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EMPLOYMENT - PRODUCTIVITY TRADE-OFF AND LABOUR COMPOSITION

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ABSTRACT/RÉSUMÉ

Employment - productivity trade-off and labour composition

This paper formalises the analysis of the employment-productivity trade-off by extending the framework developed by Gordon (1997) to account for labour heterogeneity. The extent of the trade-off is determined by the extent of the adjustment of capital to effective labour and by the changes in aggregate labour quality. The main experiment reported in the paper consists of assessing the labour utilisation and productivity impacts in OECD countries of aligning group-specific employment rates to the US levels. Matching the US employment performance defined in that sense would enable low-employment OECD countries to reduce only half of the aggregate employment-rate gap vis-à-vis the United States, the other half being mechanically due to differences in the population structure by age and educational attainment. In this experiment, a 1% gain in employment is associated with a decrease of 0.24% in labour productivity on average across countries, and of 0.35% in low-employment countries.

JEL Classification: J21; J31; E24; J10

Keywords: Labour productivity; Aggregate employment; Quality of labour; Demographics

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Compromis emploi - productivité et effets de composition

Cette étude formalise l'analyse du compromis entre emploi et productivité en étendant le cadre développé par Gordon (1997) pour prendre en compte l'hétérogénéité de la main d'œuvre. L'ampleur de ce compromis est déterminée par l'étendue de l'ajustement du capital à la main d'œuvre effective et par les changements dans la qualité de la main d'œuvre. La principale expérience rapportée dans l'étude consiste en l'évaluation de l'impact sur l'utilisation de la main d'œuvre et sur la productivité du travail de l'alignement, pour chaque pays de l'OCDE, des taux d'emplois par groupe de population sur ceux des États-Unis. Répliquant la performance des États-Unis ainsi définie permettrait aux pays de l'OCDE ayant un faible niveau d'emplois de réduire seulement la moitié de l'écart de taux d'emploi agrégé vis-à-vis des États-Unis, l'autre moitié étant due mécaniquement à la structure de la population par âge et niveau d'éducation. Dans cette expérience, des gains de 1% en termes d'emplois sont associés à une baisse de 0.24% de la productivité du travail en moyenne pour les pays de l'OCDE et de 0.35% pour les pays ayant les niveaux d'emplois les plus bas.

Classification JEL : J21 ; J31 ; E24 ; J10

Mots-clés: Productivité du travail ; Emploi agrégé ; Qualité de l'emploi ; Démographie

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1. Introduction

1. Concerns that a decrease in structural unemployment may be associated with lower average productivity growth have arisen in recent decades partly based on the contrasting experience of European and US economic performance. During the 1970s and 1980s, most European countries recorded rapid labour productivity growth combined with weak employment performance. In contrast, during the same period, the United States experienced strong employment growth and slow productivity advances. In the past decade, the European Union has performed well in terms of employment growth, albeit from low levels, but labour productivity growth has been persistently slow.

2. Such an apparent trade-off between labour productivity and labour utilisation can arise if an increase in labour utilisation generates a deterioration in the average quality of the labour force. This could be the case if significant numbers of low-productivity workers are integrated into employment, which is indeed a goal of many labour market reforms. Thus, the employment-productivity trade-off might represent the 'productivity sacrifice' of particular labour market reforms due to compositional changes.[2]

3. Previous studies have estimated that the extent of the employment-productivity trade-off could be large enough that improved employment performance would have minimal effect on GDP per capita (see OECD, 2007, for a survey). Although these studies make an important contribution to the field in drawing the attention to this pattern, they suffer from methodological limitations that question the estimated magnitudes and how they should be interpreted.

4. This paper stresses the importance of the population structure along the demographic and education dimensions in determining both aggregate employment and average productivity outcomes. Population structure is an important determinant of employment performance due to differences in employment rates across population groups. These differences stem from the influence of educational attainment, gender and age over both labour supply and demand. For example, changes in the age composition are estimated to have

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2. The trade-off can arise via other channels. Population growth might influence aggregate technology through its impact on technological adoption decisions (Beaudry and Collard, 2003). Also, labour market reforms might affect individual workers' productivity in various ways (Bassanini and Venn, 2007). In contrast, in this paper, the focus is placed explicitly on the composition effects at given technological levels. Some events that can trigger an increase in labour utilisation such as product market reforms are likely to be associated with either increases in technological levels or reductions in rents that would translate into higher labour productivity levels. These are ignored in the subsequent analysis.

increased the natural rate of unemployment (NAIRU) in the United States by 0.7 percentage point between 1960-1979 and reduced it by the same amount between 1979-1998 (Katz and Krueger, 1999). Although low employment rates for any group might reflect disincentives embedded in government policies, their consistent pattern across groups over OECD countries suggests that some groups may have an inherent disadvantage of being employed.

5. Population structure can affect productivity in different ways, beyond the emphasis placed by growth theory on the role of education in boosting long-term productivity levels. Indeed, an expanding literature puts forward the importance of demographics for productivity developments (*e.g.* Lindh and Malmerg, 1999; Bloom *et al*., 2007; Feyrer, 2008; Werding, 2008). Age structure may have a large impact on economic performance because saving rates vary over the life cycle. Moreover, workers' productivity may differ systematically over the active period of life because of experience, depreciation of knowledge and age-related trends in physical and mental capabilities.

6. This study formalises the employment-productivity trade-off as resulting from the slow adjustment of capital and the heterogeneity of labour. In a seminal paper, Gordon (1997) focuses on the case where labour is homogenous and shows that the employment-productivity trade-off results from shifts in labour supply. For example, an institutional wage push will trigger both a decrease in employment along the labour demand schedule and an increase in marginal and average labour productivity. However, this effect tends to vanish in the long-term as capital adjustment magnifies the effect on employment, but reduces that on productivity.

7. The extension provided in this paper introduces labour heterogeneity. *If* labour market reforms target certain groups of workers having a lower-than-average productivity, they will tend to reduce aggregate productivity. In the short term, both capital inertia and heterogeneity effects are at work. In the long term, the trade-off flattens out due to capital dynamics, but the heterogeneity effect remains even if capital fully adjusts. In this framework, the long-term elasticity of productivity with respect to labour utilisation is simply derived from the relative marginal productivity of the entrants compared with the average worker. Based on actual data on relative wages, as an imperfect proxy of relative marginal products of labour, a long-term elasticity associated with changes in employment of low-productivity workers of around -0.25 seems reasonable theoretically, and consistent with a short-term elasticity of around -0.50.

8. A key experiment considered herein consists in estimating the impact in terms of labour utilisation and productivity of aligning employment rates for all population groups in OECD countries on those in the United States. This case is associated with an estimated long-term elasticity of -0.24 on average across countries, and the analysis highlights heterogeneity between countries, suggesting that the long-term elasticity could be as high as -0.35 for low-employment countries. Moreover, it is shown that, even if employment rates in 30 working-age population groups were identical in the United States and Europe, *i.e.* in a sense if both regions achieved similar labour market performance, only half of the total employment-rate gap between Europe and the United States would be reduced due to differences in population structures.

9. It has been argued that if low-employment European countries had comparable labour market performance to that of the United States, *i.e.* within each group, labour productivity would be lower overall than current recorded levels. Although the analysis below supports this, the total decrease in productivity levels might not be greater than 2%. Importantly, it does not follow that the employment composition is more favourable to productivity in Europe. Indeed, the employment structure is the result of both the employment-rate and population structures. Hence, the much larger share of the working-age population with low education attainment in Europe tends to depress productivity levels, and labour composition is, in total, detrimental to productivity in Europe relative to the United States.

10. The rest of the paper is organised as follows: Section 2 introduces the theoretical framework relying on the slow adjustment of capital and labour heterogeneity. Section 3 confirms previous econometric results in

this area, but underscores serious methodological limitations. Section 4 provides a direct methodology to compute the composition effect on productivity, while Section 5 is devoted to the empirical analysis. Finally, Section 6 concludes.

2. Theory

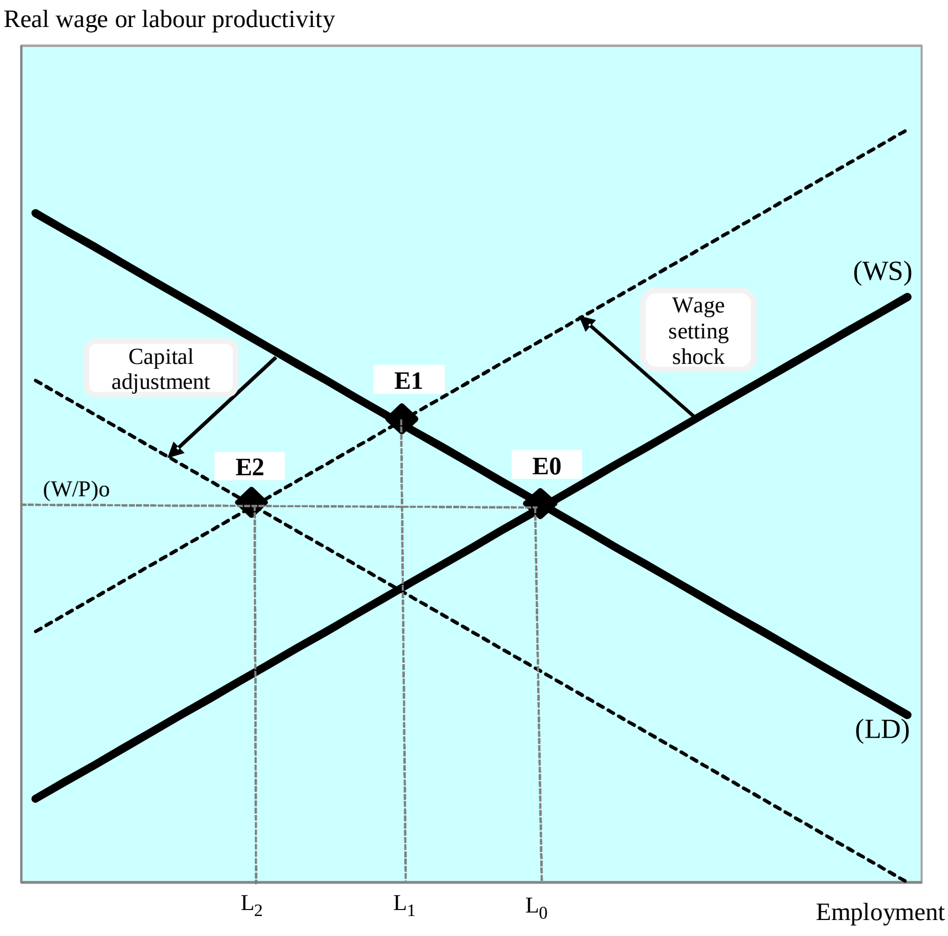
11. This section presents a theoretical framework that formalises the employment-productivity trade-off. It distinguishes short-term effects induced by changes in employment levels from long-term ones that are obtained when the dynamics of capital accumulation/decumulation are achieved. The first sub-section addresses the case of labour homogeneity, whereas the second one takes into account the additional contribution of labour heterogeneity.

