Abstract

A key feature of OECD economic growth since the early 1970s has been the secular decline in manufacturing's share of GDP and the secular rise of service sectors. This paper examines the role played by relative prices, technology, factor endowments, and labour market institutions in the process of 'de-industrialization.' We find a statistically significant and quantitatively important effect of levels of educational attainment. Furthermore, the production structure responds differently to the educational attainment of men and women. Finally, countries with stronger levels of employment protection are shown to adjust more slowly to changes in prices, technology, and factor endowments.

KEYWORDS: De-industrialization, Educational Attainment, Factor Endowments, Labour Market Institutions, Specialization
JEL Classification: F0, J0, O3

This paper was produced as part of the Centre's Globalisation and Labour Markets Programmes

Acknowledgements

This paper is produced as part of the Labour Markets and Globalisation Programmes of the ESRC funded Centre for Economic Performance at the London School of Economics. The views expressed are those of the authors alone and should not be attributed to any institution to which the authors are affiliated. We are grateful to Charlie Bean, Francis Green, Susan Harkness, Tim Leunig, Tony Venables, Anna Vignoles, and seminar participants at the London School of Economics and the CEPR ERWIT Conference (Copenhagen) for helpful comments. We would also like to thank Damon Clark, Gunilla Dahlén, Simon Evenett, Maia Guella-Rotllan, Randy E. Ilg, Marco Manacorda, Steve McIntosh, Jan van Ours, Barbara Petrongolo, Glenda Quintini, Lupin Rahman, Toshiaki Tachibanaki, Ingrid Turtola, and Colin Webb for their help with the data. We are grateful to Martin Stewart for research assistance. All opinions, results, and any errors are the authors' responsibility alone.

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Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

ISBN 0 7530 1566 8

Individual copy price: £5

Educational Attainment, Labour Market Institutions, and the Structure of Production

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September 2002

The Centre for Economic Performance is financed by the Economic and Social Research Council

1. Introduction

A key feature of economic growth in industrialized countries since the early 1970s has been the secular decline in manufacturing's share of GDP and the secular rise in the share of service sectors. Although these changes are common to all OECD countries, their magnitude and timing varies substantially. While the United Kingdom and United States were quick to 'de-industrialize', Germany and Japan have retained larger shares of manufacturing in GDP. A variety of explanations have been proposed for these changes, and there has been much popular debate concerning the causes and implications of de-industrialization.[1] However, there have been few systematic econometric analyses of the phenomenon, and what work there has been typically focuses on manufacturing to the exclusion of other sectors. This paper analyses the determinants of patterns of specialization across five broad industrial sectors (including Agriculture, Manufacturing, and Service industries) for 14 OECD countries since the mid-1970s. The analysis is firmly grounded in general equilibrium trade theory - our econometric equation is derived directly from the neoclassical theory of trade and production. Two popular explanations for de-industrialization are differential rates of technological progress and changes in relative prices. Our approach incorporates both of these considerations, while also allowing a role for factor endowments in explaining variation in the magnitude and timing of structural change and a role for labour market institutions in shaping the speed of such change.

A central theme of our analysis is that labour market outcomes and institutions play an important role in determining production structure. This theme emerges in a number of ways. First, one popular explanation for differences in industrial structure is levels of educational attainment. For example, Germany is frequently characterised as having high levels of the intermediate or vocational qualifications that are used intensively in the manufacturing sector.[2] We investigate this hypothesis using a new dataset on educational attainment constructed from individual-level information in labour force surveys.[3] The use of labour force survey data means that we maintain a definition of educational attainment that is as consistent as possible across countries; our econometric analysis explicitly controls for any remaining cross-country variation in the classification of educational levels. Information is available on an annual basis, providing a considerable advance for time-series work over the data available every five years in Barro and

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1 See Owen (1999) and Turner (2001) for recent informal discussions.

2 See, for example, Steedman and Wagner (1989), part of a wider body of case study and econometric work at the United Kingdom's National Institute of Economic and Social Research.

3 See Data Appendix for further information concerning the data used. Another paper exploiting individual-level labour force survey data is Machin and Van Reenen (1998).

Lee (1993), (2000).[4] The period since the mid-1970s is characterized by increasing educational attainment in OECD countries, although the magnitude and timing of these changes again varies substantially across countries.

Second, the sample period is characterized by marked changes in female labour participation and education decisions. Between 1971 and 1981, female labour force participation rates in Canada rose from 39.9% to 51.8%, while the percentage of the female population with a college degree or equivalent rose from 4.9% (approximately 50% of the male level) in 1975 to 11.8% in 1994 (over 75% of the male level).[5] It is plausible that male-female differences in labour market outcomes and their change over time are driven by largely exogenous cultural attitudes. Indeed, the extent of change varies markedly across countries with cultural attitudes. Thus, while the percentage of the female population with a college degree or equivalent in Japan rose rapidly between 1975 and 1994, it remained approximately 30% of the male level in 1994.

The variation in participation and education decisions between men and women is part of a wider literature that finds substantial differences in labour market outcomes between the two sexes. For example, a large number of papers find evidence of a substantial gender wage differential, even after controlling for observable characteristics (such as age, experience, and occupation) and unobserved heterogeneity.[6] There is also substantial informal evidence that industry and occupation vary substantially between men and women. For example, in 1995 the percentage of men in total employment in the UK was 71.0% in manufacturing compared to 42.2% in Business Services and 50.0% in Other Services. Further variation is observed with levels of educational attainment. Thus, in 1995 the percentage of female employees with a college degree or equivalent in UK manufacturing was approximately 7% compared to 19% for men.[7]

However, despite much informal evidence of differences in occupation and industry of employment, there has been little attempt to systematically examine the implications of changes in female-male participation and education decisions for economies' production structures. This paper undertakes such an analysis for a broad cross-section of OECD countries. Have economies that have been particularly successful in attracting women into the labour market or particularly successful in increasing levels of female educational attainment tended to specialize in

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[4] The quality of the Barro and Lee (1993) data has recently been criticised by de la Fuente and Domenech (2000) and Krueger and Lindahl (2000). See also Cohen and Soto (2001).

[5] The female labour force participation rates are taken from Killingsworth and Heckman (1986); see also Blundell and MaCurdy (2001). The educational attainment data are from Table 3 below.

[6] Examples include Blinder (1973), Oaxaca (1973), Oaxaca and Ransom (1994), and Swaffield (1999). For a discussion of changes in the gender wage differential over time, see Desai *et al.* (1999).

a different set of industries from economies that have instead retained high levels of male participation and educational attainment? In order to separate out the effects of changes in labour market participation and changes in educational attainment, we exploit data on both the percentage of the labour force and of the working age population with particular levels of educational attainment. Our preferred measure is the number of men (women) out of the working age male (female) population with a particular level of educational attainment. This variable is pre-determined by the educational decisions of previous cohorts prior to becoming working age, and rises over time as later cohorts have chosen to acquire higher and higher levels of education. We are able to explicitly test whether the effect on production structure of endowments of a particular education level is the same for men and women.

Third, a large theoretical and empirical literature emphasizes the role of institutions and public policies in shaping labour market outcomes.[8] In particular, work emphasizes the role of employment protection and job security provisions in determining the speed at which workers are reallocated from old and declining sectors to new and expanding ones. Thus, using firm-level data Hopenhayn and Rogerson (1993) find evidence of a negative effect of employment protection on aggregate productivity and growth through this mechanism. Using data on a cross-section of countries over time, Lazear (1990) finds statistically and quantitatively important effects on aggregate employment levels. In this paper, we directly examine the role of employment protection legislation in determining countries' speeds of adjustment to long-run changes in patterns of specialization. Our sample includes countries with very different extents of provision towards employment protection. The econometric equation for the share of a sector in a country's GDP that we estimate has an Equilibrium Correction Model (ECM) interpretation. Within this equation, we test econometrically whether employment protection affects the speed of adjustment towards long-run equilibrium.

The paper relates to four main strands of existing literature. First, there is a relatively informal economic history literature that has examined de-industrialization, often with particular emphasis on the United Kingdom and United States.[9] With the beginning of the Industrial Revolution in the late-Eighteenth Century, the share of agriculture in UK GDP progressively declined from 18.4% in 1856 to 3.4% in 1964. The share of manufacturing in UK GDP continued to rise into the 1960s (from 22.2% in 1856 to 33.6% in 1964), with de-industrialisation

[7] These figures on shares of industry employment by sex and by both sex and level of educational attainment are taken from Tables B2 and B3 in Appendix B, which are derived from individual-level information in the United Kingdom's New Earnings Survey.

[8] See Nickell (1997) and Nickell and Layard (1999) for recent surveys.

[9] See, for example, Crafts (1996), Kitson and Michie (1996) and Broadberry (1997).

emerging as a phenomenon in the 1970s.[10] Two clear candidate explanations for de-industrialization that we consider are pervasive technological change and systematic changes in relative prices with economic development. These are forces that are to some extent common across countries, and can explain the shared experience of structural change across OECD countries. However, we also require an explanation for differences in the magnitude and timing of structural change. Here, country-specific changes in technology and relative prices are potential explanations, as well as countries' factor endowments.

Second, the paper relates to the empirical literature that estimates the relationship between factor endowments and the international location of production. Harrigan (1995) and Bernstein and Weinstein (1998) regress output levels on factor endowments in a specification derived directly from the n-good, m-factor Heckscher-Ohlin model.[11] Factor endowments are found to have a statistically significant and quantitatively important effect on levels of production. Hanson and Slaughter (1999) and Gandal, Hanson, and Slaughter (1999) examine the generalized Rybczynski Theorem using US state-level and Israeli data respectively. As predicted by the theory, they find that changes in output mix play an important role in absorbing changes in factor endowments.

The $n \times m$ Heckscher-Ohlin model is in fact a special case of neoclassical theory, which allows for cross-country differences in preferences and technology. Harrigan (1997) estimates the neoclassical model for 8 manufacturing industries across 10 OECD countries, and finds that levels of technology as well as factor endowments are an important determinant of patterns of specialization. Harrigan and Zakrajsek (2000) further investigate the relationship between factor endowments and production in manufacturing industries. Using data on a broad sample of developed and developing countries, factor endowments are found to be a major influence on specialization.

In contrast to these papers, we analyse the determinants of specialization in manufacturing and non-manufacturing industries. Particular emphasis is placed on the determinants of de-industrialization and the role of labour market outcomes and institutions in determining patterns of production. We exploit a newly constructed dataset on educational attainment, investigate the implications of distinguishing between labour market outcomes for men and women, and consider the role of labour market institutions in shaping the speed of adjustment to structural change.

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10 These historical figures are from Matthews *et al.* (1982), Table 8.1.

11 Another literature considers the relationship between factor endowments and international trade in factor services. See, for example, Leamer (1984), Bowen *et al.* (1987), Trefler (1995), Davis *et al.* (1997), Gabaix (1997), and Davis and Weinstein (1998a). For recent surveys of the empirical trade literature, see Leamer and Levinsohn (1995) and Helpman (1999).

Third, as discussed above, the paper relates to the large labour market literature on male-female differentials and on the role of institutions in determining the pace of job creation and job destruction. However, while these ideas have been emphasized in the labour market literature, there has been very little analysis of their consequences in product markets. This paper seeks to bridge that gap by considering implications for countries' production structure and for the speed of adjustment to long-run changes in production structure.

Fourth, a recent literature has examined the relationship between international trade, skill-biased technological change, rising wage inequality, changes in relative unemployment rates, and changes in the relative supply of skilled and unskilled workers. The 1970s and 1980s were a period that saw substantial changes in the relative supply of skills as measured by either educational attainment or occupational status in many OECD countries. The same period was also characterised by a rise in the relative wage of skilled workers in the UK and US and changes in relative unemployment rates for most OECD countries (see, for example, the discussion in Katz and Murphy (1992), Nickell and Bell (1995), (1996), Berman *et al.* (1998), and Machin and Van Reenen (1998)).

Many studies have investigated the relative roles played by skill-biased technological change and international trade in explaining rising wage inequality and changes in relative unemployment rates.[12] However, with the exception of the work relating the location of production to factor endowments that was described above, there has been little attempt to examine the implications of changes in the relative supply of skills for OECD countries' patterns of production.[13] This paper undertakes a systematic analysis of these implications for 14 OECD countries since the mid-1970s. We control for other determinants of production structure such as technology and relative prices, and pay careful attention to the role of labour market institutions and to the potential differences in labour market outcomes between men and women.

The paper is structured as follows. Section 2 introduces the theoretical framework, and derives a structural equation relating the share of a sector in a country's GDP to relative prices, technology, and factor endowments. Our main econometric specification comes directly from the theoretical model and is discussed in Section 3. Section 4 examines the raw data and discusses cross-country differences in both the magnitude and timing of structural change and in the evolution of educational attainment. Section 5 presents the main econometric results, and

[12] See, for example, Lawrence and Slaughter (1993), Wood (1994), Krugman (1995), Leamer (1998), Feenstra and Hanson (1999), and many others.

[13] Maskus *et al.* (1994) and Maskus and Webster (1999) examine the implications of changing relative supplies of skills for the net factor content of trade of trade in the UK and US.

examines the contributions of the explanatory variables to observed structural change. Section 6 summarises our conclusions.

2. Theoretical Framework

The starting point for the analysis is the standard neoclassical theory of trade and production, as expounded by Dixit and Norman (1980) and Woodland (1982). Time is indexed by t, countries by $c \in \{1,...,C\}$, final goods by $j \in \{1,...,n\}$, and factors of production by $i \in \{1,..,m\}$. Each country is endowed with an exogenous vector v_{ct} of factors of production. Within this framework, production is typically assumed to occur under conditions of perfect competition and subject to a constant returns to scale technology. However, as discussed in Appendix A, it is straightforward to incorporate imperfect competition, and external economies of scale may also be introduced in the production technology. We allow for differences in factor endowments across countries c and technology differences across both countries c and industries j.

