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Education, market rigidities and growth☆

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ABSTRACT

The paper exploits macro-panel data for OECD countries. Close to the technological frontier, the education level, product market rigidities and employment protection legislation would be significantly related to TFP growth, with a substantial contribution of the interaction between market rigidities.

1. Introduction

This paper contributes to the recent literature on growth determinants that emphasises the importance of the countries' positions relative to the technological frontier (see Aghion and Howitt, 2006). Education policies or regulations on product and labour markets would not have the same effects on growth, whether they are close to or far from that frontier. The hypothesis of *complementarity* between product and labour market regulations, in terms of their effect on growth, is also investigated.

2. Growth and the complementarity of reforms

A first strand of the related literature shows a positive effect on growth of competition and entry into the product market, particularly within highly innovating sectors (see Aghion and Griffith, 2005, for a survey). A second set of papers focuses on the relationship between job protection and growth (see Saint-Paul, 1997, 2002). However, to our knowledge, previous empirical research has not yet confirmed any direct impact of job protection or of R&D investment on growth (Bassanini and Ernst, 2007).

The model we estimate in this paper, on macro annual country panel data, aims at characterising the effect on total factor productivity (TFP) growth of the level of education in the workforce, rigidities in the product and labour markets and variations in the employment rate, in hours worked and in the capacity utilisation rate (CUR). TFP growth is measured by the variation in its log (Δtfp). Concerning the level of education in the workforce, the selected variable is the percentage of population aged 15 or over having some higher education (HIGH). This human capital stock variable can be used as a proxy for educational policies since it summarizes their history for a given country. Besides, this relatively stable variable can be of particular relevance when assessing the long-run consequences of educational policies as a driver of a country's potential growth. The synthetic indicators EPL (Employment Protection and Legislation) and PMR (Product Market Regulation), provided by the OECD, are used to

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characterise rigidities in the labour and product markets, respectively. The most satisfactory estimates are obtained while taking into account the interaction between these two rigidities (rather than considering them separately), and with a two-year lag on the PMR index.

To disentangle respective effects of education and rigidities, whether the country is close to or far from the technological frontier, specific variables are constructed for the two subsets of countries. For a given year, a country will be assumed close to the frontier when its structural productivity is higher than or equal to *x*% of the structural productivity in the United States (which display the highest structural productivity levels over the whole period). A country's structural productivity is defined as its productivity level assuming hours worked and the employment rate (whose returns are strongly decreasing) are the same as in the United States.[1] This concept and its computation methods are detailed in Bourlès and Cette (2006, 2007). The frontier threshold *x* is set at 80%, which implies that 40% of the sample is close to the technological frontier. A change in this threshold does not affect the estimates significantly: if it is set at 78% (50% of the sample close to frontier) the conclusions barely differ.

The presence of changes in the employment rate (ER) and hours worked (*H*) variation makes it possible to take into account the decreasing returns from these two variables. The capacity utilisation rate variable corrects for cyclical effects.

Many other explanatory variables were alternatively introduced, but their estimated coefficients were not significantly different from zero. Amongst these, we can list: (i) concerning education, the percentage of population aged 15 or over with some primary or secondary education; (ii) for the labour market, the activity rates; (iii) regarding the production and innovation sectors, the share of ICT production in GDP, the ICT investment rate, the proportion of ICT in total investment, the share of private investment in total investment, the global investment volume or value, the share of public investment and the percentage of R&D spending in GDP; (iv) as for the financial conditions, short (3 months) and long (10 years) interest rates, both nominal and real; (v) for fiscal policy, the primary public deficit, public debt and tax proceeds over GDP; (vi) for capital market regulation, stock market capitalisation to GDP, liquid liabilities to GDP, bank overhead costs as a share of total assets, bank net interest revenue as a share of interest-bearing assets and private credit granted by deposit money banks and other financial institutions over GDP.

The non-significance of ICT variables when education and rigidities are present in the model suggests that ICT investment and production, although influencing TFP growth, are strongly correlated with education and rigidities. The estimated relation can therefore be understood as a reduced-form model, in which the impact of education and rigidities on the labour and product markets are both direct and indirect, via ICT production and investment.