2.1. Homogeneity of labour

12. This sub-section is directly inspired by Gordon (1997) who shows that the employment-productivity trade-off appears as a result of any autonomous event, such as an increase in the minimum wage or in union bargaining power, that boosts the real wage and, therefore, simultaneously raises both unemployment and labour's average product in the short run. However, when the capital stock adjusts to this shift in labour supply or wage-setting schedule, the trade-off is eliminated.

13. The labour market equilibrium is represented in Figure 1, where employment is on the x-axis and real wage or average labour productivity on the y-axis.[3] The downward sloping curve is the price-setting or labour demand schedule, constructed by holding all other inputs constant, while the upward sloping curve represents wage-setting or labour supply. The trade-off between employment and productivity is captured by a move along the labour demand schedule as a result of shifts in wage setting such as those driven by changes in the tax wedge, union power or unemployment benefits. However, it is clear also that shifts in labour demand generate a *positive* relationship between employment and productivity.

Figure 1. The employment - productivity trade-off with homogeneous labour



14. Two implications follow from this simple representation. When labour heterogeneity is ignored, the employment-productivity trade-off is identified by labour supply shifts only, and the extent of the trade-off is based on the elasticity of labour demand to wages. Short- and long-term effects need now to be distinguished.

15. In Figure 1, the initial equilibrium is at point E_0. A shift in wage setting triggering an increase in the real wage moves the equilibrium to E_1 (everything works symmetrically if the real wage decreases). However,

3. Real wage is equal to productivity multiplied by the labour share in output.

E_1 is a short-term equilibrium only. The decrease in employment triggers initially an increase in the capital-labour ratio and therefore a decrease in the marginal product of capital. The adjustment of capital that follows shifts the labour demand curve to the left. Consequently, in the long-term, the short-term impact on employment of the initial supply shift is magnified, while the slope of the trade-off is reduced. In any economy where the real interest rate is fixed, the long-term price-setting curve is flat and equilibrium is at E_2. In that case, the trade-off totally vanishes in the long-term.

2.2. Heterogeneity of labour

16. The objective in this sub-section is to calculate the impact on average labour productivity of a change in employment driven by a shift in labour composition. More explicitly, the focus is to assess the consequences in terms of average productivity levels of including (excluding) certain types of labour in (from) employment. The model below explicitly takes into account labour heterogeneity by considering two types of labour, skilled, L_s, and unskilled, L_u. The labour market for skilled workers is supposed to clear, whereas there are some imperfections in the unskilled labour market.[4] In terms of labour market policies, these imperfections are implicitly at the centre of interests in this paper. Wages, w_u and w_s, are supposed to be pre-determined to employment decisions. The production function exhibits constant returns to scale in capital, K, and labour aggregate, N, which is itself a constant returns to scale function of the two types of labour; the price of output is chosen as the numeraire:

$$Y = F(K, N) \quad \text{where} \quad N = G(L_u, L_s) \quad , \quad p_Y = 1 \tag{1}$$

As skilled labour is always fully employed, the change in total employment, $L = L_u + L_s$, is equal to the change in unskilled labour:

$$\Delta L = \Delta L_u \tag{2}$$

2.2.1. Short-term effect

17. In the short term, capital is supposed to be fixed and, using profit maximisation first-order conditions, the change in output is equal to the change in unskilled labour multiplied by the unskilled labour share:

$$\frac{\Delta Y}{Y} = \frac{\partial Y}{\partial L_u}\frac{\Delta L_u}{Y} = \frac{w_u L_u}{Y}\frac{\Delta L_u}{L_u} = s\,\frac{w_u L_u}{\overline{w} L}\frac{\Delta L_u}{L_u} = s\,\frac{w_u}{\overline{w}}\frac{\Delta L}{L} \tag{3}$$

where $\overline{w}$ is the average wage and s the total labour share. It is straightforward to derive the impact on labour productivity, LP:

$$\frac{\Delta LP}{LP} \equiv \frac{\Delta Y}{Y} - \frac{\Delta L}{L} = -\left(1 - s\frac{w_u}{\overline{w}}\right)\frac{\Delta L}{L} = -\left((1-s) + s\frac{\overline{w} - w_u}{\overline{w}}\right)\frac{\Delta L}{L} \tag{4}$$

Equation (4) highlights that the short-term trade-off has two components:

4. The model could easily be extended to incorporate several groups being subject to labour market imperfections.

$$\varepsilon_{ST} = -\left((1-s) + s\frac{\overline{w}-w_u}{\overline{w}}\right) \tag{5}$$

The first one, $(1-s)$, is due to capital fixity, as shown below, and is equal to the capital share. The second one, the short-term composition effect, is explicitly due to labour heterogeneity and is proportional to both the labour share and the difference between the average and unskilled wage, itself closely related to the respective productivity difference.

2.2.2. Long-term effect

18. The long-term effect takes into account the adjustment of capital:

$$\begin{aligned}\frac{\Delta LP}{LP} &\equiv \frac{\Delta Y}{Y} - \frac{\Delta L}{L} = \frac{\partial Y}{\partial L_u}\frac{\Delta L_u}{Y} + \frac{\partial Y}{\partial K}\frac{\Delta K}{Y} - \frac{\Delta L}{L} \\ &= s\frac{w_u}{\overline{w}}\frac{\Delta L}{L} + (1-s)\frac{\Delta K}{K} - \frac{\Delta L}{L} = -(1-s)\left(\frac{\Delta L}{L} - \frac{\Delta K}{K}\right) - s\frac{\overline{w}-w_u}{\overline{w}}\frac{\Delta L}{L}\end{aligned} \tag{6}$$

leading to the long-term elasticity:

$$\varepsilon_{LT} = -\left((1-s)\left(1 - \frac{\Delta K / K}{\Delta L / L}\right) + s\frac{\overline{w}-w_u}{\overline{w}}\right) \tag{7}$$

This expression is actually general as it encompasses the case of labour homogeneity ($w_u = \overline{w}$) and the short-term situation ($\Delta K = 0$).

19. Comparing the long-term with the short-term elasticity given by (5) confirms that the trade-off flattens in the long-term as capital and labour input changes are positively correlated. Also, in the special case of no labour heterogeneity, $w_u = \overline{w}$, the full adjustment of capital to employment, *i.e.* $\Delta K / K = \Delta L / L$, entails that the long-term trade-off vanishes. This highlights that, in the long-term, the trade-off stems solely from labour heterogeneity.

20. Due to heterogeneity in labour, the capital stock does not adjusts in line with total employment, L, but with the labour aggregate, *N*. Using Euler theorem, one gets:

$$\frac{\Delta K}{K} = \frac{\Delta N}{N} = \frac{\partial N}{\partial L_u}\frac{\Delta L_u}{N} = \frac{w_u}{\partial Y / \partial N}\frac{\Delta L_u}{N} = \frac{w_u L_u}{sY}\frac{\Delta L_u}{L_u} = \frac{w_u L_u}{\overline{w}L}\frac{\Delta L_u}{L_u} = \frac{w_u}{\overline{w}}\frac{\Delta L}{L} \tag{8}$$

In words, the capital stock adjusts to the changes in unskilled employment at a proportion that is equal to the share of unskilled labour in total wages. Given (8), the long-term elasticity simplifies into:

$$\varepsilon_{LT} = -\frac{\overline{w}-w_u}{\overline{w}} \tag{9}$$

The expression of the long-term elasticity is remarkably simple and depends solely on the gap between the marginal product of the targeted labour, labelled as “unskilled labour” in this stylised framework, and the average wage.

21. Table 1 provides the order of magnitude of the short- and long-term elasticity given by equations (5) and (9), respectively, as a function of the relative wage, fixing the labour share in output at $s = 0.65$. Three inferences are worth noting. First, as explained above, when $w_u = \overline{w}$, the short-term trade-off is equal to the capital share and the long-term one is nil. Second, the difference between the short- and long-term elasticities can be sizeable. For example, a short-term elasticity of -0.5 is consistent with a long-term one of -0.22 only. Third, the trade-off varies a lot depending upon the specific entering groups. In the case of young workers being typically paid half the average wage, the long-term elasticity is equal to -0.5, whereas a much lower trade-off should be expected when older/experienced workers are integrated into employment.

Table 1. Short-term and long-term trade-off as a function of the relative wage of low-skilled labour

Low-skilled relative wage ($w_u / \overline{w}$)	Elasticity	
	Short-term	Long-term
0.4	-0.74	-0.60
0.5	-0.68	-0.50
0.6	-0.61	-0.40
0.7	**-0.55**	**-0.30**
0.8	**-0.48**	**-0.20**
0.9	**-0.42**	**-0.10**
1.0	**-0.35**	**0.00**
1.1	-0.29	0.10
1.2	-0.22	0.20
1.3	-0.16	0.30

Note : These elasticities are computed by applying equations 5 and 9.

22. In order to get a realistic order of magnitude, Table 2, Panels A and B, presents the relative wage for 15 groups, defined by crossing 3 education levels with 5 age classes, for a selected number of countries. The relative wages $w_i / \overline{w}$ of the i groups are reported for two wage measures and Annex 1 gives the details concerning the data. When focusing on the groups recording the largest differences in employment performance across countries, *i.e.* population under the age of 35 or above 55 not having a tertiary education level, the relative wage is around 0.7 for the 25-34 age group not having an upper-secondary education to around 1.0 or above for the 55-64 having an upper-secondary level, implying a short-term elasticity in the -0.35/-0.55 range and a long-term one lower than 0.30 in absolute terms.

Table 2. Relative wage by age groups and education levels

(Average wage = 1.00, for each country)

	A. Wage measure: total wages / total hours worked[1]					B. Wage measure: mincer[1,2]				
Age groups	**15-24**	**25-34**	35-44	45-54	**55-64**	**15-24**	**25-34**	35-44	45-54	**55-64**
	Primary and lower secondary education					**Primary and lower secondary education**				
France	**0.52**	**0.69**	0.80	0.87	**0.89**	**0.43**	**0.57**	0.68	0.74	**0.74**
Germany	**0.37**	**0.85**	0.95	0.91	**0.87**	**0.41**	**0.56**	0.67	0.72	**0.72**
Italy	**0.64**	**0.80**	0.88	0.89	**0.88**	**0.50**	**0.67**	0.81	0.88	**0.88**
Spain	**0.65**	**0.76**	0.84	0.91	**0.92**	**0.52**	**0.70**	0.84	0.92	**0.92**
Sweden	**0.51**	**0.83**	0.92	0.90	**0.91**	**0.43**	**0.58**	0.70	0.76	**0.76**
United Kingdom	**0.78**	**0.90**	0.92	0.88	**0.84**	**0.41**	**0.54**	0.64	0.70	**0.71**
United States	**0.43**	**0.65**	0.74	0.78	**0.78**	**0.35**	**0.47**	0.56	0.61	**0.61**
	Upper-secondary education					**Upper-secondary education**				
France	**0.37**	**0.73**	1.03	1.25	**1.49**	**0.60**	**0.80**	0.97	1.06	**1.06**
Germany	**0.64**	**0.91**	0.99	1.01	**0.98**	**0.59**	**0.79**	0.95	1.04	**1.04**
Italy	**0.69**	**0.89**	1.08	1.23	**1.31**	**0.69**	**0.93**	1.13	1.24	**1.24**
Spain	**0.70**	**0.83**	1.05	1.32	**1.30**	**0.71**	**0.96**	1.17	1.29	**1.28**
Sweden	**0.69**	**0.87**	0.93	0.98	**1.07**	**0.61**	**0.82**	0.98	1.07	**1.07**
United Kingdom	**0.74**	**0.91**	1.02	1.03	**0.94**	**0.56**	**0.76**	0.92	1.00	**1.01**
United States	**0.48**	**0.74**	0.89	0.95	**0.96**	**0.49**	**0.65**	0.78	0.85	**0.85**
	Tertiary education					**Tertiary education**				
France	0.53	0.94	1.37	1.47	1.95	0.94	1.27	1.53	1.68	1.68
Germany	0.65	1.08	1.30	1.34	1.37	0.85	1.16	1.40	1.54	1.55
Italy	0.95	1.16	1.37	1.91	2.02	1.03	1.40	1.70	1.87	1.89
Spain	0.73	1.07	1.45	1.88	2.06	0.88	1.18	1.46	1.63	1.65
Sweden	0.60	0.99	1.28	1.23	1.45	0.79	1.06	1.27	1.39	1.38
United Kingdom	0.77	1.08	1.28	1.22	1.16	0.93	1.24	1.51	1.65	1.66
United States	0.68	1.10	1.43	1.41	1.50	0.91	1.23	1.50	1.64	1.65