General equilibrium in production may be represented using the revenue function $r_c(p_{ct},v_{ct})$, where p_{ct} is a vector of industry output prices. Under the assumption that this function is twice continuously differentiable, the country's vector of profit-maximising net outputs, $y_c(p_{ct},v_{ct})$, is equal to the gradient of $r_c(p_{ct},v_{ct})$ with respect to p_{ct}.[14] The analysis allows for Hicks neutral and factor-augmenting technology differences. In our main specification, we consider Hicks-neutral technology differences across countries, industries, and time. In this case, the production technology takes the form $y_{cjt} = \theta_{cjt} F_j(v_{cjt})$, where θ_{cjt} measures technological efficiency in industry j of country c at time t. The revenue function is given by $r_c(p_{ct},v_{ct}) = r(\theta_{ct} p_{ct},v_{ct})$, where θ_{ct} is an $n \times n$ diagonal matrix of the technology measures θ_{cjt}.[15] Changes in technology in industry j of country c have analogous effects on revenue to changes in the price of industry j output, and the economy's vector of net outputs continues to be given by the gradient of the revenue function with respect to p_{ct}. If technology differences are instead modelled as factor-augmenting, the revenue function takes the form $r_c(p_{ct},v_{ct}) = r(p_{ct},\delta_{ct} v_{ct})$, where δ_{ct} is an $m \times m$ diagonal matrix of factor quality differences.[16] Again, the economy's vector of net outputs is the gradient of the revenue function with respect to p_{ct}.

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[14] Formally, a sufficient condition for the revenue function to be twice continuously differentiable is that there are at least as many factors as goods: $m > n$. With $n > m$, production levels may be indeterminant, although this will depend on technology differences, trade costs, and whether or not there is joint production. The potential existence of production indeterminacy is really an empirical issue. We present empirical evidence that the specification below, including relative prices, technology, and factor endowments, provides a relatively successful model of patterns of production in OECD countries.

[15] See Dixit and Norman (1980), pages 137-9.

[16] See Dixit and Norman (1980).

Returning to the case of Hicks-neutral technology differences, we follow Harrigan (1997), Harrigan and Zakrajsek (2000), Kohli (1991), and Woodland (1982) in assuming a translog revenue function,[17]

$$\ln r(\theta.p,v) = \alpha_{00} + \sum_j \alpha_{0j} \ln \theta_j p_j + \frac{1}{2}\sum_j \sum_k \alpha_{jk} \ln(\theta_j p_j).\ln(\theta_k p_k)$$

$$+\sum_i \beta_{0i} \ln v_i + \frac{1}{2}\sum_i \sum_h \beta_{ih} \ln v_i . \ln v_h \qquad (1)$$

$$+\sum_j \sum_i \gamma_{ji} \ln(\theta_j p_j).\ln(v_i)$$

where $j,k \in \{1,...,n\}$ index goods and $i,h \in \{1,...,m\}$ index factors. Symmetry of cross effects implies,

$$\alpha_{jk} = \alpha_{kj} \qquad and \qquad \beta_{ih} = \beta_{hi} \qquad \forall j,k,i,h \qquad (2)$$

Linear homogeneity of degree 1 in v and p requires,

$$\sum_j \alpha_{0j} = 1, \qquad \sum_i \beta_{0i} = 1, \qquad \sum_j \alpha_{kj} = 0 \qquad (3)$$

$$\sum_i \beta_{ih} = 0, \qquad \sum_i \gamma_{ji} = 0 \qquad (4)$$

Differentiating the revenue function with respect to each p_j and imposing the linear homogeneity restrictions, we obtain the following equation for the share of industry j in country c 's GDP at time t (s_{cjt}),

$$s_{cjt} = \alpha_{0j} + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{p_{ckt}}{p_{c1t}}\right) + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{\theta_{ckt}}{\theta_{c1t}}\right) + \sum_{i=2}^{M} \gamma_{ji} \ln\left(\frac{v_{cit}}{v_{c1t}}\right) \qquad (5)$$

This equation provides a theory-consistent measure of a country's specialization in an industry (the share of the industry in the country's GDP), and relates that measure to three sets of underlying economic determinants: relative prices, technology, and factor endowments. The theoretical analysis allows for a large number of factors of production. In particular, labour may be differentiated along a wide variety of dimensions of skills, including levels of education, general skills, vectors of industry-specific skills, physical strength, analytical skills, communication and interpersonal skills, etc. In empirical work, labour endowments are typically disaggregated according to either occupation-based (non-production / production workers) or educational attainment-based measures of skills. We adopt an educational attainment-based measure of skills,

[17] To save notation, country-time subscripts are suppressed except where important. See Christensen *et al.* (1973) for

but distinguish between male and female workers. This allows for the possibility that male and female workers of the same education level *have* or *are perceived to have* different vectors of these other characteristics or dimensions of skills.

A number of labour market studies present evidence that this is indeed the case. Using data from a survey of individual workers across a variety of industries and occupations in the United Kingdom, Ashton *et al.* (1998) find that female workers have above average levels of communication skills with both clients and their peers, but below average levels of manual and problem-solving skills. The reverse is true for male workers. Green and James (2001) provide independent survey evidence for the United Kingdom that male line managers tend to underestimate the skills of their female subordinates.[18] Note that the coefficients on factor endowments in each industry regression correspond to *general equilibrium* effects. An actual or perceived difference in levels of skills relevant to only a few industries (eg physical strength in agriculture and mining; communication skills in service sectors) can result in different general equilibrium effects and hence different estimated coefficients on endowments of men and women of a given educational level.

The theoretical analysis underlying equation (5) assumes that factors of production are perfectly mobile across industries within a country. While this may be a reasonable approximation in the long-run, it is likely in practice to take time for factors of production to be reallocated from declining to expanding sectors. Equation (5) should therefore be interpreted as a long-run equilibrium relationship towards which the economy is evolving. In the empirical analysis below, we allow for a general process of dynamic adjustment towards this long-run relationship.

The translog revenue function implies coefficients on relative prices, technology, and factor endowments in equation (5) that are constant across industries and over time. This is true even without factor price equalization. Indeed, with cross-country differences in technology, factor price equalization will typically not be observed. The effect of cross-country differences in relative prices and technology on patterns of production is directly controlled for by the presence of the second and third terms on the right-hand side.

Finally, the analysis so far has made no assumptions about whether countries are large or small, and allows for both tradeable and non-tradeable goods. If countries are small and all goods are freely tradeable, the vector of relative prices will be determined exogenously on world markets. With either large countries or non-tradeable goods, relative prices will be endogenous

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a related discussion of properties of the translog production technology.

and will depend in part on a country's factor endowments and levels of technology. In the econometric analysis that follows, we control for this endogeneity. For example, other things equal and on average across industries in a given country, the relative price of a non-traded good will be lower the more intensively it uses the country's relatively abundant factors of production.

3. Empirical Specification

Our main econometric equation is derived directly from the theoretical framework above. Augmenting the specification in equation (5) with a stochastic error, we obtain,

$$s_{cjt} = \alpha_{0j} + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{p_{ckt}}{p_{c1t}}\right) + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{\theta_{ckt}}{\theta_{c1t}}\right) + \sum_{i=2}^{M} \gamma_{ji} \ln\left(\frac{v_{cit}}{v_{c1t}}\right) + \varepsilon_{cjt} \tag{6}$$

This relationship may be estimated separately for each industry *j*, pooling observations across countries *c* and time *t*. When imposing linear homogeneity, we normalise relative to manufacturing, so that manufacturing prices and technology are the excluded variables (manufacturing corresponds to industry 1 in equation (6)). Factor endowments are normalised relative to each country's endowment of physical capital. We consider a very general specification of the error term,

$$\varepsilon_{cjt} = \eta_{cj} + d_{jt} + \psi_{cjt} \tag{7}$$

where η_{cj} is a country-industry fixed effect, d_{jt} is a {0,1} industry-time dummy, and ψ_{cjt} is a stochastic error.

The fixed effect controls for unobserved heterogeneity across countries in the determinants of patterns of international specialisation, which we allow to be correlated with the explanatory variables. For example, countries in which the share of manufacturing is high due to unobserved country characteristics (eg features of geography) may be precisely the countries characterised by a low relative price of the good etc. The industry-time dummies control for common macroeconomic shocks across countries in each industry.

Equation (6) is a static long-run equilibrium relationship between the share of a sector in GDP, relative prices, technology, and factor endowments. By construction, the share of sector *j* in GDP (s_{cjt}) is bounded between 0 and 1, and is therefore I(0). However, in any finite sample, this variable may be I(1). This is particularly true of our sample period (1975-94), which is

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[18] For US evidence on sex differentials using matched employee-employer data, see Bayard, Hellerstein, Neumark, and Troske (1999). Neumark (1999) provides evidence on the importance of asymmetric information and employer perceptions in generating male-female wage differentials.

characterised by a secular decline in the share of agriculture and manufacturing in GDP and a secular rise in the share of Services. Similarly, relative prices, technology, and factor endowments may all be I(1). In this case, equation (6) should be interpreted as a long-run cointegrating relationship between the share of a sector in GDP and the right-hand side variables. In order for the equation to have this cointegrating interpretation, we require that the estimated residuals are I(0). In the empirical analysis below, we make use of recent advances in panel data cointegration techniques, and employ the panel data unit root tests of Levin and Lin (1992) and Maddala and Wu (1999).[19]

In practice, it may take time for resources to be reallocated from declining to expanding sectors. To allow for gradual adjustment towards long-run equilibrium, we also consider a dynamic specification, where equation (6) is augmented with the lagged dependent variable,

$$s_{cjt} = \delta_c s_{cjt-1} + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{p_{ckt}}{p_{c1t}}\right) + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{\theta_{ckt}}{\theta_{c1t}}\right) + \sum_{i=2}^{M} \gamma_{ji} \ln\left(\frac{v_{cit}}{v_{c1t}}\right) + \eta_{cj} + d_{jt} + \psi_{cjt} \qquad (8)$$

where *(1-δ_c)* corresponds to the speed of adjustment.[20] This relationship has an equivalent Equilibrium Correction Model (ECM) representation,

$$\Delta s_{cjt} = (1-\delta_c)\left[s^*_{cjt-1} - s_{cjt-1}\right] + (1-\delta_c).\Delta s^*_{cjt} + \eta_{cj} + d_{jt} + \psi_{cjt} \qquad (9)$$

where a superscript * denotes the long-run equilibrium value of a variable,

$$s^*_{cjt} = \frac{1}{1-\delta_c}\left[\sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{p_{ckt}}{p_{c1t}}\right) + \sum_{k=2}^{N} \alpha_{jk} \ln\left(\frac{\theta_{ckt}}{\theta_{c1t}}\right) + \sum_{i=2}^{M} \gamma_{ji} \ln\left(\frac{v_{cit}}{v_{c1t}}\right)\right] \qquad (10)$$

The speed of adjustment towards long-run equilibrium is allowed to vary across countries with labour market institutions and policies that affect the reallocation of labour from declining to expanding sectors. We employ an OECD measure of the strength of employment protection,[21] and include in our dynamic specification both the lagged dependent variable and the lagged dependent variable interacted with employment protection. That is, in terms of equations (8)-(10),

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[19] Other analyses of unit root tests and cointegration in a panel data context include Im *et al.* (1997), Pedroni (1999), Pesaran *et al.* (1998), and Quah (1994).

[20] The presence of the lagged dependent variable on the right-hand side in this specification implies that the fixed effects estimator will be biased. Nickell (1981) shows that this bias is asymptotically decreasing in the number of time periods (*T*), which in the present case is large (*T≅20*).

[21] See Nickell (1997) for an analysis of the effects of this variable on equilibrium levels of unemployment.

$$\delta_c = \delta_0 + \delta_1 .emp_c \tag{11}$$

where a positive and statistically significant value of δ_1 implies that countries with greater levels of employment protection (emp_c) adjust more slowly towards long-run equilibrium.

To measure the price of industry *j* output in country *c* (p_{cjt}) we use the producer price deflator. This is an index of industry *j* prices in country *c* at time *t* relative to their value in the same country in 1990, and takes the value 1 in 1990 in all countries. It provides information on changes in nominal prices in a particular country-industry over time. It does not capture the initial level of relative prices across countries and industries in 1990. However, this is controlled for by the country-industry fixed effect (η_{cj}) in equations (6) and (8). When imposing linear homogeneity, we normalise the price of industry *j* output in country *c* (p_{cjt}) by the manufacturing price (p_{c1t}). This yields a measure of the evolution of relative prices over time, with the initial level of relative prices again captured in the country-industry fixed effect (η_{cj}).

Note that, if all goods were freely tradeable so that goods prices were the same across countries ($p_{ckt} = p_{kt}$ for all *c*), the relative price term on the right-hand side of equations (6) and (8) could be replaced with a full set of industry-time dummies. More generally, if there are constant barriers to trade across countries in individual industries, the relative price term can be replaced by industry-time dummies and a country-industry fixed effect. Finally, if the reduction in trade barriers in an industry associated with multilateral trade liberalisation is common across countries, this can also be captured with industry-time dummies. Thus, with a country-industry fixed effect and time dummies included in the specification of the error term, an F-test of the statistical significance of the relative price variables provides a test of the null hypothesis that relative prices only differ across countries by a constant.

As discussed above, if countries are large and/or goods are non-tradeable, relative prices will be endogenous. This gives rise to a standard simultaneity problem. Other things equal, a positive shock to the share of an industry in a country's GDP will result in a lower relative price for that industry's output, imparting a downwards bias to the estimated coefficients on relative prices. Note that this bias operates in the opposite direction to the economic relationship that we are seeking to identify – a positive supply-side relationship between the relative price of a good and the share of the sector in a country's GDP. We address the simultaneity problem using Instrumental Variables estimation. Domestic relative prices are modelled as a function of a country's own factor endowments and technology and of world relative prices.