The estimated relation is as follows:

$$\Delta = a_1 \cdot HIGH + a_2 \cdot HIGH \cdot I_{x\%} + a_3 \cdot EPL \cdot PMR_{-2} + a_4 \cdot EPL \cdot PMR_{-2} \cdot I_{x\%} + a_5 \cdot \Delta ER + a_6 \cdot \Delta h + a_7 \cdot \Delta \mathrm{CUR} + \text{intercept} + u \quad (1)$$

where $I_{x\%}$ is a dummy variable characterising the technological frontier, that equals 1 if the country's structural productivity is higher than *x*% of US structural productivity, and 0 otherwise.

The expected signs are: $0<a_2$; $a_4<0$; $-1<a_5$; $a_6<0$; $0<a_7<1$. The signs of a_1 and a_3 are *a priori* uncertain, as higher education and rigidities on the labour and product markets may as well have positive or negative effects on TFP growth far from the technological frontier (see Aghion and Howitt, 2006). Empirical analysis was carried out on a panel of 17 OECD countries during the period 1985–2003.[2] The focus on this particular sub-sample was dictated by the limited availability (in terms of countries and years) of time series on selected variables.

The Ordinary Least Squares (OLS) estimates may be biased because of measurement errors or simultaneity issues, which can explain some counter-intuitive or unstable results. To remedy these biases, the instrumental variable method is implemented. The number of observations seems too small to apply the GMM.

Two tests are used to evaluate adjustment quality: the Sargan test (1958), which assesses the overall quality of the adjustment and relevance of the instruments, and the Davidson and MacKinnon test (1993) to check the *exogeneity* of the instruments. The list of instruments is detailed in Table 1, and the first-stage regressions estimates are available in Table 2.

3. Main results

The results (see Table 1) suggest that the estimated coefficient for higher education (HIGH) is systematically non-significant, while significantly different from zero (columns 6 through 8) with the expected positive sign when only countries close to the technological frontier are considered ($HIGH.I_{80\%}$). As regards the rigidities in product and labour markets, the most significant results are obtained when crossing rigidities in both markets, taking a two-year lag on the PMR index (columns 6 through 8), and separating the effects far from the technological frontier (coefficient of $EPL.PMR_{-2}$ variable) from those close to the frontier (sum of coefficients of $EPL.PMR_{-2}$ and $EPL.PMR_{-2}.I_{80\%}$ variables). Other specifications for rigidities variables give estimates non-significantly different from zero. In all estimations, the coefficient of the autoregressive term is small and non-significant (column 8). However, the coefficients related to the variations in the employment rate, in hours worked and in the CUR are always significant with the expected sign and relevant in terms of economic effects.

The most relevant specification seems to be the one in column 6. It turns out that: (i) a one-point increase in the percentage of population aged 15 or over with some higher education has no impact on TFP for countries far from frontier but increases TFP growth by about 0.1 point per year in countries close to technological frontier; (ii) a one-point decrease in the product of contemporaneous EPL with two-year lagged PMR reduces TFP growth by about 0.5 point per year for countries far from the frontier, but increases TFP growth by 0.2 point per year for countries close to frontier; (iii) a one-point increase in the employment rate reduces TFP by about 0.5; (iv) a one-percent increase in hours worked reduces TFP by about 0.7 point; (v) a one-point increase in the CUR (standardised over the whole sample) increases TFP by about 0.4 point.

These results are globally robust to the disaggregation of the various components of each indicator of rigidities. The detailed estimates are outlined in Aghion et al. (2007). Concerning the product market, there are four components: barriers to entry, market structure, public sector size and vertical integration. The labour market indicator is broken down into employment protection and legislation on regular and temporary contracts. As for product market rigidities, the only component having no positive impact on TFP growth for countries close to the frontier appears to be the public sector size. This finding is consistent with Nicoletti and Scarpetta (2003). The two labour market rigidities components appear to have a similar impact.

4. Conclusion

The results presented in this paper confirm that the education level and rigidities in labour and product markets have different effects whether the country is far from or close to the technological frontier. This recalls the results synthesised in Aghion and Howitt (2006). The presented estimates are consistent with previous studies that mainly

[1] This specification prevents from using a continuous distance to frontier index as it would imply numerous co-linearity issues about hours worked, the employment rate and productivity.