1. Wage measures are derived from micro data. See Annex 1 for details.

3. Confirmation of previous econometric results and methodological issues

23. The following sub-section confirms econometric results obtained in the literature by regressing average labour productivity on aggregate labour utilisation using panel data, and according to which the elasticity of productivity to employment is high in absolute terms, around 0.5 or even higher in some studies. The second sub-section highlights the limitations of such an approach, which makes it inappropriate to assess the effect of labour composition on productivity or the employment-productivity trade-off more generally.

3.1. Confirmation of previous econometric results

24. A growing literature based on country-year panel regressions for developed countries has found a robust negative relationship between average hourly labour productivity and labour utilisation. The estimated effect is typically large, as a 1% increase in the employment rate would result in a decrease of around 0.5% in labour productivity (Belorgey *et al*., 2006; Bourlès and Cette, 2005; Dew-Becker and Gordon, 2006; Gust and Marquez, 2004), and therefore in an increase of less than 0.5% in GDP per capita. In contrast, McGuckin and van Ark (2005) find a smaller and short-run effect only.[5]

25. Although the specifications differ across studies, the order of magnitude of the main results established so far can be obtained by estimating the following type of equation:

$$hp_{it} = a\ lab\_util_{it} + Z_{it} + u_{it} \qquad (10)$$

where hp_{it} is hourly labour productivity (in log) in country *i* and year *t*, lab_util is the labour utilisation rate defined as total hours worked divided by population of age 15-64 (in log), Z is a set of country and year fixed effects and country-specific time trends, and u_{it} is a residual. Equation (10) is typically estimated either in levels or in first-differences, and Table 3 presents the results when estimated over a sample of 20 OECD countries between 1970-2004.

Table 3. The employment - productivity trade-off in panel estimates, 1970-2004 [1]

Dependent variable : log (hourly labour productivity)	level	level	level	first differences	first differences	first differences
	(1)	(2)	(3)	(4)	(5)	(6)
Labour utilisation[2]	-0.596***	-0.432***	-0.462***	-0.492***	-0.348***	-0.467***
	(0.042)	*(0.032)*	*(0.035)*	*(0.034)*	*(0.032)*	*(0.033)*
Rho	0.870	0.784	0.821	0.211	0.123	0.082
Fixed effects						
Country	yes	yes	yes	yes	yes	yes
Year	yes	no	yes	yes	no	yes
Country specific time trend	no	yes	yes	no	yes	yes
R-square	0.99	0.99	0.99	0.47	0.37	0.54
Number of observations	657	657	657	637	637	637

Note : Standard errors are in brackets. *: significant at 10 % level; ** at 5 % level; *** at 1 % level.
1. Standard errors are robust to heteroscedasticity and contemporaneous correlation. Specification includes first-order auto-correlation within panel and *Rho* is the corresponding estimated parameter.
2. Labour utilisation is defined as total hours worked divided by the population aged 15-64 years (log).

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5. There is also some conflicting evidence based on country cross-section analysis. OECD (2007) points to a significant negative correlation between changes in labour utilisation growth and labour productivity growth for developed countries over 1970-2005. Beaudry and Collard (2002) find that the trade-off phenomenon appeared in the 1980s, whereas Cavelaars (2005) estimates a significant effect between 1961-80, and none afterwards.

26. The estimation results show a significant negative labour utilisation parameter, with Table 3 reporting an elasticity of -0.46 when the whole set of controls are included. Some papers also include average hours worked as an additional explanatory variable and find an "elasticity" of around -0.3 on top of the effect of total hours worked. Taken at face value, this would indicate that increasing average working time has a very small effect on GDP per capita. Table 4 reports the estimates when average hours worked is added in the regressions, showing that the total elasticity of average working time would be of at least -0.7.

Table 4. **The employment - productivity trade-off with average hours worked in panel estimates, 1970-2004**[1]

Dependent variable : log (hourly labour productivity)	level	level	level	first differences	first differences	first differences
	(1)	(2)	(3)	(4)	(5)	(6)
Labour utilisation[2]	-0.405***	-0.280***	-0.384***	-0.390***	-0.241***	-0.361***
	(0.047)	*(0.038)*	*(0.042)*	*(0.043)*	*(0.043)*	*(0.042)*
Average hours worked[3]	-0.700***	-0.666***	-0.345***	-0.326***	-0.388***	-0.348***
	(0.089)	*(0.074)*	*(0.089)*	*(0.090)*	*(0.083)*	*(0.085)*
Rho	0.859	0.769	0.804	0.213	0.105	0.077
Fixed effects						
Country	yes	yes	yes	yes	yes	yes
Year	yes	no	yes	yes	no	yes
Country specific time trend	no	yes	yes	no	yes	yes
R-square				0.48	0.40	0.56
Number of observations	657	657	657	637	637	637

Note : Standard errors are in brackets. *: significant at 10 % level; ** at 5 % level; *** at 1 % level.
1. Standard errors are robust to heteroscedasticity and contemporaneous correlation. Specification includes fist-order auto-correlation within panel and *Rho* is the corresponding estimated parameter.
2. Labour utilisation is defined as total hours worked divided by population aged 15-64 years (log).
3. Average hours worked is defined as total hours worked divided by employment (log).

3.2. Methodological problems

27. Using a specification like (10) in order to measure the employment-productivity trade-off raises three main issues. First, the critical difference between short- and long-term effects is either ignored, or at best heavily constrained in most papers.[6] Second, endogeneity issues are severe. Third, the effect of labour composition is not what equation (10) is about.

6. In the above studies, the distinction between short-term and long-term dynamics is either ignored or addressed through a partial adjustment specification. The latter is likely to place undue constraints between these dynamics, as results in Table 5 below suggest. An exception is McGuckin and van Ark (2005) who estimate changes over short and long periods, and find that the significance of the main parameter of interest disappears when changes over long periods are considered.

28. First, in the short run, because capital is quasi-fixed, the parameter *a* should take a value close to the negative of the capital share in GDP, which is around 0.35. The easiest way to show this is to consider the Cobb-Douglas production function $Y = K^{\alpha}(AL)^{1-\alpha}$, which implies:

$$Log(Y/L) = -\alpha \, Log \, L + \alpha \, Log \, K + (1-\alpha) Log \, A \tag{11}$$

If the changes in the capital stock are ignored (short term assumption) and technological levels controlled for, then estimating equation (10) would lead to $a = -\alpha \approx -0.35$. Besides, in an augmented Solow framework where the stock of human capital has a high inertia in the short-term, a could be estimated at even higher levels in absolute terms. This is of course related to the decreasing returns to labour in the short run and has no relation whatsoever with the composition of labour. However, in the long run as capital adjusts, labour returns to scale must be higher and not even necessarily decreasing.

29. In principle, the correct way to distinguish between short-term and long-term effects would be to estimate equation (10) as an error-correction specification, and Table 5 reports such estimates leading to the following inferences. The short-term effects are consistent with the effects reported in Table 4. Next, the estimated long-term effect of hours worked per worker, on top of that for total hours worked, is now *positive* but unstable and insignificant. As a result, including hours worked per worker might further bias the estimated long-term effect of labour utilisation, which is why it is excluded in the last three columns. Finally, the long-term effect of labour utilisation still appears high in absolute terms at around -0.50, although the precision is weaker.

Table 5. **The employment - productivity trade-off, error-correction model, 1970-2004**[1]

Dependent variable : Δ. (hourly labour productivity)	level	level	level	level	level	level
	(1)	(2)	(3)	(4)	(5)	(6)
Lag (Hourly productivity)	-0.034***	-0.063***	-0.150***	-0.047***	-0.075***	-0.147***
	(0.012)	*(0.013)*	*(0.029)*	*(0.012)*	*(0.011)*	*(0.025)*
Lag (Labour utilisation)[2]	-0.032*	-0.037*	-0.090***	-0.027	-0.028	-0.091***
	(0.018)	*(0.019)*	*(0.024)*	*(0.017)*	*(0.017)*	*(0.024)*
Lag (Average hours worked)[3]	0.069*	0.085**	-0.021			
	(0.038)	*(0.042)*	*(0.062)*			
Δ. Labour utilisation	-0.369***	-0.246***	-0.346***	-0.370***	-0.231***	-0.349***
	(0.043)	*(0.045)*	*(0.045)*	*(0.043)*	*(0.043)*	*(0.045)*
Δ. Average hours worked	-0.324***	-0.338***	-0.396***	-0.363***	-0.396***	-0.384***
	(0.090)	*(0.091)*	*(0.091)*	*(0.085)*	*(0.083)*	*(0.084)*
Rho	0.169	0.102	0.110	0.196	0.111	0.109
Fixed effects						
Country	yes	yes	yes	yes	yes	yes
Year	yes	no	yes	yes	no	yes
Specific trend	no	yes	yes	no	yes	yes
Long-term effects						
Labour utilisation	-0.95**	-0.59*	-0.60***	-0.57**	-0.37	-0.62***
	(0.44)	*(0.36)*	*(0.13)*	*(0.28)*	*(0.23)*	*(0.11)*
Average hours worked	2.04	1.35	-0.14			
	(1.48)	*(0.87)*	*(0.40)*			
R-square	0.51	0.43	0.59	0.50	0.43	0.59
Number of observations	637	637	637	637	637	637

Note : Standard errors are in brackets. *: significant at 10 % level; ** at 5 % level; *** at 1 % level.
1. Standard errors are robust to heteroscedasticity and contemporaneous correlation. Specification includes fist-order auto-correlation within panel and *Rho* is the corresponding estimated parameter.
2. Labour utilisation is defined as total hours worked divided by population aged 15-64 years (log).
3. Average hours worked is defined as total hours worked divided by employment (log).

30. Second, even properly distinguishing short- and long-term dynamics does not solve the problems generated by simultaneity. Because aggregate wages are closely related to productivity levels, estimating (10) is similar to regressing wages on employment, *i.e.* the reverse of a labour demand / supply equation, which poses very intricate endogeneity issues. In fact, because the specification is not derived from sound theoretical foundations, it is difficult to know what is actually tested. The parameter of interest might be largely influenced by the elasticity of labour demand to wages. If the objective is to estimate this elasticity, appropriate instruments must identify shifts in labour supply. However, some studies use GMM estimators based on lags of dependent and explanatory variables, but these are invalid instruments in that respect, as noted by McGuckin and van Ark (2005).