Actual data on the cost inclusive of freight (cif) price of imports are not available for each country in our sample. Therefore, we measure the local currency price of imports by constructing a relative price at the border series for each country and then converting this relative price into domestic prices using data on exchange rates and tariffs. The relative price at the border series for country c is constructed as a weighted sum of the relative prices of all other countries in the sample (expressed in a common currency (dollars)), where the weights are the shares of each of the other countries in country c's imports. This captures the idea that prices will vary geographically with transport costs, and the price of imports will be more closely related to prices in neighbouring countries with whom much trade occurs than to prices in distant countries with whom little trade occurs. The first-stage regression for relative prices is thus,

$$\ln\left[\frac{p_{cjt}}{p_{c1t}}\right] = \phi_{0j} + \sum_i \phi_{1ij} \ln v_{cit} + \sum_k \phi_{2kj} \ln \theta_{ckt} + \sum_k \phi_{3kj} \ln p^B_{ckt} + \phi_{4j} \ln e_{ct} + \phi_{5j} \ln \tau_{ct} + \omega_{cj} + D_{jt} + u_{cjt} \tag{12}$$

where p^B denotes price at the border, e is the nominal exchange rate, τ is the average tariff rate, ω_{cj} is a country-industry fixed effect, D_{jt} are industry-time dummies, and u_{cjt} is a stochastic error.

Although the output of each of the industries in our sample is to some extent tradeable, the degree of tradability varies across industries (from, for example, agriculture to service sectors). The coefficients on prices at the border are therefore allowed to vary across industries, as are the coefficients on all the other exogenous variables in the first-stage regression. Note that the normalization relative to manufacturing when imposing linear homogeneity above means that we are concerned with variation in the price of each sector's output *relative to manufacturing*. Since the latter is itself highly tradeable, world prices should be an important determinant of domestic relative prices, as will be shown to be the case empirically below. Since factor endowments and technology also appear independently on the right-hand side of equations (6) and (8), the identification of price effects comes from variation in prices at the border, exchange rates, and tariffs. We show below that these are powerful instruments in the first-stage regression. The key identifying assumption is that these variables only affect the share of a sector in a country's GDP through relative prices. We test and provide evidence for this identifying assumption in the empirical analysis that follows.

To measure technology in sector j of country c (θ_{cjt}) we employ a superlative index number measure of Total Factor Productivity (TFP).[22] In industry j, TFP in each country is evaluated relative to a common reference point – the geometric mean of all other countries in that industry. This is done in all years for that industry (e.g. we measure TFP in US Business Services in 1980 relative to the geometric mean of the Business Services industry across all countries in 1980) and for all industries j. The measure of relative TFP is given by,

$$\ln(RTFP_{cjt}) = \ln\left(\frac{Y_{cjt}}{\overline{Y}_{jt}}\right) - \overline{\sigma}_{cjt}.\ln\left(\frac{L_{cjt}}{\overline{L}_{jt}}\right) - (1-\overline{\sigma}_{cjt}).\ln\left(\frac{K_{cjt}}{\overline{K}_{jt}}\right) \tag{13}$$

where an upper bar above a variable denotes a geometric mean; Y is real value-added; L is labour input (hours worked); K is the real capital stock. The variable $\overline{\sigma}_{cjt} = 1/2.(\alpha_{cjt} + \overline{\alpha}_{jt})$ is the average of labour's share in value-added in country c (α_{cjt}) and the geometric mean labour share ($\overline{\alpha}_{jt}$).

One problem in measuring TFP is that the observed share of labour in value-added is typically quite volatile. This suggests measurement error, and we therefore exploit the properties of the translog production function to smooth labour shares. Assuming a translog production technology, α_{cjt} may be expressed as the following function of the capital-labour ratio and a country-industry constant,

$$\alpha_{cjt} = \xi_{cj} + \phi_j.\ln\left(K_{cjt}/L_{cjt}\right) \tag{14}$$

If actual labour shares deviate from their true values by an i.i.d. measurement error term, the parameters of this equation can be estimated by fixed effects panel data estimation, where we allow the coefficient on the capital-labour ratio to vary across industries j. The fitted values from this equation are used as the labour cost shares in our calculation of relative TFP above.

It is well known that measured TFP tends to be pro-cyclical (see, for example, the discussion in Hall (1990)). Furthermore, TFP is actually constructed using data on real value-added. Positive shocks to industry j output that raise the share of the sector in GDP may therefore also raise measured TFP, giving rise to a spurious positive correlation between an industry's TFP and its share in the country's GDP. We wish to identify the long-run relationship between trend changes in technical efficiency and the shares of industries in GDP, abstracting

[22] See, for example, Caves *et al.* (1982a), (1982b), Harrigan (1997), (1999), and Griffith, Redding, and Van Reenen (2000).

from such short-run shocks and business cycle fluctuations. We therefore follow the real business cycle literature (see, for example, Hodrick and Prescott (1997) and Baxter and King (1999)) in smoothing measured TFP using a Hodrick-Prescott filter. The filter separates the growth and cyclical components of the data, and we employ the standard accepted value for the smoothing parameter λ from the real business cycle literature (λ=1600 using quarterly data, which corresponds to λ=6.25 using annual data).[23]

Our factor endowment variables include measures of physical capital, land area, and labour disaggregated by both level of educational attainment and sex. We make the standard assumption in the international trade literature that these country-level endowments are exogenous with respect to shocks to production structure. Our preferred measure of educational attainment is the number of men (women) out of the working age male (female) population with a particular level of educational attainment. This variable is pre-determined by the educational decisions of previous cohorts prior to becoming working age, and rises over time as later cohorts have chosen to acquire higher and higher levels of education.

Even within countries, there are differences in the evolution of male and female levels of educational attainment over time, and there are further differences between countries. We use this variation to separately identify the male and female coefficients, and to examine whether the effects of endowments of a given education level on production structure are the same for men and women. We also experiment with an alternative measure of educational attainment, defined as the number of either men or women out of the labour force with a particular level of educational attainment. This measure captures endowments of economically active individuals (whether employed or unemployed), and enables us to exploit exogenous variation in female labour force participation decisions over time.

The estimated coefficients on factor endowments in equations (6) and (8) are *general equilibrium* effects. Even if countries have identical technologies and preferences, the existence of many goods (*n*) and factors of production (*m*) means that we cannot make predictions about the effect of factor endowments on output of individual industries. Therefore, we should not necessarily expect a factor endowment to have a positive effect on the GDP share of one particular industry that uses that factor of production relatively intensively. Nevertheless, since with many goods and factors of production the theorems of the 2×2×2 Heckscher-Ohlin model

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23 The value of 6.25 for annual data is taken from Ravn and Uhlig (2001). They show analytically that this corresponds exactly to the standard accepted value of 1600 for quarterly data. Baxter and King (1999) propose a similar value of 10 for annual data. The results that follow are robust to the use of alternative values for the smoothing parameter.

hold in a weakened form as averages or correlations,[24] we should expect a pattern of estimated coefficients across all industries as a whole that is broadly consistent with information on factor intensity.

One final econometric concern is that our measures of relative prices, TFP, and factor endowments may be subject to measurement error. This may be a particular concern for the non-manufacturing sectors, and we therefore employ a number of controls for potential measurement error. First, TFP for each country-industry-time observation is measured relative to a common reference point (the industry-time geometric mean). Any error in measuring TFP that is common across countries for a particular industry-time observation will therefore be controlled for.

Second, when linear homogeneity is imposed in equations (6) and (8), TFP and prices in each country-industry are normalized by the manufacturing values for that country. Any error in measuring TFP or prices that is common across industries for a particular country-time observation will therefore also be controlled for. Third, the country-industry fixed effect included in the econometric estimation will control for any time-invariant errors of measurement for an industry in a particular country. It will also control, for example, for any remaining differences across countries in the classification of educational attainment levels. Fourth, the industry-time dummies included in the econometric estimation will capture any errors of measurement that are common across countries for a particular industry-time observation.

Finally, any remaining classical measurement error will attenuate the estimated parameters of interest towards zero, biasing the results away from the economic relationships that we seek to identify. The potential objection that measurement error may be greater for non-manufacturing sectors must also be counterbalanced against the fact that manufacturing is typically less than 30% of GDP in OECD countries, and there is a need to understand the remaining 70% of economic activity. The dataset that we employ is a later version of that already successfully used to analyse productivity convergence in manufacturing and non-manufacturing in two influential papers by Bernard and Jones (1996a), (1996b).[25]

[24] See, for example, the discussion in Dixit and Norman (1980), Chapter 4.

[25] These papers also demonstrate the point that conclusions which hold for manufacturing may fail to hold in non-manufacturing sectors. Bernard and Jones (1996a), (1996b) find that much of the observed convergence in aggregate productivity among OECD countries is driven by convergence in non-manufacturing sectors.

4. Data Description and Analysis

The main source of data in the empirical application is the OECD's International Sectoral Data Base (ISDB), which provides information for one-digit manufacturing and non-manufacturing industries on current price value-added, constant price value-added, employment, hours worked, and the stock of physical capital. Data on GDP and a country's aggregate endowment of physical capital are also obtained from the ISDB. Information on educational endowments comes from individual countries' labour force surveys, while data on arable land area are collected from the United Nations Food and Agricultural Organisation (FAO).[26]

Our sample is an unbalanced panel of 14 OECD countries and 5 one-digit industries during the period 1975-94. The distribution of observations across countries and over time is given in Table 1A. Table 1B lists the 5 one-digit industries, together with a sixth industry 'Government Producers and Other Producers.' This is somewhat of a residual category, and is less likely to be characterized by profit-maximising behaviour. For these reasons, it is excluded in the econometric analysis that follows.[27] More detailed information on the disaggregated sectors included in each one-digit industry is given in Appendix B. Table 2 reports the evolution of industry shares of GDP over time in each of the 14 countries.

The sample period was characterised by a decline in the share of Agriculture in GDP in all countries, although the rate of decline varies substantially – from over 95% in Germany during 1975-93 to less than 30% in the Netherlands during 1975-94. In manufacturing, countries differ substantially in terms of the initial share of this industry in GDP: in Germany and Japan, manufacturing constituted about 30% of GDP in 1975, while, in Australia, Canada, and Denmark, it was responsible for only 20% of GDP.

All countries experienced a decline in manufacturing's share of GDP. However, the magnitude and timing of this decline varies across countries. In Australia and the United Kingdom, manufacturing's share of GDP declined by approximately 35% over the whole sample period, while, in Denmark and Finland, it fell by less than 10%. In the Netherlands and Norway, the decline was most rapid in the first half of the sample period, whereas, in Germany and Japan, most of the fall in manufacturing's share of GDP occurred in the second half of the sample period. In other countries, such as Italy and the United Kingdom, the rate of decline of manufacturing's share of GDP is roughly constant over time.

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26 See Appendix B for further information concerning the data sets used.

27 Since the industry 'Government Producers and Other Producers' is excluded, there are no cross-industry restrictions on the estimated coefficients. The model is estimated separately for each industry, and therefore the inclusion of 'Government Producers and Other Producers' would only affect the results in the other industries to the extent that cross-industry restrictions were imposed.

Table 1A: Estimation sample by Country (observations on the 5 one-digit industries listed in Table 1B)

Country	Period
1. Australia	1983-93
2. Belgium	1987-94
3. Canada	1976-92
4. Denmark	1984-92
5. Finland	1985-94
6. France	1983-92
7. West Germany	1985-93
8. Italy	1978-94
9. Japan	1976-94
10. Netherlands	1976-94
11. Norway	1976-91
12. Sweden	1976-94
13. United Kingdom	1976-93
14. United States	1976-93

Table 1B: Industry Composition (International Standard Industrial Classification (ISIC))

Industry	Industry Code	Further Details
1. Agriculture	10	Agriculture, Hunting, Forestry and Fishing (ISIC 10)
2. Manufacturing	30	Manufacturing (ISIC 30)
3. Other Production	40	Mining and Quarrying (ISIC 20) Electricity, Gas, and Water (ISIC 40) Construction (ISIC 50)
4. Other Services	50	Wholesale and Retail Trade, Restaurants and Hotels (ISIC 60) Transport, Storage, and Communication (ISIC 70) Community, Social, and Personal Services (ISIC 90)
5. Business Services	60	Financial Institutions and Insurance (ISIC 82) Real Estate and Business Services (ISIC 83)
Excluded industry: Government/Other Producers	70	Producers of Government Services Other Producers

Notes: see Appendix B for detailed information on the disaggregated sectors included in each one-digit industry above.

