



## Certified and uncertified skills and productivity growth performance: Cross-country evidence at industry level

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### ABSTRACT

We analyse the relationship between human capital and productivity growth using a five-country multi-industry dataset together with a measure of human capital which accounts for both certified skills (educational qualifications) and uncertified skills acquired through on-the-job training and experience. We find evidence of positive human capital effects on growth in average labour productivity, particularly when using our composite human capital measure. We also find some tentative evidence that multi-factor productivity (MFP) growth is positively related to the use of high-skilled labour. However, externalities of this kind are largely confined to industries which make intensive use of university graduates.

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### 1. Introduction<sup>1</sup>

Research on the impact of human capital on productivity growth at country level has encountered many difficulties over the years. In a survey of the econometric literature in this area, Sianesi and van Reenen (2003) concluded that, while the evidence of a positive effect for human capital was 'compelling', the empirical evidence was nonetheless 'still weak at various crucial points' (Sianesi and van Reenen, 2003: 192). In particular, they emphasised the many methodological issues that remained unresolved in this field such as how best to measure skills and how to model possible channels of influence of skills on economic performance.

Only a few years later considerable progress has been made in respect of both skills measurement and modelling the potential contribution of skills to performance. For example, de la Fuente and Domenech (2006) have developed new estimates of educational attainments for 21 OECD

countries which take care to avoid sharp breaks and implausible changes in measured skill levels over very short periods of time that often derive from changes in primary data collection methods. At the same time [Vandenbussche et al. \(2006\)](#) have built on previous work by [Nelson and Phelps \(1966\)](#) and endogenous growth theorists such as [Romer \(1990\)](#) and [Aghion and Howitt \(1992\)](#) to develop a model in which human capital contributes to multi-factor productivity (MFP) growth in different ways depending on how close countries are to the technological frontier.

However, these positive developments have hardly eliminated all the problems associated with measuring the impact of human capital on economic performance at country level. Skill measures based on certified educational attainments are unable to take account of uncertified skills acquired through employment-based training and learning. And, in a recent critique of [Vandenbussche et al. \(2006\)](#), [Inkelaar et al. \(2008\)](#) suggest that any positive correlation between human capital and MFP growth at country level disappears if due account is taken in the estimation of MFP of inter-country differences in labour quality and in the number of hours worked.

In this paper we present new evidence on the relationship between human capital and productivity growth at industry level, making use of measures of human capital which take account of uncertified as well as certified skills, and which are fully incorporated into quality-adjusted measures of labour inputs. While the construction of quality-adjusted

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indices of labour is a common practice in growth accounting studies, their use within an econometric framework has been less common.<sup>2</sup> Here we use panel methods to estimate models of productivity growth that specify the potential channels of influence by which skills might be expected to influence performance.

Our analysis makes use of a cross-country industry-level dataset which contains annual series for output, capital, labour input and workforce skills for 26 industries in five countries (UK, US, France, Germany and the Netherlands) over the period 1979–2000. Using industry-level data for a small number of advanced industrialised countries enables us to work with a more homogeneous sample than many previous cross-national studies of human capital which pooled together countries that were very different in terms of economic development. The difficulties inherent in this approach are discussed by Temple (2001) who also highlights potential differences in the quality of schooling across a wide range of countries. Although educational institutions differ in the countries included in the present study, we show below that we can minimise the effects of such differences in the construction of our human capital variable.

Throughout our analysis we undertake a systematic comparison of how our quality-adjusted measure of labour inputs (reflecting uncertified skills as well as certified skills) compares with other measures of human capital based solely on certified skills. Our main findings can be summarised as follows: we find strong evidence of the impact of human capital on average labour productivity, both in the long and in the short run. In the short-run, the analysis needs to allow for a more complex dynamic specification that accounts for the stock of human capital and the distance of countries from the technological frontier. We also find some limited evidence of spillovers onto MFP growth from the use of high-level skills. However, we do not find any support for the argument that such externalities are stronger in countries/industries that are close to the technological frontier.

The paper is ordered as follows. In Section 2 we discuss skills measurement issues in detail and outline the theoretical framework underlying the main hypotheses to be tested regarding the impact of human capital on relative labour productivity and MFP growth rates at country/industry level. Section 3 describes our dataset and our benchmark model. Sections 4–6 report our results and discuss our main findings on the impact of human capital on productivity growth at country/industry level. Section 7 concludes the paper.