[2] The 17 countries selected were: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Portugal, Spain, Sweden, the United-Kingdom and the United States.

Table 1
Relation (1) estimated under the instrumental variables method with country fixed effects

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Δtfp_{-1}								−0.0352
								(0.1155)
HIGH (share of workforce with some higher education)	−0.0152	−0.0438	−0.0176	−0.0139	−0.0123	−0.0226		
	(0.0581)	(0.0594)	(0.0591)	(0.0549)	(0.0841)	(0.0599)		
$HIGH.I_{80\%}$		0.0727***	0.0919**	0.1134***	0.1507***	0.1368***	0.1341***	0.1345***
		(0.0255)	(0.0381)	(0.0297)	(0.0520)	(0.0370)	(0.0357)	(0.0376)
EPL (employment protection legislation)	0.0101*	0.0079	−0.0137		0.0183			
	(0.0053)	(0.0108)	(0.0348)		(0.0390)			
$EPL.I_{80\%}$		−0.0058						
		(0.0051)						
PMR (product market regulations)	−0.0004	0.0012	−0.0035 (0.0088)					
	(0.0017)	(0.0023)						
$PMR.I_{80\%}$		−0.0017						
		(0.0023)						
PMR_{-2}					0.0045			
					(0.0090)			
EPL.PMR			0.0051	0.0043***				
			(0.0039)	(0.0012)				
$EPL.PMR.I_{80\%}$			−0.0035	−0.0058***				
			(0.0031)	(0.0018)				
$EPL.PMR_{-2}$					0.0026	0.0048***	0.0050***	0.0050***
					(0.0051)	(0.0014)	(0.0014)	(0.0015)
$EPL.PMR_{-2}.I_{80\%}$					−0.0079**	−0.0068***	−0.0067***	−0.0066***
					(0.0031)	(0.0021)	(0.0020)	(0.0021)
ΔER (variation in the employment rate)	−0.3077**	−0.5451***	−0.4317**	−0.3229*	−0.5327**	−0.4907**	−0.4742**	−0.4559**
	(0.1487)	(0.1889)	(0.1853)	(0.1746)	(0.2679)	(0.2092)	(0.2013)	(0.2052)
Δh (variation in the log of hours worked)	−0.7676***	−0.5931***	−0.7006***	−0.6742***	−0.7310**	−0.6930**	−0.6883**	−0.6588**
	(0.1867)	(0.1887)	(0.2190)	(0.2512)	(0.3258)	(0.2810)	(0.2763)	(0.2746)
ΔCUR (variation in the capital utilisation rate)	0.3147***	0.3862***	0.3558***	0.3225***	0.4265***	0.4113***	0.4106***	0.4037***
	(0.0528)	(0.0567)	(0.0626)	(0.0692)	(0.0950)	(0.0801)	(0.0788)	(0.0791)
Intercept	−0.0036	0.0035***	0.0226	−0.0021	−0.0352	−0.0025	−0.0080	−0.0083
	(0.0197)	(0.0271)	(0.0677)	(0.0140)	(0.0672)	(0.0158)	(0.0061)	(0.0064)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$[HIGH]+[HIGH.I_{80\%}]$		0.0289	0.0743	0.0995*	0.1384	0.1142*		
$[EPL]+[EPL.I_{80\%}]$		0.0021						
$[PMR]+[PMR.I_{80\%}]$		−0.0005						
$[EPL.PMR]+[EPL.PMR.I_{80\%}]$			0.0016	0.0015				
$[EPL.PMR_{-2}]$ $+[EPL.PMR_{-2}.I_{80\%}]$					−0.0053	−0.0020*	−0.0017**	−0.0016**
Davidson and McKinnon test								
Statistic	3.1596	2.9117	3.7468	6.8375	5.4761	7.6918	9.5671	9.5367
p-value	0.0153	0.0069	0.0009	8.7e-06	1.3e-05	1.8e-06	6.2e-07	6.9e-07
Sargan test								
Statistic	8.021	8.954	3.407	4.918	2.044	2.892	3.119	2.367
p-value	0.2365	0.1109	0.4922	0.8414	0.9573	0.9684	0.9785	0.9927
Number of observations	216	189	188	180	178	178	178	174

