	OECD data	32.65	8.57	35.20	8.82
H	Average annual hours actually worked per worker	OECD: Labour market	1 761	262.06	1 745	271.64
ER	Employment/population ratio	OECD: Labour market	0.66	0.08	0.67	0.07
CUR	Capacity utilisation rate	OECD: Monthly economic indicators	0.8178	0.0356	0,8169	0.0375
ITPR	Share of ICT production in total value added (current price)	STAN data	0.06	0.02	0.06	0.02
INVR	Total investment in volume as a % of GDP	OECD: Economic Outlook	0.21	0.04	0.22	0.04
GDP	Gross domestic product in USD millions, constant prices, constant PPPs, reference year 2000,	OECD: National accounts	1 127 343	1 936 387	1 131 987	1 948 684
ERp	Employment rate of population with below upper secondary education.	OECD: Boulhol			0.53	0.08
ERs	Employment rate of the population with upper secondary education.	OECD: Boulhol			0.70	0.08
ERt	Employment rate of the population with tertiary education.	OECD: Boulhol			0.81	0.05
ER1	The contribution to the employment rate of the group with "below upper secondary" education	Using OECD data			0.19	0.10
ER2	The contribution of the employment rate of the group with "upper secondary" education	Using OECD data			0.30	0.09
ER3	The contribution to the employment rate of the group with "tertiary" education	Using OECD data			0.18	0.06
P1/P	Population with less than upper secondary education - total population ratio	Using OECD data			0.35	0.15
P2/P	Population with upper secondary education - total population ratio	Using OECD data			0.42	0.11
P3/P	Population with tertiary education - total population ratio	Using OECD data			0.23	0.08

* The 21 countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Iceland, Italy, Japan, Korea, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States. The 22 countries are these 21 and Switzerland.