## 2. Measurement and theoretical issues

### 2.1. Measurement of certified and uncertified skills

As an intangible asset, human capital is notoriously difficult to measure. Typically, use is made of proxy measures of skill such as educational level, occupation and wages. Discussions in this area are sometimes hampered by the use of terms like ‘attainments’ (an output concept) to refer to input measures such as years of completed schooling – a measure of attendance rather than attainment. Education output measures such as formal qualifications (diplomas) have the advantage of capturing something of what has actually been learned while undergoing education, rather than just signifying attendance. However, they have the disadvantage of being hard to compare across countries with different education systems and, like the years of schooling measure, they ignore skills acquired in the workplace without formal certification.

Hanushek and Kimko (2000) address concerns about the comparability of formal qualifications by constructing a new measure of labour

force quality based on student performance in international tests of academic achievement in mathematics and science. This measure is found to be significantly and positively related to growth in per capita GDP in several countries, observed over the period 1960–1990. By contrast, in this analysis, years of schooling measures based on Barro and Lee (1993) estimates prove to be statistically insignificant when the test-based indicator of labour force quality is included.

More recently, the importance of uncertified skills has been noted by Ingram and Neumann (2006) who attribute increasing variation in wage income within formal qualification groups in the US to unobserved skill heterogeneity within those educational categories. They report evidence that other measures of skill such as mathematical ability or hand-eye coordination (derived from analysis of job characteristics) contribute substantially to the increase in wage dispersion among workers in different formal qualification groups.

At the same time, there are good reasons to believe that uncertified skills which are developed through employment-based training and experience may in some ways be complementary to certified skills. One of the great regularities in empirical research on employer-provided training is that highly-educated employees typically receive more training than do employees with few or no formal qualifications. Economic theory points to three main reasons why this outcome should be expected. First, high levels of ability (as signified by educational qualifications) are likely to contribute to higher (and quicker) returns to training provision by employers (Booth, 1991; Green, 1993; Lynch and Black, 1998; Acemoglu and Pischke, 1998). Second, highly-qualified workers are more able to co-invest in their own education and training as they tend to be less credit-constrained than low-qualified workers. Third, in some institutional and labour market settings, ‘compressed’ wage structures may develop such that wages increase more slowly than productivity as skills increase, thus providing further incentives to employers to support further training for workers who are already well-qualified (Acemoglu and Pischke, 1999; Booth and Zoega, 2004).

In this context our objective in this study is to develop measures of skill at country level which take full account of both certified and uncertified skills and any complementarities between them. Accordingly, we build on quality-adjusted skills measures developed for growth accounting purposes, as in Jorgenson et al. (2005), which make use of education output data (formal qualifications) combined with relative earnings data in order to capture differences in relative productivity between different qualification groups. Since individual productivity reflects the possession of uncertified skills as well as certified educational attainments, we expect this approach to help to produce better skill measures than those which are based solely on formal qualifications.

The use of relative earnings data for this purpose rests on the assumption of perfectly competitive markets in which a firm will hire an additional hour of labour up to the point where that worker’s marginal productivity equals his/her marginal cost. Under this assumption, a measure of quality-adjusted total labour input can be obtained by weighting each different type of labour input (as signified by qualification levels) by its relative wage rate or the share that each type of labour occupies in total labour compensation. In fact, of course, employee wages may deviate from their marginal products due to imperfect labour market conditions and the operations of country-specific labour market institutions such as collective bargaining procedures and minimum wage legislation. Nonetheless, wage-based measures of relative labour quality go further than any other type of available measure towards capturing variations in relative marginal products across different qualification groups in each country.

Another problem in measuring skills is that even formal qualification categories may be hard to match across countries. In particular, there are pronounced inter-country differences in institutional arrangements for education and training which cause a lack of clear equivalence between intermediate qualification groups in different countries such as A levels in the UK, the Baccalaureate in France and

<sup>2</sup> Griliches and Regev (1995) use a quality adjusted measure of labour in the estimation of a production function using Israeli data, and others have followed this approach particularly in work based on agricultural data (see Jamison and Lau, 1982 for a survey). See O’Mahony and Vecchi (2005) for a more recent example of the use of quality-adjusted labour measures in regression analysis.

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