Table 2: Shares of Industrial Sectors in a Country's GDP (per cent)[a]

Country	Year	Agric	Manuf	Other Prod.	Business Services	Other Services	Gov./ Other
Australia	1975	4.96	20.35	15.90	15.14	39.02	4.63
	1985	3.94	16.94	16.81	18.68	39.59	4.04
	1994	2.76	14.25	12.78	24.51	42.08	3.62
Belgium	1975	2.92	25.91	12.84	3.44 (a)	39.39	15.50
	1985	2.32	22.67	10.30	5.76 (a)	44.01	14.94
	1994	1.57	19.70	9.75	5.45 (a)	50.09	13.44
Canada	1975	4.91	20.35	15.01	15.28	26.14	18.31
	1985	3.10	18.96	15.77	18.22	25.78	18.17
	1992	2.38	16.26	12.77	21.29	26.94	20.36
Denmark	1975	5.59	19.99	10.21	14.58	29.19	20.44
	1985	5.60	19.57	8.15	16.76	27.83	22.09
	1992	3.86	18.53	8.60	17.95	28.36	22.70
Finland	1975	10.54	26.05	14.06	12.69	21.38	15.28
	1985	8.06	25.09	10.92	14.37	22.95	18.61
	1994	5.47	24.42	8.13	18.82	22.23	20.93
France	1975	5.60	27.22	10.36	15.95	25.55	15.32
	1985	4.07	23.07	8.95	19.23	26.92	17.76
	1992	2.93	20.80	8.33	22.83	28.11	17.00
West Germany	1975	2.88	35.40	10.10	4.64 (a)	26.28	14.32
	1985	1.80	32.62	9.09	5.66 (a)	29.33	14.09
	1993	1.09	27.16	8.32	6.04 (a)	35.67	13.68
Italy	1975	7.14	27.43	13.59	5.11 (b)	35.48	11.25
	1985	4.55	24.61	11.08	4.79 (b)	41.86	13.11
	1994	2.94	20.52	11.16	4.99 (b)	46.82	13.57
Japan	1975	5.28	29.05	11.74	12.93	16.73 (c)	10.05
	1985	3.06	28.37	10.98	14.78	20.22 (c)	9.74
	1994	2.05	23.49	13.25	17.17	22.21 (c)	9.64
Netherl.	1975	4.72	22.69	13.38	13.73	31.08	14.40
	1985	4.15	18.64	15.50	18.29	31.20	12.22
	1994	3.52	18.63	9.64	24.10	33.37	10.74
Norway	1975	5.01	21.81	12.21	14.32	30.99	15.66
	1985	3.30	13.69	27.35	15.22	25.45	14.99
	1991	3.14	12.14	20.49	18.23	28.74	17.26
Sweden	1975	4.84	28.02	10.25	14.40	21.37	21.12
	1985	3.59	23.66	9.81	17.58	21.21	24.15
	1994	2.16	21.44	8.56	23.33	21.53	22.98
United Kingdom	1975	2.58	28.21	11.33	15.71	24.73	17.44
	1985	1.90	23.92	15.36	18.80	24.24	15.78
	1993	1.88	19.94	9.76	24.54	28.69	15.19
United States	1975	3.46	22.28	10.07	18.21	31.68	14.30
	1985	2.07	19.47	10.78	23.08	31.85	12.75
	1993	1.65	17.39	8.08	26.74	33.05	13.09

Notes: 'Government and Other Producers' (ISIC 70) is the excluded industry in the econometric analysis that follows. (a) Figures are for the sub-sector 'Financial Institutions and Insurance' (ISIC 82), and the numbers therefore sum to less than 100%. (b) Figures are for the sub-sector 'Financial Institutions and Insurance (ISIC 82). (c) Figures for 'Other Services' exclude the sub-sector 'Wholesale and Retail Trade, Restaurants and Hotels' (ISIC 60), and therefore the numbers sum to less than 100%. Source: OECD International Sectoral Database (ISDB). See Appendix B for more information concerning the data used.

The initial level of the share of Other Production in GDP varies from about 10% in Germany and the United States to over 15% in the natural resource rich countries of Australia and Canada. In all countries except Norway and Japan, the share of this sector in GDP declined during 1975-94. The share of Business Services in GDP rose in all countries for which data are available during 1975-94.[28] The increase was most rapid in Australia, the Netherlands, Sweden, and the United Kingdom, and was least rapid in Denmark and Norway. The share of Other Services in GDP rose in all countries except Denmark and Norway.

Table 3 reports male and female educational attainment as a percentage of the male and female population respectively for the years 1975, 1985, and 1994. Data for 1975 are only available for half of the 14 countries, and, therefore, the discussion here concentrates on the period 1985-94. As discussed earlier, this period was characterised by increases in educational attainment in the OECD. Considering men and women together, all countries in Table 3 experienced an increase in the share of the population with high education (college degree or equivalent).[29] The rate of increase varies markedly across countries: from 38% and 36% in Italy and the Netherlands during 1985-94, to 14% and 15% in Denmark and the United States during the same period.

Considering men and women separately, all countries in Table 3 display an increase in the share of the male population and the share of the female population with high education. The increase is typically largest for women, and this is reflected in a rise in the share of women in the total number of individuals (men plus women) with high education in all countries except France. There are notable differences in patterns of educational attainment across countries. Educational attainment in Germany and Norway is disproportionately concentrated in the medium education group relative to other OECD countries. In the United Kingdom in 1975, over 50% of the male population and over 60% of the female population were in the low education group, compared with less than 30% of the male population and less than 25% of the female population in the United States.

The share of the male population with high education typically exceeds the share of the female population. However, this is not always so - in France, Italy, and Sweden in 1985, the share of the female population with high education exceeded that of the male population. There are large changes in the relative educational levels of men and women over time, and the rate of change varies substantially across countries. In Australia in 1982 and Canada in 1975, the share

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[28] For Belgium, Germany, and Italy, the data are for a sub-sector of Business Services: Financial Institutions and Insurance (ISIC 80).

of women with high education was just over half the value for men. However, by 1993 in Australia and 1994 in Canada, the share of women with high education was over 75% of the value for men. In contrast, in Japan, the share of women with high education in 1994 remained about 30% of the value for men.

Multiplying the percentage shares in Table 3 by the male and female population levels reported in Table 4, we obtain our preferred measure of countries' endowments of men and women with each education level. Table B1 of Appendix B shows that not only do educational endowments vary substantially across countries and over time, but there is also a large degree of variation in the intensity with which the 5 one-digit industries employ men and women of any given educational level.

Information on endowments of physical capital and arable land is also reported in Table 4. There is much variation in the relative abundance of these two factor endowments across countries. In 1975, the ratio of arable land to physical capital in the United States was approximately 10 times that in the Netherlands. Countries also display very different rates of physical capital accumulation, with the physical capital stock rising by 113% in Japan during 1975-92, compared with a rise of 34% in Denmark during the same period.

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[29] The aggregate educational attainment data (for men and women together) are not reported in Table 3, but are a weighted average of those reported for men and women separately.

Table 3: Education attainment as a Percentage of the Male and Female Working Age Populations (1975, 1985, and 1994)

		Men			Women		
Country	**Year**	**Low**	**Med**	**High**	**Low**	**Med**	**High**
Australia	1982	.484	.438	.078	.623	.333	.044
	1985	.462	.448	.091	.592	.353	.055
	1993	.341	.542	.117	.441	.469	.090
Belgium	1975	-	-	-	-	-	-
	1986	.349	.600	.051	.457	.523	.021
	1994	.277	.649	.073	.350	.614	.035
Canada	1975	.272	.639	.089	.264	.687	.049
	1985	.198	.682	.120	.189	.727	.084
	1994	.127	.696	.147	.133	.723	.118
Denmark	1983	.337	.611	.053	.452	.531	.017
	1985	.240	.707	.053	.386	.595	.019
	1994	.190	.751	.055	.302	.665	.028
Finland	1984	.526	.387	.086	.562	.359	.079
	1985	.512	.399	.089	.547	.370	.082
	1994	.438	.440	.121	.440	.435	.125
France	1982	.469	.421	.109	.466	.405	.129
	1985	.425	.449	.125	.418	.436	.146
	1994	.307	.511	.181	.308	.485	.207
West Germany	1984	.148	.783	.109	.315	.647	.051
	1985	.143	.774	.121	.311	.644	.057
	1994	.132	.758	.140	.252	.681	.083
Italy	1979	.529	.426	.044	.474	.477	.049
	1985	.392	.550	.058	.330	.607	.063
	1994	.217	.715	.083	.172	.744	.094
Japan	1975	.433	.425	.142	.484	.487	.029
	1985	.306	.501	.193	.336	.619	.045
	1994	.228	.534	.238	.226	.703	.071
Netherlands	1975	.371	.526	.103	.490	.460	.050
	1985	.216	.630	.153	.278	.621	.100
	1994	.146	.648	.206	.169	.671	.160
Norway	1976	.023	.862	.114	.018	.915	.067
	1985	.030	.822	.147	.025	.869	.106
	1994	.029	.775	.195	.028	.803	.169
Sweden	1975	.553	.323	.123	.596	.301	.103
	1985	.410	.413	.177	.420	.398	.181
	1994	.293	.430	.203	.262	.443	.227
United Kingdom	1975	.514	.438	.048	.634	.352	.015
	1985	.375	.528	.097	.447	.508	.046
	1994	.258	.618	.124	.314	.613	.073
United States	1975	.274	.549	.177	.229	.625	.146
	1985	.166	.598	.237	.122	.672	.206
	1994	.117	.605	.270	.083	.659	.257

Notes: educational attainment data are from individual-level information in country labour force surveys. Low corresponds to no education or primary education; Medium corresponds to secondary and/or vocational qualifications; High corresponds to college degree or equivalent. See Appendix B for further information concerning the data used.

Table 4: Endowments of Physical Capital (billions US dollars, 1990 prices), Population (thousands), and Arable Land Area (thousands of hectares)

Country	Year	Capital	Male Pop.	Female Pop.	Arable
Australia	1979	789.80	4777	4651	43932
	1985	971.04	5294	5148	47150
	1993	1226.92	5944	5828	46300
Belgium	1975	385.88	-	-	982
	1986	536.11	3338	3312	765
	1994	671.63	3378	3325	777
Canada	1975	1123.04	7649	7531	44000
	1985	1686.04	8946	8827	45900
	1992	2192.23	9756	9609	45370
Denmark	1983	374.89	1702	1673	2593
	1985	389.32	1716	1683	2601
	1992	441.74	1768	1721	2539
Finland	1984	353.87	1663	1663	2294
	1985	365.18	1672	1667	2276
	1994	457.47	1719	1685	2267
France	1982	2419.60	17674	17611	17651
	1985	2573.97	18181	18224	17923
	1992	3061.88	18797	18839	18046
West Germany	1984	3756.45	21259	21396	11952
	1985	3845.38	21355	21385	11957
	1993	4716.85	28117	27127	11676
Italy	1977	2380.55	17800	18645	9359
	1985	3054.87	19313	19973	9050
	1994	3911.39	19353	19607	8329
Japan	1975	2757.52	37180	38460	4460
	1985	5276.81	40950	41360	4209
	1994	8572.96	43630	43360	3999
Netherlands	1975	583.50	4406	4322	759
	1985	732.83	5023	4899	826
	1994	886.90	5182	5353	885
Norway	1975	203.16	1266	1239	792
	1985	319.33	1355	1314	858
	1991	376.38	1403	1355	892
Sweden	1975	414.12	2660	2599	3006
	1985	532.66	2729	2665	2922
	1994	669.49	2844	2754	2780
United Kingdom	1975	1970.63	17554	17638	6883
	1985	2464.50	18643	18555	7006
	1993	3063.79	19019	18763	6081
United States	1975	13658.82	68335	70560	186472
	1985	18257.51	78450	80067	187765
	1993	22083.93	83768	84837	181950

Notes: capital is stock of real physical capital from OECD's International Sectoral Database (ISDB) (billions of 1990 US dollars). Male and Female Population data from individual country labour force surveys (thousands). Arable is arable land area from United Nations Food and Agricultural Organisation (FAO) (thousands of hectares). See Appendix B for further information concerning the data used.

5. Econometric Estimation

We begin by considering the static long-run relationship between the share of a sector in GDP, relative prices, technology, and factor endowments in equation (6). As reported in Table C1 of Appendix C, the majority of industry GDP shares and independent variables are I(1) during the sample period according to the Levin and Lin (1992) and Maddala and Wu (1999) panel data unit root tests. Columns (1)-(5) of Table 5 present the results of estimating equation (6) for Agriculture, Manufacturing, Other Production, Other Services, and Business Services using the within groups (fixed effects) estimator. As reported in the lower panel of the table, we reject the null hypothesis of a unit root in the residuals in the vast majority of cases with either the Levin and Lin or Maddala and Wu panel data tests. This finding that the residuals are I(0) provides support for the cointegrating interpretation given above.

The pattern of estimated coefficients on the relative price and TFP terms in Table 5 is consistent with the predictions of theory. In all 5 industries, the estimated own-industry price terms are positive and statistically significant at the 5% level (imposing linear homogeneity means that, in Manufacturing, the own-industry estimated coefficient is minus the sum of the estimated coefficients on the other industry terms). With the exception of Other Services, the estimated coefficients on the own-industry TFP terms are positive and statistically significant at conventional critical values (in Manufacturing, the own-industry effect is again minus the sum of the estimated effects on the other industry terms). We noted earlier that, if industry trade barriers differ across countries by a constant, the relative price terms can be replaced by a country-industry fixed effect and industry-time dummies. However, an F-test of the null hypothesis that the estimated coefficients on the relative price terms are zero is rejected at the 5% level in all industries. This provides evidence of the importance of country-specific changes in industry relative prices over time.

Our measures of factor endowments have a statistically significant effect on patterns of production. The coefficients on individual endowments vary substantially across industries. For example, while endowments of low education men have a positive and statistically significant effect on the share of Agriculture and Other Services, the effect in Manufacturing and Business Services is negative with the Manufacturing coefficient significant at the 12% level. Male and female educational endowments have very different implications for patterns of production. For example, while endowments of medium education men have a negative and statistically significant effect on the share of business services in GDP, the effect of endowments of medium education women is positive and statistically significant. The null hypothesis that the estimated coefficients on all male educational endowments equal those on female educational endowments is rejected at the 5% level in all industries except Manufacturing. This provides support for the idea that men and women of the same educational level have or are perceived to have different vectors of other characteristics or dimension of skills. It is consistent with the large labour market literature reviewed earlier that finds substantial differences between men and women in terms of labour market outcomes.

In Table 6, we examine the potential endogeneity of our measures of relative prices. The specification in equation (6) is re-estimated using Instrumental Variables. Our instruments for relative prices are: prices at the border, exchange rates, and average tariff rates (as described in more detail in Section 3). The instruments are highly statistically significant in the first stage-regression for relative prices. The lower panel of Table 6 reports *p*-values for an F-test of the null hypothesis that the coefficients on the excluded exogenous variables are equal to zero in the first-stage. In all cases, the null hypothesis is rejected at conventional critical values. The key identifying assumption in the IV estimation is that the instruments only affect the share of a sector in a country's GDP in so far as they influence domestic relative prices. The lower panel of Table 6 also reports the results of a Sargan test of the model's overidentifying restrictions. In all industries, we are unable to reject the null hypothesis that the excluded exogenous variables are uncorrelated with the residuals in the second-stage regression for GDP shares. This provides support for our key identifying assumption.