31. Third, there might be a mismatch between the chosen approach as represented by (10) and the objective of assessing the employment-productivity trade-off. The implicit idea behind the trade-off lies in the extent to which an increase in employment *for a given country at one point in time* is associated with a decrease in average productivity *via* a deterioration in the aggregate quality of labour. However, observed changes in employment levels might be unrelated to changes in labour quality. The implicit assumption behind (10) that labour quality both across countries and through time could be proxied by labour utilisation rate in panel analysis is, therefore, highly questionable. *Over time*, it could even be argued that skill deepening is likely to have generated an increase in both labour productivity and utilisation, since labour utilisation typically increases with the education level.

4. Direct computation of the composition effect on productivity

32. This section provides a direct computation of the labour composition effect on productivity levels. The theoretical framework developed in section 2 is general enough that it can easily be extended to encompass several targeted groups of workers. However, elasticities there are valid for incremental changes only. In order to calculate exact changes between two states of an economy, some structure has to be imposed on the production function.

33. The chosen method borrows from the framework developed by Jorgenson *et al*. (1987) to assess the contribution of labour quality to labour productivity growth. It is regularly being applied, as for example by the US Bureau of Labor Statistics (BLS, 1993) and in central banks or academic research programmes (*e.g.* Bell *et al*., 2005 and Schwerdt and Turunen, 2007). Although this framework has been designed to analyse actual changes through time, the analysis here, as explained below, consists of extending it to simulated states of an economy.

34. The objective is then to calculate the changes in labour productivity induced by changes in the composition of labour, from the current situation of an economy to a simulated scenario, *e.g.* one in which the employment rates reach the level of a reference country *for each labour group*. The production function $Y = F(K, AN)$ is supposed to have constant returns to scale and the labour aggregate N is a translog function of labour inputs determined by the hours worked H_i, $i = 1,...,n$, of n groups of workers.[7] Assuming that wages are given when choosing employment, output growth between two states of an economy, t and $t+1$, and hourly labour productivity (LP) growth are given by, respectively:

$$\Delta Log\ Y = (1-s)\ \Delta Log\ K + s\ \Delta Log\ N + s\ \Delta Log\ A \tag{12}$$

7. The transcendental logarithmic (translog) function was introduced by Christensen *et al*. (1971). Whereas the Cobb-Douglas function is a log-linear function of the various inputs, the translog function is log-quadratic.

$$\Delta Log\ LP \equiv \Delta Log\ \frac{Y}{H} = \Delta Log\ A + (1-s)\ \Delta Log\ \frac{K}{A\,N} + \Delta\ Log\ \frac{N}{H} \tag{13}$$

where $H = \sum H_i$ is total hours worked. As before, labour quality, Q, is implicitly defined by $N \equiv Q\,H$ and, in the long-term, as capital adjusts to aggregate effective labour, $A\,N$, productivity growth is the sum of labour-augmenting technological progress and labour quality growth:

$$\Delta\ Log\ LP = \Delta\ Log\ A + \Delta\ Log\ Q \tag{14}$$

With a translog functional form, changes in aggregate labour are measured exactly by changes in Tornqvist indexes of labour inputs (Diewert, 1976):

$$\Delta Log\ N = \sum_i \frac{a_i(t) + a_i(t+1)}{2}\ \Delta Log\ H_i \tag{15}$$

where a_i is the share of group i in total wages. Consequently, changes in labour quality become:

$$\Delta Log\ Q = \Delta Log\ N - \Delta Log\ H = \sum_i \frac{a_i(t) + a_i(t+1)}{2}\ \Delta Log\ \frac{H_i}{H} \tag{16a}$$

35. This means that the change in labour quality is equal to the sum of the changes in input shares, H_i / H, weighted by the average of i's share in total wages over the two states of the economy. Based on equation (16a), as $a_i(t)$ is observed, the only unknown is $a_i(t+1)$, *i.e.* how changes in labour composition affect the group shares. Equation (16a) can be re-written as follows:

$$\Delta Log\ Q = \sum_i a_i(t)\ \Delta Log\ \frac{H_i}{H} + \sum_i \frac{\Delta a_i(t)}{2}\ \Delta Log\ H_i \tag{16b}$$

A helpful approximation provides a more intuitive interpretation of equations (16a-b), with s_i^H denoting the share of group i in total hours worked:

$$\begin{aligned}\Delta Log\ Q &\approx \sum_i \left(a_i(t) - s_i^H(t)\right)\frac{\Delta H_i}{H_i} + \sum_i \frac{\Delta a_i(t)}{2}\ \frac{\Delta H_i}{H_i} \\ &\approx \sum_i \frac{w_i(t) - \overline{w}(t)}{\overline{w}(t)}\ \frac{\Delta H_i}{H} + \sum_i \frac{\Delta a_i(t)}{2}\ \frac{\Delta H_i}{H_i}\end{aligned} \tag{17}$$

The first term on the right-hand side makes it clear that an increase in group i labour utilisation has a negative (positive) effect on labour quality, and therefore aggregate productivity, if group i wage is lower (greater) than the average wage, *i.e.* if group i has below (above) average marginal productivity. This elasticity is entirely consistent with that found in Section 2 (equation 9). However, there is here an extra term, the second one in (17), which indicates that an increase in hours worked by group i further weakens productivity if it is associated with a decrease in the wage share of that group, and vice-versa.[8]

8. This second effect is due to the concavity of the aggregate labour input with respect to each group input. It is second order for incremental changes as it comes from the product of changes in hours and in shares, which is why it is absent in the theoretical section. However, in the cases studied

36. Three cases will be explored. The straightforward one assumes that aggregate labour is a Cobb-Douglas function of all labour inputs, in which case $a_i(t+1) = a_i(t)$ and:

$$\Delta Log\, Q = \sum_i a_i(t)\, \Delta Log\, \frac{H_i}{H} \quad \left(\approx \sum_i \frac{w_i(t) - \overline{w}(t)}{\overline{w}(t)}\, \frac{\Delta H_i}{H} \right) \tag{18a}$$

The second case assumes that the elasticity of substitution between any two labour inputs when moving from t to $t+1$ is equal to $\sigma(t)$.[9] Annex 2 shows that in this case:

$$\Delta Log\, Q = \sum_i a_i(t)\, \Delta Log\, \frac{H_i}{H} + \frac{\sigma(t)-1}{2\,\sigma(t)} \sum_i a_i(t) \Delta LogH_i \left(\Delta LogH_i - \sum_j a_j(t) \Delta LogH_j \right) \tag{18b}$$

If the elasticity of substitution is greater than 1, a relative increase in group i labour utilisation is associated with an increase in the wage share of that group. This entails that the second term in equations (16b, 17, 18b) contributes positively to productivity growth. This is the opposite if σ is lower than 1.

37. The third case sticks to the Cobb-Douglas case, but considers that labour is not homogenous even *within* each of group. Specifically, it is assumed that, within each group, the population that is unemployed in state t or falls into unemployment at $t+1$ is less productive than the group average, and $\lambda < 1$ denotes the relative productivity within each group between those out of work and those in work. In that case, by extending (18a), the change in productivity levels is simply given by:

$$\Delta Log\, Q = \sum_i \lambda\, a_i(t)\, \Delta Log\, H_i - \Delta Log\, H \quad \left(\approx \sum_i \frac{\lambda\, w_i(t) - \overline{w}(t)}{\overline{w}(t)}\, \frac{\Delta H_i}{H} \right) \tag{18c}$$

5. Empirical analysis

38. The working-age population is broken down into 30 groups: 5 age classes, 3 educational levels and genders. The consistent comparable data of educational attainment are defined according to International Standard Classification of Education (ISCED).[10] All three cases detailed above, *i.e.* Cobb-Douglas, non-unitary elasticity between groups and heterogeneity within groups, have been studied pointing to the sensitivity of the results to key synthetic parameters. Annex 1 gives the detail about the four wage measures that have been used to test the robustness of the results. As shown above in Table 2, there are important differences in both the age profile and education premium across wage measures.

39. A comment is warranted about the exact meaning of using relative wages as a proxy for relative productivity levels. The assumption of the model is that wages are pre-determined to employment decisions. It follows that the model can be consistent with the fact that relative wages do not reflect relative intrinsic abilities. Indeed, if the wage structure is "internalised" by employers, relative wages would equate *marginal* relative productivity, even though both differ from relative abilities. Nevertheless, as gender discrimination

below, the changes are not necessarily incremental; the advantages of the translog specification lie in providing an exact calculation (eq. 16a-b).

9. This does not mean that the production function is CES, *i.e.* that $\sigma(t) = \sigma \quad \forall\, t$, which could be inconsistent with the translog assumption.

10. The chosen approach of a direct computation of the composition effect on productivity relies heavily on the comparability of education levels across countries using International Standard Classification of Education (ISCED).

might raise the most serious concern regarding the approach, results have also been replicated ignoring gender differences, which led to very similar results. At the end of the day, what matters is that the wage structure broadly reflects the productivity differences across both educational attainments and age, and that results are robust across various wage measures.

40. This section is organised as follows. The first sub-section is descriptive and highlights the differences in population structure across countries. The second one reports the results of an initial experiment, studying the employment and productivity impacts of non-US countries matching the US employment rate within each group, a generally-considered good achievement in terms of employment performance. Sub-section 5.3 tentatively computes "composition-adjusted" productivity levels taking into account both employment-rate and population structures. Finally, the last sub-section focuses on Spain and Italy, where recent strong employment performance is often believed to have been detrimental in terms of productivity.