Explained variable: Δtfp (variation in the log of total factor productivity).
The numbers in brackets beneath the coefficients are their standard deviation. Estimate coefficients are significant at the 1% level if ***, 5% if **, 10% if *.
Source: OECD datasets, except PRIM, SEC, HIGH from Cohen and Soto (2007).
The Davidson–Mc Kinnon test evaluates regressor exogeneity for a fixed-effect regression estimated via instrumental variables, which is similar to the (Durbin–Wu–)Hausman test in this context. If the associated *p*-value is equal or lower than 1%, we can consider the regressors as exogenous, with a 1% error risk. According to this criterion, all of the 8 specifications considered above would satisfy the exogeneity of regressors, with a 1% error risk.
The Sargan test evaluates overidentifying restrictions for a panel data fixed effects regression estimated via instrumental variables in which the number of instruments exceeds the number of regressors: that is, for an overidentified equation. If the associated *p*-value is equal or greater than 10%, we can consider that the instruments are valid and not correlated to the error term, with a 10% error risk. According to this criterion, all of the 8 specifications considered above would display valid instruments, with a 10% error risk.
List of instruments:

Column [1]: Δh; Δh_{-1}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; TY; EPL_{-2}; PMR_{-2}; SEC_{-2}; HERD;
Column [2]: Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; TY; $EPL_{-2}.I_{80\%}$; $PMR_{-2}.I_{80\%}$; SEC_{-1}; $HIGH_{-2}$; HERD; $DEBT.I_{80\%}$;
Column [3]: Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; TY; $(EPL.PMR)_{-2}$; SEC_{-1}; SUP_{-2}; HERD; $DEBT.I_{80\%}$;
Column [4]: Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; PINVal; TY; E1524; $(EPL.PMR_{-2})_{-2}$; $PRIM_{-2}$; SEC_{-1}; $HIGH_{-2}$; $DEBT.I_{80\%}$;
Column [5]: Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; PINVal; TY; E1524; $(EPL.PMR_{-2})_{-2}$; $PRIM_{-2}$; SEC_{-1}; $HIGH_{-2}$; HERD; $DEBT.I_{80\%}$;
Column [6]: Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; PINVal; TY; E1524; $(EPL.PMR_{-2})_{-2}$; $PRIM_{-2}$; SEC_{-1}; $HIGH_{-2}$; HERD; $DEBT.I_{80\%}$;
Column [7]: Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; PINVal; TY; E1524; $(EPL.PMR_{-2})_{-2}$; $PRIM_{-2}$; SEC_{-1}; $HIGH_{-2}$; HERD; $DEBT.I_{80\%}$;
Column [8]: Δtfp_{-1}; Δh; Δh_{-2}; ΔCUR; ΔER_{-1}; ΔER_{-2}; ITPR; TINVol; PINVal; TY; E1524; $(EPL.PMR_{-2})_{-2}$; $PRIM_{-2}$; SEC_{-1}; $HIGH_{-2}$; HERD; $DEBT.I_{80\%}$;

with, DEBT the public debt as a share of GDP; E1524 the share of population aged 15–24 in the employment; HERD the higher education expenditures on R&D as a share of GDP; ITPR the ICT production as a share of GDP; PINVal the value of private non-residential fixed capital formation as a share of GDP; PRIM the share of workforce with some primary education; SEC the share of workforce with some secondary education; TINVol the volume of total fixed investment as a share of GDP; TY the years of schooling of population 15–64 who is not studying.
Δ is the first-difference operator. Cap variables are direct levels and lower case variables are log values.
The first stage regressions estimates for the most relevant specification (column 6) are available in Table 2. First stage results for other columns are available upon request to the authors.