In general, the Instrumental Variables coefficients lie close to those estimated in Table 5 using within groups. The lower panel of Table 6 also reports the results of a Hausman test of the null hypothesis that within groups is consistent and efficient. In each industry, we are unable to reject the null hypothesis at conventional critical values. Taken together, this provides evidence that the within groups estimates are not substantially biased by the potential endogeneity of relative prices. Hence, in the remainder of the paper we focus on the within groups results.

Table 5: Baseline Within Groups Estimation

GDP share$_{cjt}$	(1) Agriculture	(2) Manufact.	(3) Other Production	(4) Other Services	(5) Business Services
Obs	200	200	200	200	200
Years	1976-94	1976-94	1976-94	1976-94	1976-94
Mskill1$_{ct}$ (γ_1)	0.0355	-0.0290	0.0016	0.0358	-0.0129
	(5.55)	*(-1.55)*	*(0.09)*	*(2.30)*	*(-1.07)*
Mskill2$_{ct}$ (γ_2)	-0.0034	-0.0215	-0.0921	0.1356	-0.0809
	(-0.25)	*(-0.83)*	*(-2.65)*	*(4.55)*	*(-3.72)*
Mskill3$_{ct}$ (γ_3)	-0.0013	-0.0268	0.0249	0.0254	-0.0116
	(-0.19)	*(-1.40)*	*(1.33)*	*(1.80)*	*(-0.74)*
Fskill1$_{ct}$ (γ_4)	-0.0378	0.0126	0.0150	-0.0290	-0.0003
	(-5.37)	*(0.65)*	*(0.73)*	*(-1.76)*	*(-0.02)*
Fskill2$_{ct}$ (γ_5)	0.0036	0.0081	0.0420	-0.0383	0.0610
	(0.36)	*(0.32)*	*(1.47)*	*(-1.60)*	*(3.35)*
Fskill3$_{ct}$ (γ_6)	0.0100	0.0070	-0.0448	-0.0007	0.0116
	(2.17)	*(0.49)*	*(-3.10)*	*(-0.07)*	*(1.06)*
Arable$_{ct}$ (γ_7)	-0.0045	0.0204	0.0300	-0.1082	0.0140
	(-0.71)	*(0.93)*	*(1.21)*	*(-4.76)*	*(1.12)*
P10$_{ct}$ (α_1)	0.0275	0.0057	-0.0360	0.0138	0.0065
	(12.63)	*(0.88)*	*(-2.97)*	*(1.87)*	*(1.16)*
P40$_{ct}$ (α_2)	-0.0088	-0.0510	0.1277	-0.0241	-0.0262
	(-3.87)	*(-7.61)*	*(10.22)*	*(-2.95)*	*(-5.75)*
P50$_{ct}$ (α_3)	-0.0053	0.0101	-0.0343	0.0571	-0.0716
	(-1.07)	*(0.66)*	*(-1.78)*	*(3.65)*	*(-7.30)*
P60$_{ct}$ (α_4)	0.0046	-0.0446	-0.0091	-0.0481	0.1079
	(1.43)	*(-3.35)*	*(-0.77)*	*(-3.99)*	*(13.65)*
TFP10$_{ct}$ (β_1)	0.0220	-0.0058	0.0041	-0.0162	0.0103
	(8.58)	*(-0.84)*	*(0.27)*	*(-1.64)*	*(1.49)*
TFP40$_{ct}$ (β_2)	0.0029	-0.0374	0.0849	-0.0188	-0.0190
	(0.826)	*(-4.36)*	*(4.97)*	*(-1.72)*	*(-2.21)*
TFP50$_{ct}$ (β_3)	0.0066	0.0588	-0.0625	-0.0041	0.0018
	(1.32)	*(3.06)*	*(-3.74)*	*(-0.33)*	*(0.19)*
TFP60$_{ct}$ (β_4)	0.0088	-0.0421	0.0066	0.0432	0.0199
	(1.66)	*(-2.00)*	*(0.38)*	*(2.98)*	*(1.77)*
Year Dummies	yes	yes	yes	yes	yes
Country-Industry Fixed effect	yes	yes	yes	yes	yes
Maddala-Wu *(p-value)*	0.000	0.000	0.000	0.000	0.015
Levin-Lin *(unit root t-statistic)*	-8.311	-7.720	-4.462	-6.318	-6.163
Adjusted R^2	0.9764	0.9807	0.9654	0.9955	0.9945

Notes: Asymptotic t-statistics in parentheses (based on Huber-White heteroscedasticity robust standard errors). Regressions are estimated industry-by-industry, pooling observations across countries and over time. Estimation is by within groups (least squares dummy variables). All specifications include country-industry fixed effects and full set of industry-year dummies. Dependent variable is share of a sector in a country's GDP. Independent variables: Mskill1 is log number of males out of working age male population with low education relative to stock of physical capital; Mskill2 is log number of males with medium education relative to physical capital; Mskill3 is log number of males with high education relative to physical capital; Fskill1-Fskill3 are female educational endowments defined analogously; Arable is log arable land area relative to physical capital; P10 is log price of industry 10 output (Agriculture) relative to industry 30 output (Manufacturing), and so on for the other industries; industry 40 is Other Production; industry 50 is Other Services; industry 60 is Business Services; TFP10 is a log superlative index number measure of TFP in industry 10 relative to TFP in industry 30, and so on for the other industries; to abstract from short-run fluctuations all TFP measures are smoothed with a Hodrick-Prescott filter; Maddala-Wu is the Maddala and Wu (1999) panel data test of the null hypothesis that there is a unit root in the residuals. Levin-Lin is the Levin and Lin (1992) panel data test of the null hypothesis that there is a unit root in the residuals. Critical values are from Levin and Lin (1992), Table 5: 1% critical value = -6.72; 5% critical value = -6.28; 10% critical value = -6.04.

Table 6: Instrumental Variables Estimation

GDP share$_{cjt}$	(1) Agriculture	(2) Manufact.	(3) Other Production	(4) Other Services	(5) Business Services
Obs	200	200	200	200	200
Years	1976-94	1976-94	1976-94	1976-94	1976-94
Mskill1$_{ct}$ (γ_1)	0.0453	-0.0269	0.0227	0.0257	-0.0100
	(5.08)	*(-0.96)*	*(0.75)*	*(1.07)*	*(-0.65)*
Mskill2$_{ct}$ (γ_2)	0.0034	-0.0223	-0.0823	0.1248	-0.0754
	(0.22)	*(-0.52)*	*(-1.72)*	*(3.14)*	*(-3.12)*
Mskill3$_{ct}$ (γ_3)	0.0021	-0.0068	0.0530	0.0015	-0.014
	(0.20)	*(-0.25)*	*(1.87)*	*(0.07)*	*(-0.74)*
Fskill1$_{ct}$ (γ_4)	-0.0493	0.0066	-0.0041	-0.0182	-0.0070
	(-4.96)	*(0.20)*	*(-0.12)*	*(-0.65)*	*(-0.41)*
Fskill2$_{ct}$ (γ_5)	-0.0026	-0.0258	0.0207	-0.0172	0.0550
	(-0.20)	*(-0.53)*	*(0.58)*	*(-0.49)*	*(2.37)*
Fskill3$_{ct}$ (γ_6)	0.0098	0.0220	-0.0456	0.0001	0.0139
	(1.712)	*(0.96)*	*(-1.92)*	*(0.01)*	*(1.09)*
Arable$_{ct}$ (γ_7)	-0.0158	0.0721	0.0562	-0.1465	0.0029
	(-0.28)	*(1.38)*	*(0.97)*	*(-3.23)*	*(0.11)*
P10$_{ct}$ (α_1)	0.0354	-0.0014	0.0294	-0.0279	-0.0118
	(5.23)	*(-0.05)*	*(1.13)*	*(-1.37)*	*(-0.89)*
P40$_{ct}$ (α_2)	-0.0092	-0.1055	0.0953	0.0239	-0.0289
	(-1.06)	*(-2.50)*	*(2.70)*	*(0.89)*	*(-1.58)*
P50$_{ct}$ (α_3)	-0.0234	0.1222	0.0388	-0.0449	-0.0924
	(-1.35)	*(1.43)*	*(0.50)*	*(-0.75)*	*(-2.30)*
P60$_{ct}$ (α_4)	0.0256	0.0123	0.0019	-0.0396	0.1335
	(1.52)	*(0.24)*	*(0.04)*	*(-0.93)*	*(4.18)*
TFP10$_{ct}$ (β_1)	0.0206	-0.0177	0.0329	-0.0372	-0.0045
	(4.16)	*(-0.96)*	*(1.36)*	*(-2.23)*	*(-0.37)*
TFP40$_{ct}$ (β_2)	0.0041	-0.0582	0.0668	0.0002	-0.0152
	(0.81)	*(-2.59)*	*(2.06)*	*(0.01)*	*(-1.11)*
TFP50$_{ct}$ (β_3)	-0.0018	0.1274	0.0013	-0.0780	-0.0156
	(-0.16)	*(2.18)*	*(0.03)*	*(-2.22)*	*(-0.62)*
TFP60$_{ct}$ (β_4)	0.0252	0.0262	0.0165	0.0421	0.0450
	(1.45)	*(0.48)*	*(0.28)*	*(0.95)*	*(1.30)*
Year Dummies	yes	yes	yes	yes	yes
Country-Industry Fixed Effect	yes	yes	yes	yes	yes
First-Stage F-test *(p-value)*	0.000	-	0.000	0.000	0.001
Hausman *(p-value)*	0.999	0.999	0.999	0.999	0.999
Sargan *(p-value)*	0.978	0.788	0.879	0.986	0.999
Adjusted R^2	0.9695	0.9604	0.9407	0.9909	0.9938

Notes: Asymptotic t-statistics in parentheses (based on Huber-White heteroscedasticity robust standard errors). Regressions are estimated industry-by-industry, pooling observations across countries and over time. Estimation is by Instrumental Variables. All specifications include country-industry fixed effects and full set of industry-year dummies. Dependent variable is share of a sector in a country's GDP. Independent variables: Mskill1 is log number of males out of working age male population with low education relative to stock of physical capital; Mskill2 is log number of males with medium education relative to physical capital; Mskill3 is log number of males with high education relative to physical capital; Fskill1-Fskill3 are female educational endowments defined analogously; Arable is log arable land area relative to physical capital; P10 is log price of industry 10 output (Agriculture) relative to industry 30 output (Manufacturing), and so on for the other industries; industry 40 is Other Production; industry 50 is Other Services; industry 60 is Business Services; TFP10 is a log superlative index number measure of TFP in industry 10 relative to TFP in industry 30, and so on for the other industries. To abstract from short-run fluctuations all TFP measures are smoothed with a Hodrick-Prescott filter. Endogenous variables: P10, P40, P50, and P60. Exogenous variables Mskill1-Mskill3, Fskill1-Fskill3, TFP10-TFP60, Z10-Z60, Exrate, and Tariff. Z10 is a measure of log price at the border, calculated as trade-weighted sum of the price of industry 10 output in all other countries; Exrate is log nominal exchange rate; Tariff is the log average tariff rate. First-stage F-test is a test of the joint significance of the excluded exogenous variables in the first-stage regression for industry prices. Since each industry's price is normalised relative to manufacturing when linear homogeneity is imposed, there is no first-stage regression for manufacturing prices. Hausman is the Hausman (1978) specification test of the null hypothesis that within groups is consistent and efficient; Sargan is the Sargan (1958) test of the model's overidentifying restrictions.

In practice, it is likely to take time for factors of production to be reallocated from declining to expanding sectors. Equation (6) should therefore be interpreted as a long-run relationship towards which gradual adjustment occurs. The speed at which factors of production are able to be reallocated may depend on labour market policies and institutions – in particular, on employment protection provisions that limit the ability of firms in declining sectors to shed labour or raise the cost of them doing so. Table 7 therefore augments equation (6) with a lagged dependent variable and with the lagged dependent variable interacted with a measure of the extent of employment protection.[30] We thus arrive at the dynamic specification in equation (8), where the speed of adjustment towards long-run equilibrium is given by $(1-\delta_0-(\delta_1 \times EmProt_c))$. For convenience, the employment protection measure is normalized by its mean across countries; this normalization implies that one minus the estimated coefficient on the lagged dependent variable ($1-\delta_0$) can be interpreted as a measure of the speed of adjustment at sample mean values of employment protection.

The estimated coefficient on the lagged dependent variable in Table 7 is positive and highly statistically significant in all industries, providing evidence of partial adjustment. The employment protection interaction is positively signed and statistically significant in the 3 industries that declined as a share of GDP during the sample period – Agriculture, Manufacturing, and Other Production. This provides evidence that countries with higher levels of employment protection were slower to reallocate resources away from these sectors in response to a change in long-run patterns of specialization. The employment interaction is positively signed although not statistically significant in the 2 industries which expanded as a share of GDP during the sample period – Other Services and Business Services. This is consistent with the idea that the main effect of employment protection is to raise the cost of shedding labour in declining sectors. The effects of employment protection are not only statistically significant but also quantitatively important. Moving from the country with the lowest levels of employment protection (the United States) to the country with the highest (Italy) raises the estimated coefficient on the lagged dependent variable in Manufacturing from 0.44 to 0.78 (an increase of over 75%) and reduces the implied speed of adjustment from 0.56 to 0.22.

[30] See Appendix A and Nickell (1997) for further information concerning the employment protection measure.