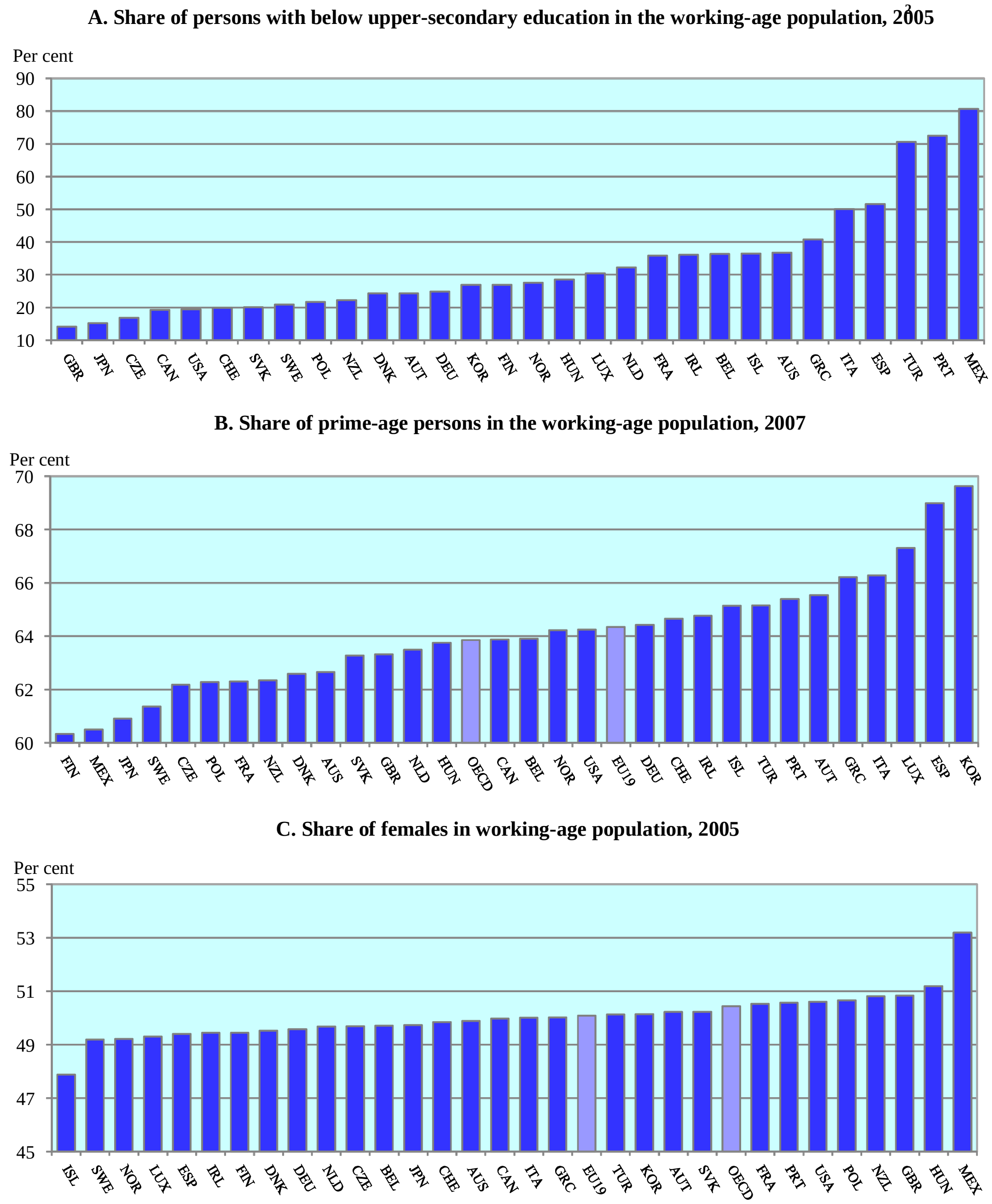
5.1. Descriptive analysis

41. The working-age population structure differs markedly across countries (Figure 2). The most significant variations are along the education dimension. Not only Mexico and the southern European countries, but also Iceland, Ireland, Belgium, Australia and France have a relatively large share of population not having an upper-secondary level attainment, whereas Japan, Sweden, Switzerland, the other English-speaking countries and central European countries except Hungary have a relatively low share of their population with such low attainment.[11] Differences are also important along the age structure, the prime-age population (25-to-54) representing 60 to 70% of the working-age population depending on the country; the share is comparatively low in Finland, Mexico, Japan and Sweden and relatively high in Korea, Spain and Luxembourg. Finally, they are minimal across gender, the working-age population being almost equally split in almost all countries.[12]

11. This share might be significantly under-estimated for Poland and the United Kingdom, as it excludes the 'ISCED 3C Short' programme that is at the limit of the lower/upper-secondary level. 'ISCED 3C Short' represents 34% of the working-age population in Poland, 19% for the United Kingdom in 2005; Iceland comes third with only 7%.

12. Only Iceland and Mexico present an unusual gender distribution for the *working-age* population. This is due to working-age male migration, inward and outward respectively.

Figure 2. **Differences in population structure across OECD countries**[1]



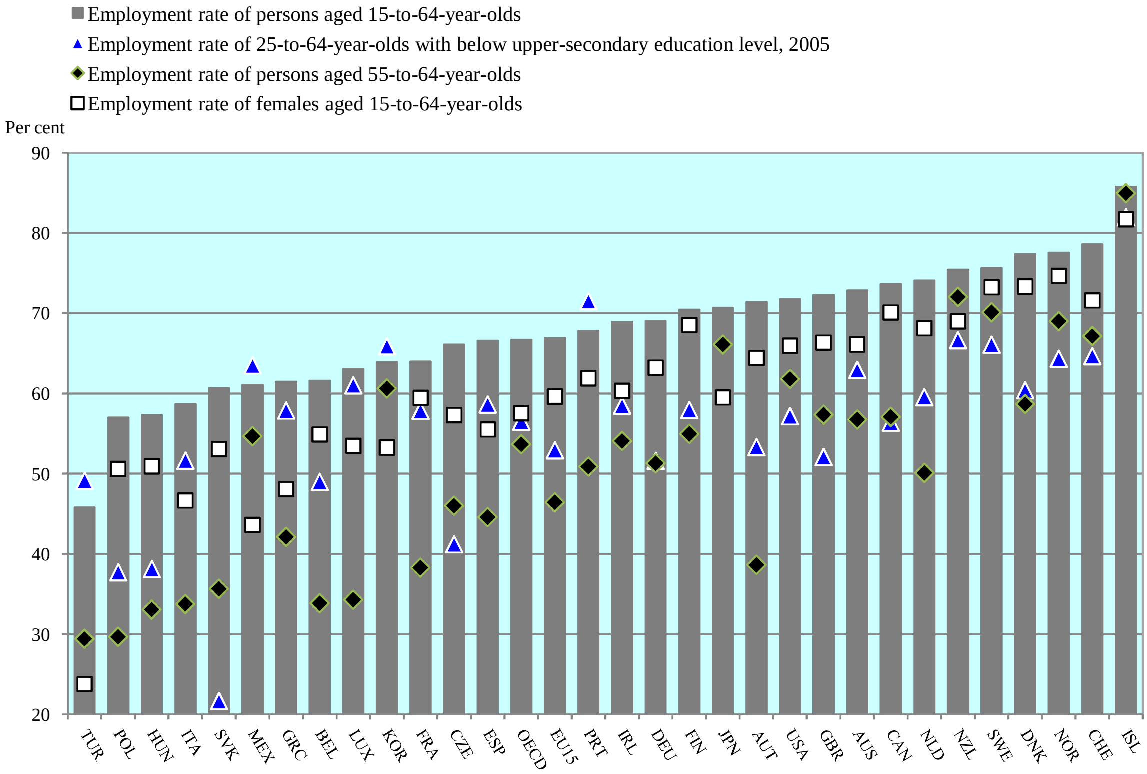
1. The working-age population refers to the population aged 15 to 64, the prime-age population refers to the population aged 25 to 54.

2. See footnote 10 in the main text.

42. Employment rates for the lower-educated, the older workers and female workers are significantly below the aggregate one in all OECD countries (Figure 3; this is true also for the young, not represented in the

figure). Even countries that have a good overall employment record, like Canada, Switzerland, the United Kingdom and the United States, have a low employment rate for the low-educated group.[13] They have, however, a small share of individuals with below upper-secondary education, as shown above. Figure 4 based on upper-secondary education shows that these differences are much less pronounced for the population aged between 25-34 than for the population older than 45. Over time, changes in structure induced by skill upgrading, especially in countries that lag behind in terms of educational achievements, are likely to increase labour utilisation mechanically.

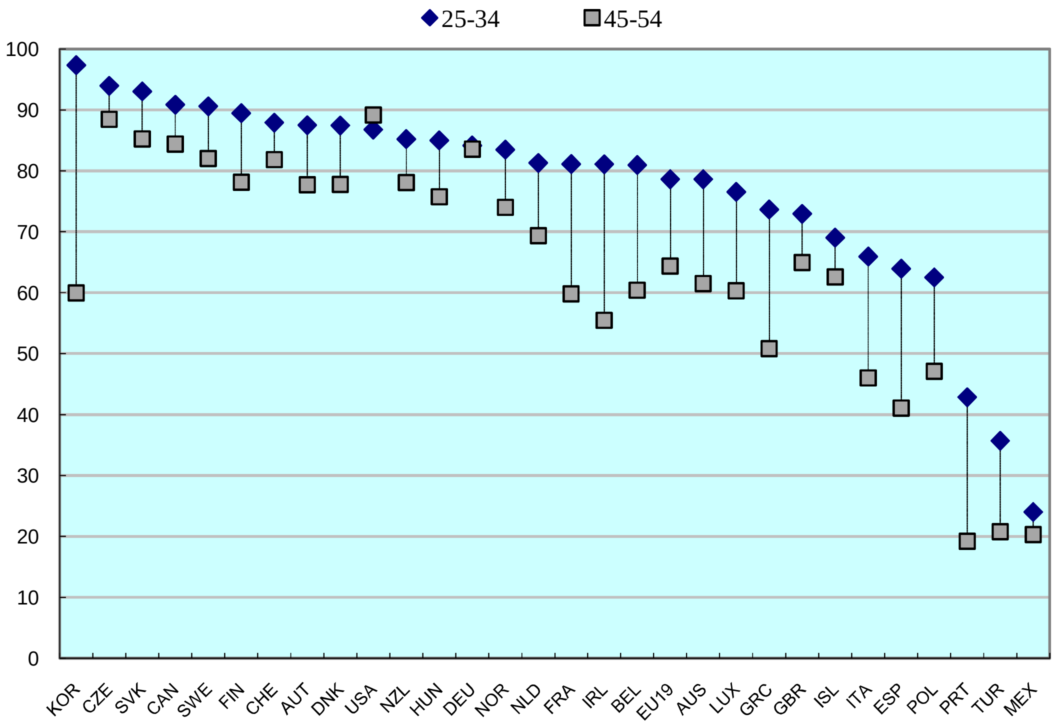
Figure 3. **Group-specific employment rates *vs* aggregate employment rate, 2007**



13. Looking at a more disaggregated level is required to get a more relevant picture. For example, even though France and the United States have comparable employment rate for the population below upper-secondary education, the employment rates by age within this broad group are very different between the two countries. For the youngest (15-24), which are also the least productive, among those below upper-secondary, the employment rate was 12 and 16 percentage points higher for males and females, respectively, in the United States in 2004.