Table 2
Instruments used in Column 6 — Ordinary Least Squares first stage regressions

Explained variable is	[A] ΔER	[B] HIGH	[C] HIGH.I$_{80\%}$	[D] EPL.PMR$_{-2}$	[E] EPL.PMR$_{-2}$.$I_{80\%}$
Δh_{-2}	−0.1142	−0.0397	0.8961	−21.11	−66.4084*
	(0.1275)	(0.0780)	(0.8378)	(16.249)	(40.9772)
ER$_{-1}$	0.7167***	0.0527	1.1728***	−7.5763	33.9319
	(0.0686)	(0.0419)	(0.4507)	(9.1195)	(22.9978)
ΔER$_{-2}$	−0.29478***	−0.0112	−0.1587	7.5348	10.7130
	(0.0664)	(0.0406)	(0.4363)	(8.6687)	(21.8608)
ITPR	0.0621	−0.0423	0.0087	1.7839	48.1787***
	(0.0505)	(0.039)	(0.3316)	(6.4481)	(16.2609)
TY	−0.0004	−0.0022*	0.0246*	−0.2072	1.3521*
	(0.0023)	(0.0014)	(0.0149)	(0.3031)	(0.7644)
TINVol	−0.0211	0.02256	0.4176*	−7.7653*	−45.6006***
	(0.03844)	(0.02351)	(0.2526)	(4.9426)	(12.4644)
PINVal	0.0708*	−0.0611**	−0.6781**	10.4797*	19.0702
	(0.0463)	(0.0283)	(0.3045)	(5.9103)	(14.9047)
E1524	0.0014	−0.0032	0.1559	4.8449*	0.3547
	(0.0227)	(0.0139)	(0.1492)	(2.8942)	(7.2986)
PRIM$_{-2}$	−0.2205***	−0.1883***	1.8479***	5.5445	114.9728***
	(0.0716)	(0.0438)	(0.4708)	(9.1047)	(22.9606)
SEC$_{-1}$	−0.2252***	−0.1742***	1.7394***	5.3821	117.0566***
	(0.0714)	(0.04367)	(0.4692)	(9.0807)	(22.8998)
HIGH$_{-2}$	−0.2347***	0.8557***	2.0939***	8.0411	123.3501***
	(0.0777)	(0.0475)	(0.5108)	(9.8916)	(24.9449)
(EPL.PMR$_{-2}$)$_{-2}$	−0.0004*	−0.001	0.0015	0.9537***	0.9359***
	(0.0002)	(0.0001)	(0.0014)	(0.0282)	(0.07115)
HERD	0.0016	0.0002	0.00899	0.8236	−2.8128*
	(0.0051)	(0.0031)	(0.0335)	(0.6663)	(1.6802)
DEBT.$I_{80\%}$	0.0051**	−0.0022*	0.1839***	−0.1648	7.3017***
	(0.0021)	(0.0013)	(0.0141)	(0.2798)	(0.7055)
Intercept	0.2188***	0.2150***	−2.0560***	−5.3019	−134.1709***
	(0.0707)	(0.0432)	(0.4645)	(8.9904)	(22.6722)
R^2	0.5127	0.9941	0.7179	0.9614	0.8231
Number of observations	233	233	233	227	227

The numbers in brackets beneath the coefficients are their standard deviations. Estimate coefficients are significant at the 1% level if ***, 5% if **, 10% if *.
Source: OECD datasets, except PRIM, SEC, HIGH from Cohen and Soto (2007).

focused on product market rigidities (see for example Nicoletti and Scarpetta, 2003, 2005) but did not attempt either to characterise the crossed effect of rigidities on labour and product effects or to differentiate a specific effect close to the frontier (see Crafts, 2006 for a survey). As regards the rigidities, an interaction between labour and product market regulations clearly appears; most significant results are obtained after lagging product market rigidities by 2 years. This confirms the results of previous analyses, such as that of Blanchard and Giavazzi (2003). Concerning the product market regulations, the "public sector size" component appears not to have a significant effect. There is no consensus in the empirical literature on the effect of labour and product markets rigidities on growth. Numerous studies assess very disparate results: either no effect, or a positive or a negative impact (for a survey emphasising this diversity, see Babetskii and Campos, 2007). Pointing out the dependence upon the position relative to the technological frontier, our study provides an explanation for this disparity. Ignoring this heterogeneity may lead to various results depending on the countries present in the panel and their distance to the technological frontier.

The above analysis should of course be viewed with the usual caution. They rely on inevitably fragile estimates conducted on a small panel of industrialised countries. The estimates, nevertheless, suggest important gains in productivity growth, i.e. in potential growth, that may be achieved in some industrialised, mainly European, countries after undertaking ambitious reforms to increase the education level in the workforce and decrease rigidities in labour and product markets.

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