Table 7: Dynamic Within Groups Estimation: Partial Adjustment and the Role of Employment Protection

GDP share$_{ct}$	**(1) Agriculture**	**(2) Manufact.**	**(3) Other Production**	**(4) Other Services**	**(5) Business Services**
Obs	200	200	200	200	200
Years	1976-94	1976-94	1976-94	1976-94	1976-94
GDP share$_{ct-1}$ (δ_0)	0.4297	0.5885	0.4452	0.6229	0.6247
	(4.810)	*(10.224)*	*(3.455)*	*(7.070)*	*(11.065)*
EmProt*GDP share$_{ct-1}$ (δ_1)	0.0166	0.0181	0.0353	0.0139	0.0068
	(2.164)	*(2.760)*	*(2.546)*	*(1.380)*	*(0.928)*
Mskill1$_{ct}$ (γ_1)	0.0236	-0.0362	0.0354	0.0058	0.0028
	(3.155)	*(-2.565)*	*(2.217)*	*(0.465)*	*(0.288)*
Mskill2$_{ct}$ (γ_2)	0.0091	0.0159	-0.0338	0.0468	-0.0581
	(0.760)	*(0.801)*	*(-1.889)*	*(2.574)*	*(-4.097)*
Mskill3$_{ct}$ (γ_3)	0.0019	-0.0096	0.0212	0.0054	0.0015
	(0.323)	*(-0.630)*	*(1.612)*	*(0.593)*	*(0.142)*
Fskill1$_{ct}$ (γ_4)	-0.0242	0.0280	-0.0394	0.0043	-0.0029
	(-2.847)	*(1.790)*	*(-2.159)*	*(0.295)*	*(-0.253)*
Fskill2$_{ct}$ (γ_5)	-0.0047	-0.0164	0.0227	-0.0087	0.0394
	(-0.504)	*(-0.942)*	*(1.392)*	*(-0.572)*	*(2.973)*
Fskill3$_{ct}$ (γ_6)	0.0029	-0.0036	-0.0344	-0.0028	0.0049
	(0.723)	*(-0.302)*	*(-3.589)*	*(0.393)*	*(0.602)*
Arable$_{ct}$ (γ_7)	0.0025	0.0576	0.0052	-0.0587	-0.0004
	(0.443)	*(3.387)*	*(0.363)*	*(-4.699)*	*(-0.044)*
P10$_{ct}$ (α_1)	0.0196	-0.0018	-0.0294	0.0156	0.0031
	(7.943)	*(-0.357)*	*(-2.686)*	*(2.625)*	*(0.764)*
P40$_{ct}$ (α_2)	-0.0042	-0.0258	0.0669	-0.0138	-0.0081
	(-2.119)	*(-5.061)*	*(3.943)*	*(-2.497)*	*(-2.364)*
P50$_{ct}$ (α_3)	-0.0002	0.0198	-0.0160	0.0175	-0.0319
	(-0.037)	*(1.936)*	*(-1.078)*	*(1.574)*	*(-3.867)*
P60$_{ct}$ (α_4)	-0.0025	-0.0321	-0.0060	-0.0233	0.0559
	(-0.825)	*(-3.438)*	*(-0.677)*	*(-2.579)*	*(7.561)*
TFP10$_{ct}$ (β_1)	0.0106	-0.0239	0.0016	0.0063	0.0020
	(3.524)	*(-3.219)*	*(0.170)*	*(0.943)*	*(0.355)*
TFP40$_{ct}$ (β_2)	0.0022	-0.0130	0.0656	-0.0102	-0.0170
	(0.625)	*(-1.759)*	*(3.733)*	*(-1.075)*	*(-2.618)*
TFP50$_{ct}$ (β_3)	0.0050	0.0316	-0.0396	0.0128	-0.0076
	(1.294)	*(2.802)*	*(-3.003)*	*(1.309)*	*(-0.913)*
TFP60$_{ct}$ (β_4)	-0.0004	-0.0357	0.0204	-0.0006	0.0235
	(-0.097)	*(-2.919)*	*(1.647)*	*(-0.063)*	*(2.808)*
Year Dummies	yes	yes	yes	yes	yes
Country-industry Fixed Effect	yes	yes	yes	yes	yes
Adjusted R^2	0.9830	0.989	0.979	0.998	0.997

Notes: asymptotic t-statistics in parentheses (based on Huber-White heteroscedasticity robust standard errors). Regressions are estimated industry-by-industry, pooling observations across countries and over time. Estimation is by within groups (least squares dummy variables). All specifications include country-industry fixed effects and full set of industry-year dummies. Dependent variable is share of a sector in a country's GDP. Independent variables: EmProt is an OECD measure of the strength of employment protection institutions and policies which ranges from 1 to 20; Mskill1 is log number of males out of working age male population with low education relative to stock of physical capital; Mskill2 is log number of males with medium education relative to physical capital; Mskill3 is log number of males with high education relative to physical capital; Fskill1-Fskill3 are female educational endowments defined analogously; Arable is log arable land area relative to physical capital; P10 is log price of industry 10 output (Agriculture) relative to industry 30 output (Manufacturing), and so on for the other industries; industry 40 is Other Production; industry 50 is Other Services; industry 60 is Business Services; TFP10 is a log superlative index number measure of TFP in industry 10 relative to TFP in industry 30, and so on for the other industries. To abstract from short-run fluctuations all TFP measures are smoothed with a Hodrick-Prescott filter.

The long-run coefficients on relative prices, technology, and factor endowments evaluated at mean levels of employment protection can be obtained from Table 7 by dividing the estimated coefficients by *(1-δ_0)* (*0.41* in Manufacturing). These are the long-run coefficients reported in Table 8. In general, they correspond closely to the parameter estimates from the static specification in Tables 5 and 6. For example, the estimated long-run coefficient of 0.0414 on male low education corresponds to a value of 0.0355 in Table 5 and 0.0453 in Table 6. The pattern of estimated coefficients on the relative price and TFP terms again conforms to the predictions of theory: the estimated coefficients on own-industry relative prices and TFP in Tables 7 and 8 are all positive (where the estimated manufacturing coefficient is minus the sum of the estimated coefficients on the other industry terms).

Table 8 : Implied Long-run Estimated Coefficients at Mean Values of Employment Protection

GDP share$_{ct}$		**(1) Agriculture**	**(2) Manufact.**	**(3) Other Production**	**(4) Other Services**	**(5) Business Services**
Obs		200	200	200	200	200
Years		1976-94	1976-94	1976-94	1976-94	1976-94
Mskill1$_{ct}$	$(\gamma_1/(1-\delta_0))$	0.0414	-0.0881	0.0638	0.0155	0.0075
Mskill2$_{ct}$	$(\gamma_2/(1-\delta_0))$	0.0159	0.0385	-0.0609	0.1242	-0.1547
Mskill3$_{ct}$	$(\gamma_3/(1-\delta_0))$	0.0033	-0.0233	0.0382	0.0142	0.0041
Fkill1$_{ct}$	$(\gamma_4/(1-\delta_0))$	-0.0425	0.0681	-0.0710	0.0114	-0.0077
Fkill2$_{ct}$	$(\gamma_5/(1-\delta_0))$	-0.0083	-0.0399	0.0409	-0.0231	0.1051
Fkill3$_{ct}$	$(\gamma_6/(1-\delta_0))$	0.0051	-0.0088	-0.0620	0.0075	0.0130
Arable$_{ct}$	$(\gamma_7/(1-\delta_0))$	0.0044	0.1401	0.0093	-0.1558	-0.0011
P10$_{ct}$	$(\alpha_1/(1-\delta_0))$	0.0343	-0.0043	-0.0531	0.0414	0.0083
P40$_{ct}$	$(\alpha_2/(1-\delta_0))$	-0.0073	-0.0627	0.1206	-0.0366	-0.0217
P50$_{ct}$	$(\alpha_3/(1-\delta_0))$	-0.0003	0.0482	-0.0289	0.0464	-0.0849
P60$_{ct}$	$(\alpha_4/(1-\delta_0))$	-0.0043	-0.0780	-0.0109	-0.0618	0.1489
TFP10$_{ct}$	$(\beta_1/(1-\delta_0))$	0.0185	-0.0581	0.0029	0.0166	0.0053
TFP40$_{ct}$	$(\beta_2/(1-\delta_0))$	0.0038	-0.0317	0.1182	-0.0269	-0.0452
TFP50$_{ct}$	$(\beta_3/(1-\delta_0))$	0.0087	-0.0767	-0.0715	0.0340	-0.0204
TFP60$_{ct}$	$(\beta_4/(1-\delta_0))$	-0.0006	-0.0868	0.0368	-0.0017	0.0626

Notes: long-run estimated coefficients evaluated at the mean value of employment protection across countries from the dynamic within groups specification in Table 7. Since the employment protection variable in the interaction term is normalised by its mean across countries, these long-run coefficients are obtained from the parameter estimates reported in Table 7 by dividing by 1 minus the estimated coefficient on the lagged dependent variable *(1-δ_0)*. Mskill1 is log number of males out of working age male population with low education relative to stock of physical capital; Mskill2 is log number of males with medium education relative to physical capital; Mskill3 is log number of males with high education relative to physical capital; Fskill1-Fskill3 are female educational endowments defined analogously; Arable is log arable land area relative to physical capital; P10 is log price of industry 10 output (Agriculture) relative to industry 30 output (Manufacturing), and so on for the other industries; industry 40 is Other Production; industry 50 is Other Services; industry 60 is Business Services; TFP10 is a log superlative index number measure of TFP in industry 10 relative to TFP in industry 30, and so on for the other industries. To abstract from short-run fluctuations all TFP measures are smoothed with a Hodrick-Prescott filter.

Analyzing the pattern of long-run coefficients across industries, we see that moving a man from low to medium education reduces the share of Agriculture and Other Production in GDP but increases the share of Manufacturing and Other Services. In contrast, the general equilibrium effect of moving a woman from low to medium education is to reduce specialization in Manufacturing but increase specialization in Business Services. Similarly, moving a man from medium to high education increases specialization in Business Services, while moving a woman from medium to high education has exactly the opposite effect. Thus, production structure responds very differently to the educational attainment of men and women, and these results emphasize the importance of distinguishing between male and female labour market outcomes. With many factors of production plus an uneven number of industries and factors of production, there is no one appropriate measure of factor intensity. However, taking all industries together, the pattern of estimated coefficients is broadly consistent with information on factor intensity. For example, low education men account for a relatively large share of total employment in Other Production, while women account for a very small share of employment in this industry.

Table 9 evaluates the contribution of each of the explanatory variables to observed changes in shares of GDP during the sample period. For simplicity, we focus on the static specification excluding the lagged dependent variable, and take the instrumental variables estimates reported in Table 6 (results using the within groups estimates from Table 5 are extremely similar). Taking differences between the beginning and end of the sample period in equation (6), the change in GDP shares predicted by the model can be compared with the change in actual GDP shares, and the predicted changes can be decomposed into the contributions of factor endowments, relative prices, TFP, and the year effects. Table 9 reports the results of such an analysis. In the interests of comparability, the same time-period of 1976-93 is used for Japan, United Kingdom, and United States, while data availability constrains the time-period for West Germany to 1985-93. Since equation (6) is log-linear, the contributions of the individual explanatory variables sum to change in predicted GDP shares.

Looking across industries, the predicted change in GDP shares typically lies close to the actual change, providing evidence that the model is relatively successful in explaining changes in specialization over time. For example, the average absolute prediction error across countries in Manufacturing in Table 9 is 1.05%, compared to an average initial share of Manufacturing in GDP in the 4 countries of 28.74%. The model is least successful in Other Production, which is consistent with the existence of unobserved changes in known mineral resources that are important for this sector. The year effects play a substantial role in all sectors except Business Services, suggesting the importance of common changes in relative prices, TFP, and factor endowments across the 14 OECD countries during the sample period. This is consistent with the idea of de-industrialization as a secular trend or shared experience across OECD countries.

Table 9: Contribution of Explanatory Variables to Changes in Shares of GDP, Second-stage IV Parameter Estimates from Table 6

	(1) Agriculture	(2) Manufact.	(3) Other Production	(4) Business Services	(5) Other Services
West Germany (1985-93)					
Actual Change in GDP Share	-0.71	-5.46	-0.78	0.38	6.34
Predicted Change in GDP Share	-0.92	-4.54	-2.26	2.38	5.25
Education (Male + Female)	1.41	-1.10	-1.12	-0.39	3.25
Capital	0.14	-0.39	-0.42	0.71	0.61
Arable Land	0.04	-0.17	-0.13	-0.01	0.35
TFP	0.38	1.51	0.31	0.12	-1.01
Prices	-1.33	0.00	-1.32	0.68	1.12
Year Effects	-1.56	-4.39	0.43	1.27	0.94
Japan (1976-93)					
Actual Change in GDP Share	-3.14	-4.93	1.81	3.43	5.43
Predicted Change in GDP Share	-3.45	-5.47	2.50	3.88	4.57
Education (Male + Female)	1.89	0.38	-3.56	0.95	3.70
Capital	0.71	-1.90	-2.07	3.53	3.02
Arable Land	0.15	-0.67	-0.52	-0.03	1.36
TFP	-2.01	2.55	-1.54	-1.01	0.62
Prices	-1.01	-0.51	6.68	-1.15	-1.46
Year Effects	-3.17	-5.33	3.51	1.58	-2.67
United Kingdom (1976-93)					
Actual Change in GDP Share	-0.92	-7.65	-2.14	8.48	3.97
Predicted Change in GDP Share	-1.30	-9.16	0.09	8.88	2.22
Education (Male + Female)	1.98	1.52	-4.43	1.91	3.56
Capital	0.29	-0.78	-0.85	1.45	1.24
Arable Land	0.20	-0.92	-0.72	-0.04	1.87
TFP	0.25	-4.70	3.87	-1.73	-1.43
Prices	-0.86	1.04	-1.29	5.70	-0.36
Year Effects	-3.17	-5.33	3.51	1.58	-2.67
United States (1976-93)					
Actual Change in GDP Share	-1.39	-5.48	-2.07	8.64	1.22
Predicted Change in GDP Share	-1.89	-6.69	-1.27	8.12	1.98
Education (Male + Female)	1.97	0.89	-2.92	0.32	3.08
Capital	0.32	-0.85	-0.93	1.58	1.35
Arable Land	0.04	-0.18	-0.14	-0.01	0.36
TFP	0.86	-0.03	-1.37	0.58	-0.98
Prices	-1.91	-1.20	0.56	4.06	0.83
Year Effects	-3.17	-5.33	3.51	1.58	-2.67

Notes: equation (6) is used to decompose the change in shares of GDP into the contributions of changes in the individual explanatory variables between the beginning and end of the sample period. Parameter estimates are taken from the second-stage IV results in Table 6. Education contribution calculated as follows. Multiply the change in the log of each education endowment by its estimated coefficient to yield the predicted effect of changes in that education endowment. Sum across education endowments to give the estimated contribution of changes in education to changes in shares of GDP. Contributions of other variables are calculated analogously. Since equation (6) is log linear, summing the contributions of individual variables yields the change in predicted shares of GDP. The table reports the average contributions over time for individual country-industries. Changes in shares of GDP and their components are reported as percentages. Thus, in Germany, Agriculture's share of GDP was predicted to fall by 0.92%. The change in relative prices implied a fall in Agriculture's share of GDP of 1.33%. The year effects capture the effect of any change in relative prices, technology, and factor endowments that is common across countries. The time-period over which averages are taken is 1976-93, except for West Germany where the time-period is 1985-93. This variation in time-period explains the difference in the year effects' contribution between West Germany and the other countries.