Figure 4. **Educational attainment, upper-secondary education in 2005**

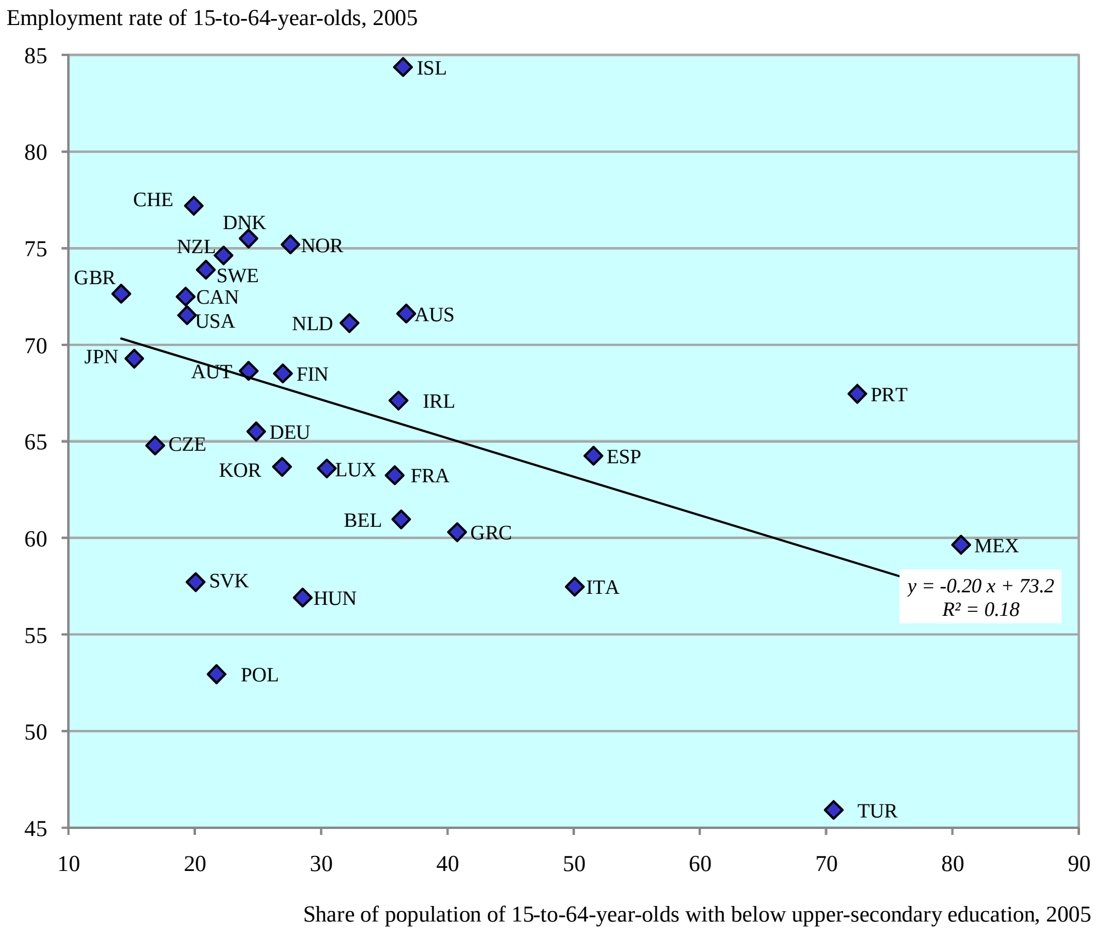
Percentage of population aged 25-34 and 45-54



Source : OECD, *Education at a glance*, 2007.

43. The link between population structure and total employment rate appears clearly in the educational dimension. The share of the working age population not having an upper-secondary education level is significantly and negatively correlated with total employment rate across countries (Figure 5). Based on this relation, a decrease of 10 points in the population share with below upper-secondary education would be associated with an increase in the total employment rate of 2 percentage points. This suggests that education affects GDP-per-capita beyond its effect on aggregate labour productivity.

Figure 5. **The share of population with below upper-secondary education is negatively correlated with the total employment rate**



1. The coefficient is -0.20 with a standard error of 0.08 (P-value 0.02). When the countries recording a GDP per capita lower than half of the US level (Hungary, Mexico, Poland, the Slovak Republic and Turkey) are excluded, the coefficient is -0.17 (s.e. 0.09, P-value 0.07). When Portugal and Iceland are further excluded, the coefficient is -0.34 (s.e. 0.09, P-value < 0.01).

5.2. Adjusted employment and impact on productivity

44. This sub-section analyses the consequences, in terms of labour utilisation and productivity, of matching *within each group* the employment performance of a reference country chosen to be the United States. The outcome in terms of employment can be very different from what could be expected by focussing only on aggregate labour utilisation. This is so because both population structures, including education, and employment rates differ importantly across countries and groups, respectively. The employment level obtained in this analysis is called “adjusted employment”.

5.2.1. Adjusted employment

45. Denoting $ER_{i,k}$ and $s_{i,k}^{pop}$ the employment rate and population share of group i in country k, respectively, the overall adjusted employment rate in country k is given by:

$$ER_k^{adj} = \sum_i s_{i,k}^{pop} ER_{i,USA} \tag{19}$$

The employment rate gap between the United States and country *k* can be broken down into "between-group" and "within-group" differences, as follows:

$$\begin{aligned} ER\ gap_k &\equiv ER_{USA} - ER_k \\ &= Between + Within \end{aligned} \tag{20}$$

The "between-group" component is the difference between the adjusted employment rate and the total US employment rate. If all 30 groups included in the analysis had the same employment rate, population structure would not matter and the "between-group" component would be nil. That is, the structural effect reflects differences in employment rates across groups as much as differences in population structure across countries:

$$Between = ER_{USA} - ER_k^{adj} = \sum_i \left(s_{i,USA}^{pop} - s_{i,k}^{pop}\right) ER_{i,USA} = \sum_i \left(s_{i,USA}^{pop} - s_{i,k}^{pop}\right)\left(ER_{i,USA} - ER_{USA}\right) \tag{21}$$

The "within-group" component is the difference between the adjusted employment rate and the actual employment rate, *i.e.* the change in total employment rate when matching the employment performance of the reference country. It depends on a country's population structure:

$$Within = \Delta ER \equiv ER_k^{adj} - ER_k = \sum_i s_{i,k}^{pop}\left(ER_{i,USA} - ER_{i,k}\right) \tag{22a}$$

$$\frac{\Delta L_k}{L_k} \equiv \frac{ER_k^{adj} - ER_k}{ER_k} = \frac{\sum_i s_{i,k}^{pop}\left(ER_{i,USA} - ER_{i,k}\right)}{\sum_i s_{i,k}^{pop} ER_{i,k}} \tag{22b}$$

46. The relative differences in average working-time between groups should also be taken into account, as groups having a relatively low employment rate tend to have a relatively low average working/time as well. In that case, denoting $h_{i,k}$ the average hours worked by group i in country k relative to the overall average hours worked in that country, the equivalent of eq. (22) in terms of total hours is:[14]

$$Within = \Delta Utilisation = \sum_i s_{i,k}^{pop}\left(h_{i,USA} ER_{i,USA} - h_{i,k} ER_{i,k}\right) \tag{23a}$$

$$\frac{\Delta H_k}{H_k} = \frac{\sum_i s_{i,k}^{pop}\left(h_{i,USA} ER_{i,USA} - h_{i,k} ER_{i,k}\right)}{\sum_i s_{i,k}^{pop} h_{i,k} ER_{i,k}} \tag{23b}$$

14. The use of relative average working hours rather than absolute is justified because the interest is not in comparing total average working hours between countries.

47. Computing these total implied changes in labour utilisation leads to the results reported in Table 6 for 2004.[15] Fourteen countries (from Italy to Japan in the table) would have to increase total employment by more than 4% to reach the US aggregate level. However, for eight of them (Austria, Ireland, Spain, Finland, Italy, France, Greece and Portugal), the structure of the 15-64 population with respect to education, age and gender, is such that less than one half of the total employment rate gap *vis-à-vis* the United States can actually be filled by reaching the US employment rates in each group, while for the Czech Republic and Belgium, this ratio is less than two-thirds. Only Germany, Korea, Luxembourg and Japan could close at least three-quarters of the gap. The implication is that, given their population structures, most countries would have to perform better in terms of group-specific employment rates than the United States to reach a similar aggregate employment rate.[16]

15. The trade-off analysis below might be distorted if countries have too different standards of living. For that reason, the OECD countries recording a GDP per capita lower than half of the US level in 2004 (Hungary, Mexico, Poland, the Slovak Republic and Turkey) were not included in the analysis.

16. The conclusions are similar when taking into account differences in average working hours across groups (equation 23b instead of 22b), although the implied changes in labour utilisation are a bit lower, as expected. Moreover, in order to expand data coverage, in the last column, relative average hours worked for each country, $h_{i,k}$, is assumed to be equal to that for the United States, $h_{i,USA}$ with minimal changes.

Table 6. **Change in labour utilisation obtained when matching US employment rates within each group, 2004**

(in percentage points)

Country	Aggregate employment rate	Employment rate gap vs USA	"within-group" difference[1]		
			Employment	Hours worked[2]	Hours worked[3]
Italy	57.4	13.8	6.0	5.8	5.2
Greece	59.6	11.6	6.2	6.0	5.1
Belgium	60.4	10.8	7.1	7.0	6.1
Spain	62.0	9.2	2.8	2.7	2.3
France	62.4	8.9	4.2	3.7	3.3
Luxembourg	62.5	8.8	8.0	8.4	6.9
Korea	63.6	7.6	6.2	.	5.2
Czech Republic	64.2	7.0	4.6	.	3.5
Germany	65.0	6.2	4.7	5.1	4.7
Ireland	65.5	5.7	1.6	0.9	1.3
Finland	67.2	4.0	1.7	1.8	1.6
Austria	67.8	3.5	0.9	0.9	0.9
Portugal	67.8	3.4	-8.8	-9.6	-8.9
Japan[4]	68.4	2.9	5.2	.	4.1
Australia	70.3	0.9	-3.3	.	-2.8
United States	71.2	0.0	0.0	0.0	0.0
Netherlands	71.2	0.0	-3.1	-2.8	-2.3
Canada	72.5	-1.3	-0.2	.	0.1
United Kingdom	72.7	-1.4	0.4	0.4	0.4
Sweden	73.5	-2.2	-2.1	-1.9	-2.2
New Zealand	73.5	-2.3	-3.4	.	-2.9
Norway	75.6	-4.4	-2.2	.	-2.2
Denmark	76.0	-4.8	-6.3	.	-5.4
Switzerland	77.4	-6.2	-7.5	.	-7.4
Iceland	82.9	-11.7	-16.3	.	-15.1

1. The "within-group" difference is computed according to equation (22a) for the column labelled "Employment" and to equation (23a) for the column labelled "Hours worked", which takes into account differences in average working time across groups.
2. Based on each country relative average working time by group $h_{i,k}$.
3. Based on US relative average working time by group $h_{i,USA}$.
4. Refers to 2003.

5.2.2. Impact on productivity and the employment-productivity trade-off

48. The main factors found to be driving the impact on average productivity are the population and the employment-rate structures. In contrast, the estimated impact varies only modestly across the various considered relative wage measures, and the sensitivity across measures is discussed below. Given this low sensitivity, the choice of the baseline relative wage measure has therefore been guided by the maximum available data coverage. This means that, when data are not available for a given country, the available employment levels for each group in that country are combined in the baseline with US relative hourly wages,

obtained by dividing total wages by hours worked in each group in 2003 (wage measure 1, see Annex 1), and with the US relative average hours worked, $h_{i,USA}$.

49. Table 7 presents the impact on aggregated labour input, productivity and GDP in 2004 derived from this baseline measure, ordering countries by the level of employment rates. For Italy as an example, productivity level, and therefore an increase of 6.1% in GDP. As shown more precisely below, the trade-off is mostly apparent for the low employment-rate countries, from Italy to Austria in the table. For these countries, the average employment increase is equal to 6.9%, while the average productivity decrease is 2.7%.

Table 7. **Employment and productivity changes when matching US employment rates within each group, 2004**[1]

(in per cent)

Country	Aggregate observed employment rate	Hours worked changes[2]	Productivity changes	GDP changes
Italy	57.4	10.1	-3.5	6.2
Greece	59.6	10.0	-1.5	8.4
Belgium	60.4	11.6	-3.9	7.3
Spain	62.0	4.3	-1.6	2.6
France	62.4	5.9	-3.0	2.7
Luxembourg	62.5	13.4	-6.7	5.7
Korea	63.6	8.3	-4.5	3.4
Czech Republic	64.2	5.5	-4.5	0.7
Germany	65.0	7.9	-1.8	5.9
Ireland	65.5	1.4	-1.6	-0.3
Finland	67.2	2.7	-1.1	1.6
Austria	67.8	1.4	-0.8	0.5
Portugal	67.8	-14.2	2.9	-11.7
Japan[3]	68.4	6.0	-4.1	1.6
Australia	70.3	-4.0	1.8	-2.2
United States	71.2	0.0	0.0	0.0
Netherlands	71.2	-3.9	-2.1	-6.0
Canada	72.5	0.1	1.2	1.3
United Kingdom	72.7	0.5	-1.8	-1.2
Sweden	73.5	-2.6	-3.1	-5.6
New Zealamd	73.5	-4.0	1.7	-2.3
Norway	75.6	-2.9	-0.3	-3.2
Denmark	76.0	-7.1	2.0	-5.2
Switzerland	77.4	-9.5	-0.5	-10.0
Iceland	82.9	-18.2	2.4	-16.2

1. Changes in hours worked are computed according to equation (23b). Productivity changes follow from equation (18). When wage shares are not available, US 2003 relative wages are obtained by divided total wages by total hours worked.

2. This column is entirely consistent with the next-to-last column of Table 6 (last one when data is missing). Since the interest is in estimating the elasticity, employment changes are expressed in percentages. For Italy, as an example, 10.1% * 57.4 = 5.8 reported in Table 6.

3. Refers to 2003.

50. The overall employment-productivity trade-off can be estimated by regressing the computed changes in productivity levels on those in hours worked, using the panel made of the 25 countries over 1997-2004 (Table 8). The elasticity is around -0.25, very robust across the different wage measures and equal to -0.24 in the baseline with a standard error of 0.015. This means that, on average, if countries were to match US employment performance within each group, any gain in labour utilisation would be one-quarter offset by a decrease in average productivity due to induced changes in labour composition.

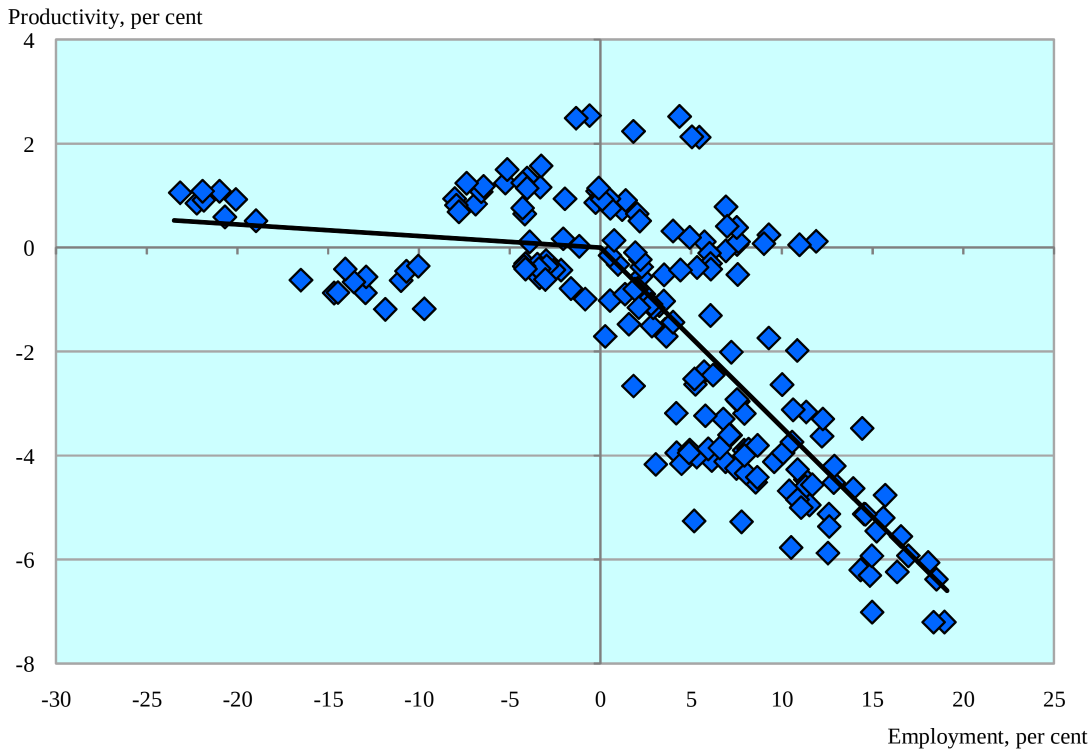
Table 8. **Elasticity of productivity with respect to employment changes for various relative wage measures**[1]

	Elasticity	Standard estimation	Number of observations
		$\sigma = 1 \quad \lambda = 1$	
Measure 1 (Country wages)[2]	-0.271	0.016	74
Measure 1 (Country wages)[2,3]	-0.265	0.016	119
Measure 2 (Mincer 1)[2,3]	-0.265	0.016	119
Measure 3 (Mincer 2)[2,3]	-0.251	0.017	119
Measure 3 (US Mincer 2)[2,3]	-0.254	0.019	119
Measure 4 (US wages, relative US hours)[4]	-0.238	0.014	197
Baseline[3,5]	**-0.243**	**0.015**	**197**
		$\lambda = 1$	
Baseline, $\sigma = 0.75$	-0.276	0.018	197
Baseline, $\sigma = 1.25$	-0.215	0.013	197
		$\sigma = 1$	
Baseline, $\lambda = 0.9$	-0.314	0.013	197
Baseline, $\lambda = 0.8$	-0.390	0.012	197

1. See Annex 1 for details.
2. The following countries are not taken into account in the analysis because data on hours worked per group are unavailable: Australia, Canada, Czech Republic, Denmark, Iceland, Japan, Korea, New Zealand, Norway and Switzerland.
3. For each country, relative wages are set, for all years, to the value of the most recent year for which the series are available.
4. US relative wages, obtained by dividing total wages by total hours worked in each group, and US relative average hours worked by group are used for all countries.
5. In the baseline, the relative wages measure is "country wages" (measure 1) using the last available year. For a given country, if the relative wages serie is not available, US relative wages 2003 is used.

51. This elasticity is about half of the elasticity obtained econometrically following the approach described in Section 3. Figure 6 plots the computed employment and productivity changes to give a visual representation of the trade-off. Some points on the left, due to Iceland, Switzerland and Portugal, seem to be outliers with sharp implied decrease in employment but little impact on productivity. Excluding these three countries raises the overall elasticity from -0.24 to -0.34.

Figure 6. **The employment - productivity trade-off, baseline 1997-2004** [1]



1. Each diamond represents a country x year pair.

52. The lower part of the table reports the sensitivities of the estimated elasticity to the elasticity of substitution between groups (eq. 18b) and the heterogeneity within groups (eq. 18c). Changing the elasticity of substitution has a moderate impact, whereas within group heterogeneity has an important effect. For example, if entrants are 10% less productive than employed workers ($\lambda = 0.9$) within each group, the estimated elasticity jumps from -0.24 to -0.31.

53. Another important result is related to the difference in the extent of the trade-off across countries. Although only seven or eight yearly point-estimates are available per country, trade-off elasticities can differ significantly across countries, as shown in Table 9. The average elasticity (mean group) is -0.23, close to the pooled estimate reported above (-0.24). Breaking down the countries between low- and high-employment level in 2004, the cut-off being the US level, reveals that the average elasticity is around -0.35 for the low-

employment countries and around 0 for the high-employment ones. This suggests that differences in total employment rates across the high-employment countries are spread evenly over the various population groups.

Table 9. **Employment - productivity trade-off by country, baseline 2004**[1]

Country	Aggregate observed employment rate, per cent	Elasticity	Standard deviation
Italy	57.4	-0.27	0.01
Greece	59.6	-0.18	0.01
Belgium	60.4	-0.35	0.01
Spain	62.0	-0.38	0.01
France	62.4	-0.34	0.03
Luxembourg	62.5	-0.38	0.05
Korea	63.6	-0.52	0.04
Czech Republic	64.2	-0.75	0.08
Germany	65.0	-0.21	0.02
Ireland	65.5	-0.35	0.05
Finland	67.2	-0.24	0.02
Austria	67.8	-0.44	0.10
Portugal	67.8	-0.13	0.01
Japan[2]	68.4	-0.75	0.04
Australia	70.3	-0.36	0.21
United States	71.2	.	.
Netherlands	71.2	0.51	0.25
Canada	72.5	0.03	0.05
United Kingdom	72.7	-0.35	0.07
Sweden	73.5	0.20	0.44
New Zealamd	73.5	0.37	0.26
Norway	75.6	0.11	0.02
Denmark	76.0	-0.31	0.06
Switzerland	77.4	-0.01	0.05
Iceland	82.9	-0.11	0.01
Total average		-0.23	
Low-employment rate countries, average		-0.35	
High-employment rate countries, average		0.04	

1. The estimated elasticity and the standard deviation are obtained by regressing, for each country over the 1997-2004 period, the computed changes in productivity levels on those in hours worked.
2. Refers to 2003.

54. To summarise, the direct computation of labour composition effect reveals that the long-term productivity-employment elasticity is around -0.25 over all countries in the sample in this experiment. This elasticity could be significantly higher in absolute terms if, within each gender-age-education grouping, the

out-of-work individuals are much less productive than the employed ones. In contrast, the elasticity is not very sensitive to the degree of substitution between groups. Finally, the extent of the trade-off differs markedly between countries, with the elasticity being possibly as high (in absolute terms) as -0.35 for low-employment countries.

5.3. Composition-adjusted productivity

55. Although the previous sub-section highlights the possible consequences, in terms of aggregate labour utilisation and productivity, of matching US employment rates within each labour group, adjusting productivity for employment composition requires to account for the differences in population structure. This could be estimated by computing changes in productivity obtained if countries had hypothetically the same population structure as the United States, on top of the same employment-rate structure, *i.e.* the same employment structure.[17]

56. In many countries, the total productivity outcome of matching the US employment structure is the result of two offsetting effects. As shown in the previous sub-section, the current employment-rate structure is reflected in higher measured productivity in most low-employment countries through the exclusion of low-productivity workers. However, these countries tend also to have a much greater share of the population not reaching an upper-secondary education level compared with the United States, thus lowering labour quality *ceteris paribus*. Which effect dominates is therefore an empirical question. The total effect can be computed following the same methodology as before according to equation (16a) which becomes in this context:

$$\Delta Log\ LP = \Delta Log\ Q = \sum_i \frac{a_i(t) + a_i(t+1)}{2}\,\Delta Log\,\frac{H_i}{H} = \sum_i \frac{a_i(t) + a_{i,USA}(t)}{2}\,Log\,\frac{s^H_{i,USA}}{s^H_i} \qquad (24)$$

17. Because the considered population shifts are sometimes huge, the quadratic approximation of the production function implied by the translog assumption is on the edge of what the methodology can support in this specific experiment. This exercise is simply meant to provide orders of magnitude and highlight the main mechanisms at work.