However, we noted earlier that the timing and magnitude of de-industrialization varies substantially. The decline in manufacturing's share of GDP occurred earlier and was more extensive in the United Kingdom and United States than in Germany and Japan. Table 9 suggests that this is largely explained by differences in rates of TFP growth across the 4 countries. While the net contribution of TFP growth in all 5 sectors to changes in Manufacturing's share of GDP was negative in the United Kingdom and United States (-4.70% and –0.03% respectively), West Germany and Japan experienced positive contributions (1.51% and 2.55% respectively). The especially rapid decline in Agriculture's share of GDP in Japan (3.14%) is largely explained by rates of TFP growth (a contribution of 2.01%), although the evolution of relative prices across sectors also plays an important role (a contribution of 1.01%).

Rising educational attainment made a large negative contribution to the change in Other Production's GDP share and a large positive contribution to the change in Other Services' GDP share. Thus, other things equal, countries with more rapid increases in educational attainment experienced larger rises in the share of Other Services in GDP, and this is consistent with the idea that many service sectors are relatively skill intensive. Table 9 suggests that the more rapid increase in Business Services' GDP share in the United Kingdom and United States relative to West Germany and Japan was largely due to country-specific changes in relative prices (which, for example, made a contribution of 5.70% in the United Kingdom and –1.15% in Japan). Physical capital also made a positive contribution to the expansion of Business Services and Other Services, and this is consistent with the extremely high values of Buildings and Structures capital (in particular, real estate) in these sectors.

6. Conclusions

A key feature of economic growth in industrialized countries since the early 1970s has been the secular decline in manufacturing's share of GDP and the secular rise in the share of service sectors. Although these changes are common to all OECD countries, their magnitude and timing varies substantially. This paper examines the role played by relative prices, technology, factor endowments, and labour market institutions in the process of 'de-industrialization'.

We find a statistically significant and quantitatively important effect of levels of educational attainment on patterns of production. The effect of a given level of educational attainment varies substantially between men and women. While moving a man from low to medium education reduces the share of Agriculture and Other Production in GDP and increases the share of Manufacturing and Other Services, moving a woman from low to medium education reduces specialization in Manufacturing and increases specialization in Business Services. These findings are consistent with the large labour market literature on male-female differentials and suggest that men and women of the same educational level have or are perceived to have different vectors of other characteristics or dimensions of skills.

The effects of relative prices and technical efficiency on patterns of production confirm to the predictions of theory. We find positive and statistically significant impact of own-industry prices and technical efficiency on the share of a sector in GDP. In a specification including a country-industry effect and industry-time dummies, we reject the null hypothesis that the coefficients on relative prices are equal to zero, suggesting an important role for country-specific changes in relative prices. The results are robust to instrumenting domestic relative prices using prices at the border, exchange rates, and average tariff levels. We provide evidence that the instruments are highly statistically significant in the first-stage regression and that the identifying assumptions underlying the instrumental variables estimation are satisfied.

There is evidence of partial adjustment towards long-run patterns of specialization, and the speed of adjustment is shown to vary systematically across countries with their extent of provision for employment protection. This confirms the importance of labour market policies and institutions in facilitating the reallocation of resources from declining to expanding sectors. Taken together, our results emphasize the role of labour market characteristics, policies, and institutions in shaping product market outcomes.

Appendix A: Imperfect Competition and External Economies of Scale

Although the neoclassical model is typically analysed under the assumption of perfect competition, it is relatively straightforward to introduce imperfect competition following Helpman (1984). Suppose that the representative consumer's utility function is weakly separable in the output of sectors $j=1,\ldots,n$, while, within each sector j, a variety of differentiated products are consumed $g=1,\ldots,G$,

$$U = U\left[u_1(\cdot), u_2(\cdot), \cdots, u_n(\cdot)\right] \tag{A1}$$

$$u_j(y_{j1}, \cdots, y_{jG}) = \left(\sum_{g=1}^{G} y_{jg}^{\beta_j} \right)^{1/\beta_j}, \qquad 0<\beta_j<1 \tag{A2}$$

where, for simplicity, we assume that the sub-utility function $u_j(A)$ takes the Dixit-Stiglitz form. Profit maximization yields the following standard result,

$$p_{jg} = p_j = \left(\frac{\sigma_j}{\sigma_j - 1} \right) . b_j(q) \tag{A3}$$

where $\sigma_j=1/(1-\beta_j)$ is the perceived elasticity of demand facing the producer of each variety in sector j ; $b_j(\cdot)$ is the unit cost function – assumed to be the same for all producers in a given sector; q is the vector of factor prices. The revenue function is again defined as the value of profit maximising outputs $(r(p,v)=p.y(p,v))$, where the value of output of good j is simply $\sum_g p_{jg}.y_{jg} = p_j . \sum_g y_{jg}$.

The analysis may also be extended to introduce external economies of scale or localized knowledge spillovers (see Helpman (1984)).[31] This corresponds to the case where the country-industry technology variable (θ_{cjt}) in Section 2 is a function of the scale or density of economic activity in a particular location (as in Ciccone and Hall (1996)).

[31] See Davis and Weinstein (1998b), (1999), Fujita, Krugman, and Venables (1999), and Midelfart-Knarvik, Overman, and Venables (2000) for work combining factor endowments and economic geography as determinants of production structure.

Appendix B: Data Sources

B.1 Summary of educational attainment data sources

Australia: 1982-1993 & 1979-93, male & female separately, population and labour force.
Data for labour force and population male & female separately from the "Labour Statistics Australia ABS Catalogue No.6101.0".
Actual population & labour force data for the years 1982-1993 & 1979-93 respectively.
Three groups: **(low)** Didn't attend highest level of Secondary School **(middle)** Attended highest level of Secondary School + Trade, Tech or Certificate **(high)** Degree
Belgium: 1986-1995 male & female separately, population only.
Data for the population male & female separately from "Enquete sur les forces de travail" Statistiques Sociales, Ministere des Affaires Economiques 1995 & 1991.
Actual population data for all the years.
Three groups: **(low)** Enseignement primaire ou non **(middle)** Enseignement secondaire inferieur + Enseignement secondaire superieur + Enseignement superieur non universitaire de type court + Enseignement superieur non universitaire de type long **(high)** Enseignement universitaire
Canada: 1975-1995 male & female separately, population and labour force.
Data for labour force and population male & female separately from the "Annual Labour Force Averages 1981-1988 & 1989-1994 & 1995 & 1996" & "The Labour Force: 1975, 1976, 1977, 1978 & 1979".
Actual population & labour force data for all the years but with some data replaced by interpolations for 1990-95.
Three groups (pre 1981): **(low)** 0-8 years **(middle)** Some high school & no post-secondary + Some post-secondary + Post-secondary certificate or diploma **(high)** University Degree
Three groups (1981-89): **(low)** 0-8 years **(middle)** 9-13 years + Some post-secondary + Post-secondary certificate or diploma **(high)** University Degree
Three groups (1990-96): **(low)** 0-8 years **(middle)** 9-13 years + Graduated from high school + Some post-secondary + Post-secondary certificate or diploma **(high)** University Degree
Denmark: 1983-1995, male & female separately, population only.
Data for population male & female separately from the Danish Annual Statistics "Statistik Arbog".
Actual population data for the years 1983, 1985, 1987, 1988, 1990, 1991, 1993 & 1995. Missing years of data were filled in by interpolation between 1983 and 1995 and but with some data replaced by interpolations for 1991-95.
Three groups: **(low)** second level, first stage **(middle)** second level, second stage (general and vocational) and education at the third level, first stage (university and non-university type) **(high)** third level, second stage.
France: 1982-1995, male & female separately, labour force only.
Data for labour force male & female separately from the "Enquete sur l'emploi: resultats detaille", les collections de l'insee, institut national de la statistique et des etudes economiques.
Actual labour force data for the years 1982, 1983, 1986-90, 1992, 1993, 1994 & 1997 for men and women separately. Missing years of data were filled in by interpolation between 1982 and 1997.
Three groups (pre 1994): **(low)** Aucun diplome ou certificat d'etudes (cep) seul **(middle)** Brevet d'etudes du premier cycle (bepc) seul + Cap, bep, ou autre diplome de ce niveau + Baccalaureat ou brevet professional, ou autre diplome de ce niveau **(high)** Diplome du 1er cycle universitaire, bts, dut, diplome paramedical ou social + Diplome du 2e or 3e cycle universitiaire, diplome d'une grande ecole ou ecole d'ingenier
Three groups (1994 onwards): **(low)** Aucun diplome ou CEP **(middle)** BEPC seul + Cap, bep, ou autre diplome de ce niveau + Baccalaureat, brevet professional ou autre diplome de ce niveau **(high)** Baccalaureat + 2 ans + Diplome superieur
Finland: 1984-1995 male & female separately, population and labour force.
Data for labour force and population male & female separately from the "Tyovoiman koulutus ja ammatit" Statistics Finland.
Actual population & labour force data for all the years.
Three groups: **(low)** Basic education only **(middle)** Upper secondary education - lower level + Upper secondary education – upper level **(high)** Higher education - lower level + Higher education – upper level

Germany: 1984-1995 male & female separately, population and labour force.
Data for the population and labour force, male & female separately from German Socio-Economic Panel (GSOEP).
Actual population & labour force data for all years but with some data replaced by interpolations for 1991-95.
Three groups: **(low)** 9 years of schooling + no vocational **(middle)** 10 years of schooling and no vocational + 9 years of schooling and some vocational + 10 years of schooling and some vocational + 13 years of schooling + College **(high)** University
Thanks to Damon Clark (CEP, LSE)
Italy: 1977-1995 male & female separately, labour force only.
Data for the population male & female separately from "Indagine sulle forze di lavoro" in the table "Forze di lavoro secondo di sesso, la classe di eta, il titolo di studio e la condizione".
Actual labour force data for all years but with some data replaced by interpolations for 1993-95.
Three groups (pre 1993): **(low)** Senza titolo e licenza elementare **(middle)** Licenza scuola media inferiore + Licenza scuola media superiore **(high)** Laurea
Three groups (1993+): **(low)** Dottorato di ricerca o Specializzazione + Laurea **(middle)** Diploma Univ. o Laureabreve + Diploma accesso Universita + Qualifica Lic. Non accesso Universita + Licenza media **(high)** Licenza elementare, nessun titolo
Thanks to Marco Manacorda (Berkeley, USA) and Barbara Petrongolo (Madrid, Spain)
Japan: 1975-1995, male & female separately, labour force only.
Data for labour force male & female separately from the Employment Status Survey published by the Statistics Bureau, Management and Coordination Agency, Government of Japan.
Actual labour force data for the years 1971, 1974, 1979, 1982, 1987, 1992 & 1997 for men and women separately. Missing years of data were filled in by interpolation between 1971 and 1997.
Three groups: **(low pre 1980)** never attended, elementary school and Junior high school **(low post 1980)** elementary school and Junior high school **(middle)** Senior high school and Junior college, technical college **(high)** College or university, including graduate school.
Thanks to Toshiaki Tachibanaki (KIER, Kyoto University) for supplying us directly with these figures.
Netherlands: 1975-1995 male & female separately, population and labour force.
Data for the population male & female separately from the Population Survey (Volkstelling), the Annual Labour Force Survey (Arbeidskrachtentelling (AKT)) and the Monthly Labour Force Survey (Enquete Beroepsbevolking (EBB)).
Actual population & labour force data for the years 1975, 1977, 1979, 1981, 1983, 1985, 1988-95. Missing years of data were filled in by interpolation between 1975 and 1995.
Three groups: **(low)** no qualifications **(middle)** lower + intermediate **(high)** higher qualifications
Thanks to Jan van Ours (Tilburg, Netherlands) for supplying us directly with these figures.
Norway: 1975-1995 male & female separately, population only.
Data for the population male & female separately from Statistical Yearbook of Norway, Statistics Norway.
Actual population data for the years 1975, 1980, 1985, 1986, 1988, 1989 & 1990-95. Missing years of data were filled in by interpolation between 1975 and 1995
Three groups: **(low)** Unknown or no completed education **(middle)** Education at the second level, first stage + Education at the second level, second stage **(high)** Education at the third stage.
Sweden: 1975-1995 male & female separately, population only.
Data for the population male & female separately from Swedish Labour Force Survey.
Actual population data for all the years.
Three groups: **(low)** Elementary school (< 9 years) + 9-year compulsory school **(middle)** Upper secondary school, 2 years or shorter + Upper secondary school, 3 years **(high)** Tertiary (post-secondary) education, 3 years or longer + postgraduate education
Thanks to Gunilla Dahlén (SCB, Sweden) and Ingrid Turtola (SCB, Sweden)
UK: 1975-1995 male & female separately, population and labour force.
Data for the population and labour force with male & female separately from General Household Survey.
Actual population & labour force data for all the years.
Three groups (1977-90): **(low)** no qualifications **(middle)** voc-high + teaching + nursing + A-level + voc-middle + O-level 5+ + voc-low + O-level & clerical + O-level 1-4 + clerical + voc-other + other **(high)** University