57. Table 10 reports the net effect of changes in labour utilisation and population structure according to (24). For most countries, the change in population structure dominates that of employment-rate structure, which was analysed in the preceding sub-section. This is the case especially in southern European countries, France, Austria and Ireland.

Table 10. **Productivity impact of moving to US population structure and US employment rates within each group, 2004**[1]

(in percentage points)

Country	Aggregate observed employment rate	Effect on productivity changes of:		
		Population structure	Employment-rate structure	Total employment structure
Italy	57.4	16.6	-3.5	12.5
Greece	59.6	10.7	-1.5	9.1
Belgium	60.4	4.3	-3.9	0.3
Spain	62.0	7.4	-1.6	5.6
France	62.4	8.2	-3.0	4.9
Luxembourg	62.5	9.0	-6.7	1.6
Korea	63.6	7.1	-4.5	2.3
Czech Republic	64.2	15.2	-4.5	10.0
Germany	65.0	3.9	-1.8	2.0
Ireland	65.5	9.7	-1.6	7.9
Finland	67.2	0.7	-1.1	-0.4
Austria	67.8	11.3	-0.8	10.4
Portugal	67.8	7.5	2.9	10.6
Japan	68.4	0.0	-4.1	-4.1
Australia	70.3	6.2	1.8	8.1
United States	71.2	0.0	0.0	0.0
Netherlands	71.2	5.8	-2.1	3.5
Canada	72.5	-1.9	1.2	-0.7
United Kingdom	72.7	5.0	-1.8	3.1
Sweden	73.5	2.7	-3.1	-0.5
New Zealand	73.5	10.2	1.7	12.0
Norway	75.6	2.0	-0.3	1.8
Denmark	76.0	1.8	2.0	3.9
Switzerland	77.4	0.7	-0.5	0.2
Iceland	82.9	5.7	2.4	8.3

1. Changes in productivity levels when matching US employment structure are given by equation (24).

5.4. Italy and Spain

58. There have been some concerns that the poor performance of Italy and Spain in terms of labour productivity growth over the past decade or so has been due to the weakening in labour quality growth due to low productivity people being integrated into the workforce following labour market reforms. It should be noted upfront that the two countries have very different employment performance. Indeed, while total hours worked increased by 3.4% annually in Spain on average over 1997-2004, the average growth rate in Italy was only 1.0%.

59. These concerns seem to be unwarranted. In contrast to the above experiments, the assessment of actual labour quality changes for a given country is standard following the methodology developed by Jorgenson *et al*. (equation 16a). Table 11 reports the average annual growth rate in labour quality for 14 countries. Both Italy and Spain record a strong performance, posting an average annual growth of 0.6%. There remains a possibility that the improvement in labour quality would have been greater if labour market reforms had not taken place. However, comparison with estimates in other studies for Italy since 1985 (Jorgenson, 2004; Schwerdt and Turunen, 2007) suggests that these improvements are not below trends: annual labour quality growth is estimated to have picked up from 0.3% in the 1980s to 0.6% since the 1990s with a peak at 0.7% in the second-half of the 1990s.

Table 11. **Annual growth in labour quality, average 1997-2004**

(in per cent)

Austria	0.77
Greece	0.69
Ireland	0.68
Italy	**0.62**
Spain	**0.61**
United States	0.56
France	0.44
Belgium	0.38
Sweden	0.37
United Kingdom	0.33
Netherlands	0.32
Portugal	0.27
Finland	0.27
Germany	0.22

Note : Jorgerson et *al.* (1987)'s methodology (equation 16).

60. Table 12 shows that the main factor in these quality improvements in both countries is the decrease by around 10 percentage points in the share of hours worked by those with less than upper-secondary education in total hours worked over the period. At a greater level of detail, the main groups contributing to the increase in total hours worked are females above the age of 35 with at least upper-secondary education, males older than 45 with upper-secondary education and males with tertiary education for Spain; females with tertiary education, females with upper-secondary education and older than 45, and males with tertiary education for Italy.

Table 12. **Change in hours share, 1997-2004**

(in percentage points)

	Spain	**Italy**
Gender		
Men	-3.4	-1.7
Women	3.4	1.7
Level of education		
Primary and lower secondary	-10.1	-8.5
Upper-secondary	4.4	5.5
Tertiary	5.6	3.0
Age-group		
15-24	-2.4	-1.9
25-34	3.6	-2.1
35-44	1.1	2.2
45-54	-1.3	1.5
55-64	-1.0	0.3

61. This means that the channel of the long-term employment-productivity trade-off, namely the decrease in labour quality as employment expands, has not been operating in these two countries. The obvious implication of this improvement in labour quality is that poor productivity growth must be explained by the other components of labour productivity growth, namely technological progress and/or capital deepening (equation 13).

62. Using series of growth in capital services enables to breakdown labour productivity growth into its three components: labour augmenting technological progress, contribution of growth in capital to effective labour ratio and labour quality growth (Table 13). This decomposition reveals that capital accumulation has not lagged behind the rapid labour input growth. Indeed, the average annual increase of 0.4% in labour productivity over 1997-2004 is explained by an increase of 0.6% due to capital/labour ratio, an increase of 0.6% in labour quality and a decrease of 0.8% in labour augmenting technological levels, leaving basically unexplained the poor productivity performance recorded in Spain.

Table 13. **Spain : Breakdown of labour productivity growth**

Annual growth rates, per cent

	Output growth	Hours worked	Capital services	Capital to effective labour ratio[1]	Labour productivity	of which		
						Capital to labour ratio contribution[2]	Labour quality	Labour augmenting technology
1998	4.4	4.6	6.0	2.1	-0.2	0.5	0.5	-1.2
1999	4.6	4.5	6.7	2.7	0.1	0.6	0.0	-0.5
2000	4.9	4.9	6.7	2.2	0.1	0.5	1.0	-1.4
2001	3.6	2.9	6.3	3.5	0.7	0.8	0.5	-0.6
2002	2.7	2.0	5.5	3.6	0.6	0.8	0.7	-0.9
2003	3.0	2.2	5.2	2.8	0.9	0.6	0.5	-0.3
2004	3.2	2.5	5.1	2.5	0.7	0.6	1.0	-0.9
Average	3.8	3.4	5.9	2.8	0.4	0.6	0.6	-0.8

1. Effective labour input growth is the sum of hours worked growth, labour quality growth and labour augmenting technological progress.

2. Capital-to-labour-ratio contribution is the product of the growth of capital-to-effective-labour-ratio and of the capital share in output.

Source : OECD, Productivity database.

6. Conclusion

63. The negative impact of employment growth on labour productivity growth appears if increases in employment are associated with decreases in either labour quality or the capital-labour ratio.[18] Therefore, although specific policies aiming at integrating low-productivity workers would generate this trade-off, many past employment growth episodes, especially those related to education achievements, have not been associated with a deterioration of labour quality. If low-employment OECD countries were to match US employment performance in the sense of achieving US employment rates within each age/gender/education population group, about half of the aggregate employment rate gap *vis-à-vis* the United States would be filled. In other words, about half of the employment rate gap is mechanically due to the demographic and education structure of the working-age population.[19] For these low-employment countries, a 1% employment gain would be offset by a decrease of 0.35% in labour productivity, while this experiment leads to a -0.24 elasticity on average across all countries. Such a trade-off implies that labour market reforms that increase labour utilisation of low-productivity workers would increase GDP per capita, but less than proportionally. In the above

18. At least, when the effects of employment growth on technological progress, which are unclear *a priori*, are ignored.

19. The effect of population structure on both labour productivity and utilisation is the subject of Boulhol (2009).

experiment, about two thirds of the employment gains would *ceteris paribus* be reflected in GDP increases in low-employment countries.

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ANNEX 1: DATA SOURCES

Labour productivity and total hours worked: OECD Productivity Database

Employment and population by gender, age and education: Labour Force Surveys according to ISCED Classification

Hours worked by group: OECD Secretariat's estimates based on European Labour Force Surveys (see Table F of the Statistical Annex in the Employment Outlook) and Census Population Survey for the United States

RELATIVE WAGE MEASURES

Measure 1: "country wages": total wages / total hours worked.

Source: European Community Household Panel for Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom up to 2001, and Census Population Survey up to 2003 for the United States.

Measure 2: "Mincer 1"

It is derived from estimations of Mincer equations controlling for the effects of education, age and gender. Source: Strauss and de la Maisonneuve (2007), Table 3.

Measure 3: "Mincer 2"

Because the prime objective of Strauss and de la Maisonneuve (2007) was to estimate the wage premium due to education, controls might be inadequate to infer the effect of age. Therefore, the age coefficients were constrained to be equal, for each country, to their estimated average across countries. This gives a coefficient of 0.335 on age and -0.0487 on age-squared.

Measure 4: "US wages"

It applies the measure 1 calculated for the United States to all countries.

ANNEX 2: NON-UNITARY ELASTICITY OF SUBSTITUTION BETWEEN GROUPS

It is supposed in this Annex that the elasticity of substitution between any two labour inputs at time t is equal to $\sigma(t)$. Omitting t to simplify notations, this means:

$$\frac{w_i}{w_j} = \frac{b_i}{b_j}\left(\frac{H_i}{H_j}\right)^{-1/\sigma} \qquad \forall\, i,\, j \tag{A2.1}$$

the b's being constants. Average wage $\overline{w}$ can therefore be written as:

$$\overline{w} = \sum_i w_i \frac{H_i}{H} = \frac{w_j}{b_j}\frac{H_j^{\;1/\sigma}}{H}\sum_i b_i H_i^{\;(\sigma-1)/\sigma} \tag{A2.2}$$

which implies the expression of the relative wage and the wage share of group i:

$$\frac{w_i}{\overline{w}} = \frac{b_i\left(H_i / H\right)^{-1/\sigma}}{\sum_i b_i\left(H_i / H\right)^{(\sigma-1)/\sigma}} \tag{A2.3}$$

$$a_i \equiv \frac{w_i H_i}{\overline{w}H} = \frac{b_i\left(H_i / H\right)^{(\sigma-1)/\sigma}}{\sum_i b_i\left(H_i / H\right)^{(\sigma-1)/\sigma}} \tag{A2.4}$$

It follows that:

$$\Delta Log\; a_i = \frac{\sigma-1}{\sigma}\Delta Log\frac{H_i}{H} + Z \quad \text{where } Z = -\Delta Log\left(\sum_i b_i\left(H_i / H\right)^{(\sigma-1)/\sigma}\right) \tag{A2.5}$$

$$\Rightarrow \qquad \Delta a_i \approx a_i\left(\frac{\sigma-1}{\sigma}\Delta Log\frac{H_i}{H} + Z\right) \tag{A2.6}$$

As $\sum_i \Delta a_i = 0$, summing over i leads to the expression of $Z = -\frac{\sigma-1}{\sigma}\sum_i a_i \Delta Log\frac{H_i}{H}$ and:

$$\Delta a_i \approx \frac{\sigma-1}{\sigma}a_i\left(\Delta Log\frac{H_i}{H} - \sum_j a_j \Delta Log\frac{H_j}{H}\right) = \frac{\sigma-1}{\sigma}a_i\left(\Delta Log\, H_i - \sum_j a_j \Delta Log\, H_j\right) \tag{A2.7}$$

Using this expression of the change in the wage share in equation (17b) leads to the general expression (18b).

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