Three groups (1991-95): **(low)** no qualifications **(middle)** Teaching + other high + nursing + gce a level + gce a level + gcse & olevel + gcse & olevel + gcse & olevel + comm q, n + cse grd + apprenticeship + scst g6- + foreign + other qual **(high)** higher degree + first degree
Thanks to Glenda Quintini (CEP, LSE) and Steve McIntosh (CEP, LSE)
USA: 1975-1995 male & female separately, population and labour force.
Data for the population and labour force for male & female separately are from the Current Population Survey (CPS).
Actual population & labour force data for all years except 1976 and 1978 (for population data) and some data replaced by interpolations for 1992-95.
Three groups: **(low)** non high school graduates **(middle)** high school graduates + college and associated degrees **(high)** bachelors and higher
Thanks to Lupin Rahman (CEP, LSE) and Randy E. Ilg (Bureau of Labor Statistics, USA)

B2. Production Data and Other Independent Variables

OECD International Sectoral Database (ISDB): data on current price value-added, real value-added (1990 US dollars), real physical capital stock (1990 US dollars), employment, and hours worked for the one-digit industries listed in Table 1B in the main text for the years 1976-94. Data on current price GDP and aggregate real physical stock (1990 US dollars) for 1976-94.
United Nations FAO: data on arable land area (thousands of hectares) for 1970-94.
OECD Bilateral Trade Database: data on bilateral imports between the 14 OECD countries for 1970-94 used to construct prices at the border.
OECD Structural Analysis Industrial Database (STAN): data on nominal exchange rates for converting prices at the border to national currencies.
IMF International Financial Statistics, IMF Government Finance Statistics, and Annual Reports of the European Commission: data on the ratio of tariff revenues to the value of imports. See Djankov *et al.* (1999) for further information concerning these data.
OECD Jobs Study: Evidence and Explanations: index of the strength of employment protection institutions and policies. See Nickell (1997) for further information concerning these data.

Table B1: Breakdown of the Disaggregated Sectors Included in each One-Digit Industry (International Standard Industrial Classification (ISIC))

Code	ISIC	Industry
10	10	Agriculture, Hunting, Forestry, and Fishing
	11	Agriculture and Hunting
	11.1	Agriculture and Livestock Production
	11.2	Agricultural Services
	11.3	Hunting, Trapping, and Game Propagation
	12	Forestry and Logging
	12.1	Forestry
	12.2	Logging
	13	Fishing
	1301	Ocean and Coastal Fishing
	1302	Fishing Not Elsewhere Classified
30	30	Manufacturing
	31	Food, Beverages, and Tobacco
	32	Textile, Wearing Apparel, and Leather Industries
	33	Wood and Wood Products, Including Furniture
	34	Paper and Paper Products; Printing and Publishing
	35	Chemicals and Chemical Products; Petroleum, Coal, Rubber, and Plastic
	36	Non-metallic Mineral Products, except Petroleum and Coal
	37	Basic Metal Industries
	38	Fabricated Metal Products, Machinery and Equipment
	39	Other Manufacturing Industries
40		Other Production
	20	Mining and Quarrying
	21	Coal Mining
	22	Crude Petroleum and Natural Gas Production
	23	Metal Ore Mining
	29	Other Mining
	40	Electricity, Gas, and Water
	41	Electricity, Gas, and Steam
	42	Water Works and Suppy
	50	Construction
		Construction of Dwellings
		Construction of Non-residential Buildings
		Civil Engineering Works
		Demolition of Buildings
602	80	Business Services
	81	Financial Institutions
	8101	Monetary Institutions
	8102	Other Financial Institutions
	8103	Financial Services
	82	Insurance
	83	Real Estate and Business Services
	831	Real Estate
	832	Business Services Except Machinery and Equipment Rentals and Leasing
	833	Machinery and Equipment Rental and Leasing

Table B1 (cont): Breakdown of the Disaggregated Sectors Included in each One-Digit Industry (International Standard Industrial Classification (ISIC))

Code	ISIC	Industry
601		Other Services
	60	Wholesale and Retail Trade, Restaurants and Hotels
	61	Wholesale Trade
	62	Retail Trade
	63	Restaurants and Hotels
	631	Restaurants, Cafes, and Other Eating and Drinking Places
	632	Hotels, Rooming Houses, Camps, and Other Lodging Places
	70	Transport, Storage, and Communication
	71	Transport and Storage
	711	Land Transport
	712	Water Transport
	713	Air Transport
	719	Services Allied to Transport
	72	Communication
	90	Community, Social, and Personal Services
	91	Public Administration and Defence
	92	Sanitary and Similar Services
	93	Social and Related Community Services
	931	Education Services
	932	Research and Scientific Institutes
	933	Medical, Dental, Other Health, and Veterinary Services
	934	Welfare Institutions
	935	Business, Professional, and Labour Associations
	939	Other Social and Related Community Services
	94	Recreational and Cultural Services
	941	Motion Picture and Other Entertainment Services
	942	Libraries, Museums, Botanical Gardens, and Other Cultural Services nes
	949	Amusement and Recreational Services nes
	95	Personal and Household Services
	951	Repair Services nes
	96	International and Other Extra-territorial Bodies
100		Producers of Government Services and Other Producers
		Producers of Government Services
		Other Producers
1000		Total Including All Taxes

Table B2: Female & Male Employment as a Percentage of Total Employment, United Kingdom, 1975, 1985 & 1995

Industry		Year	Percentage
Agriculture			
	Male	1975	84.4
		1985	83.0
		1995	79.4
	Female	1975	15.6
		1985	17.0
		1995	20.6
Manufacturing			
	Male	1975	69.6
		1985	71.5
		1995	71.0
	Female	1975	30.4
		1985	28.5
		1995	29.0
Other Production			
	Male	1975	86.0
		1985	85.5
		1995	80.8
	Female	1975	14.0
		1985	14.5
		1995	19.2
Business Services			
	Male	1975	52.5
		1985	46.6
		1995	42.2
	Female	1975	47.5
		1985	53.4
		1995	57.8
Other Services			
	Male	1975	53.5
		1985	50.4
		1995	50.0
	Female	1975	46.5
		1985	49.6
		1995	50.0

Notes: for each year and each industry, the male employment percentage is number of male employees divided by total number of employees (male plus female) expressed as a percentage. The female employment percentage is defined analogously. Source: United Kingdom New Earnings Survey.

Table B3: Percentages of Female & Male Employment by Level of Educational Attainment, United Kingdom, 1975, 1985 & 1995

Industry		Year	Low	Medium	High
Agriculture					
	Male	1975	3.03 *(2.56)*	92.36 *(77.94)*	4.61 *(3.89)*
		1985	3.12 *(2.59)*	92.57 *(76.80)*	4.30 *(3.57)*
		1995	1.89 *(1.50)*	94.25 *(74.80)*	3.86 *(3.07)*
	Female	1975	5.12 *(0.80)*	89.42 *(13.96)*	5.46 *(0.85)*
		1985	3.38 *(0.58)*	91.89 *(15.66)*	4.73 *(0.81)*
		1995	3.63 *(0.75)*	92.74 *(19.14)*	3.63 *(0.75)*
Manufacturing					
	Male	1975	6.07 *(4.23)*	82.71 *(57.60)*	11.22 *(7.82)*
		1985	5.33 *(3.81)*	80.44 *(57.50)*	14.23 *(10.17)*
		1995	3.81 *(2.70)*	77.51 *(55.05)*	18.68 *(13.27)*
	Female	1975	6.74 *(2.05)*	90.18 *(27.37)*	3.08 *(0.93)*
		1985	5.31 *(1.51)*	90.59 *(25.84)*	4.11 *(1.17)*
		1995	3.45 *(1.00)*	89.90 *(26.05)*	6.65 *(1.93)*
Other Production					
	Male	1975	12.63 *(10.86)*	75.52 *(64.95)*	11.85 *(10.20)*
		1985	12.43 *(10.63)*	73.82 *(63.13)*	13.74 *(11.75)*
		1995	8.56 *(6.91)*	68.12 *(55.04)*	23.32 *(18.84)*
	Female	1975	9.25 *(1.29)*	86.29 *(12.07)*	4.46 *(0.62)*
		1985	8.38 *(1.21)*	84.74 *(12.27)*	6.88 *(1.00)*
		1995	4.15 *(0.80)*	84.86 *(16.30)*	10.99 *(2.11)*
Business Services					
	Male	1975	11.31 *(5.94)*	70.39 *(36.95)*	18.31 *(9.61)*
		1985	10.70 *(4.99)*	69.88 *(32.58)*	19.43 *(9.06)*
		1995	11.05 *(4.67)*	67.74 *(28.60)*	21.20 *(8.95)*
	Female	1975	16.05 *(7.62)*	70.50 *(33.49)*	13.45 *(6.39)*
		1985	15.38 *(8.21)*	70.13 *(37.43)*	14.49 *(7.73)*
		1995	12.25 *(7.08)*	72.80 *(42.06)*	14.95 *(8.64)*
Other Services					
	Male	1975	5.21 *(2.79)*	73.03 *(39.08)*	21.75 *(11.64)*
		1985	3.49 *(1.76)*	71.28 *(35.91)*	25.23 *(12.71)*
		1995	2.87 *(1.44)*	67.95 *(34.01)*	29.18 *(14.60)*
	Female	1975	4.24 *(1.97)*	90.67 *(42.15)*	5.09 *(2.37)*
		1985	2.99 *(1.48)*	90.90 *(45.10)*	6.11 *(3.03)*
		1995	2.53 *(1.26)*	86.18 *(43.05)*	11.29 *(5.64)*

Notes: the value 3.03 in the top left-hand cell is the number of men with low education in Agriculture in 1975 expressed as a percentage of all male employees. The values for women and for the other cells are defined analogously. The figures in parenthesis are expressed as a percentage of all employees. The value 2.56 in the top left-hand cell is thus the number of men with low education in Agriculture in 1975 expressed as a percentage of all employees (male plus female). The values for women and for the other cells are defined analogously. Source: United Kingdom New Earnings Survey.

Appendix C: Panel Data Unit Root Tests

Table C1: Unit Root Tests (Levin and Lin (1992) and Maddala and Wu (1999))

Levin-Lin		Maddala-Wu	
Variable	**Test Statistic**	**Variable**	**Test Statistic**
$Mskill1_{ct}$	-2.071	$Mskill1_{ct}$	73.011
$Mskill2_{ct}$	-5.485	$Mskill2_{ct}$	15.299
$Mskill3_{ct}$	-5.948	$Mskill3_{ct}$	90.047
$Fskill1_{ct}$	-1.776	$Fskill1_{ct}$	17.621
$Fskill2_{ct}$	-8.166	$Fskill2_{ct}$	20.411
$Fskill3_{ct}$	-7.460	$Fskill3_{ct}$	101.824
$Arable_{ct}$	-2.592	$Arable_{ct}$	50.352
$P10_{ct}$	-9.011	$P10_{ct}$	13.301
$P40_{ct}$	-6.339	$P40_{ct}$	32.670
$P50_{ct}$	-5.094	$P50_{ct}$	39.438
$P60_{ct}$	-5.214	$P60_{ct}$	8.813
$TFP10_{ct}$	-5.364	$TFP10_{ct}$	115.300
$TFP40_{ct}$	-4.117	$TFP40_{ct}$	17.145
$TFP50_{ct}$	-6.626	$TFP50_{ct}$	23.696
$TFP60_{ct}$	-1.854	$TFP60_{ct}$	94.296
$Gdpsh10_{ct}$	-5.974	$Gdpsh10_{ct}$	19.432
$Gdpsh30_{ct}$	-2.371	$Gdpsh30_{ct}$	22.345
$Gdpsh40_{ct}$	-1.734	$Gdpsh40_{ct}$	53.389
$Gdpsh50_{ct}$	-1.762	$Gdpsh50_{ct}$	44.240
$Gdpsh60_{ct}$	-0.607	$Gdpsh60_{ct}$	36.748

Notes: Mskill1 is log number of males out of working age male population with low education relative to stock of physical capital; Mskill2 is log number of males with medium education relative to physical capital; Mskill3 is log number of males with high education relative to physical capital; Fskill1-Fskill3 are female educational endowments defined analogously; Arable is log arable land area relative to physical capital; P10 is log price of industry 10 output (Agriculture) relative to industry 30 output (Manufacturing), and so on for the other industries; industry 40 is Other Production; industry 50 is Other Services; industry 60 is Business Services; TFP10 is a log superlative index number measure of TFP in industry 10 relative to TFP in industry 30, and so on for the other industries. Gdpsh10 is share of industry 10 in country GDP, and so on for the other industries. Δ denotes the difference operator. Equation estimated for Levin and Lin (1992) panel data unit root test is $y_{ct} = \rho y_{ct-1} + \eta_c + \varepsilon_{ct}$. Null hypothesis, $H_0 : \rho = 1$. Critical values are taken from Levin and Lin *op cit.*, Table 5: 1% critical value = -6.72; 5% critical value = -6.28; 10% critical value = -6.04. Equation estimated for Maddala and Wu (1999) panel data unit root test is: $\Delta y_{ct} = \rho_c y_{ct-1} + \alpha_1 \Delta y_{ct-1} + \Delta\alpha_2 \Delta y_{ct-2} + \eta_c + \varepsilon_{ct}$ (an Augmented Dickey-Fuller specification). Equation estimated separately for each country. Null hypothesis is $H_0 : \rho_c = 0$ for $c = 1,2,\ldots,C$, against the alternative $H_1 : \rho_c \neq 0$. Denote the MacKinnon approximate *p-value* for the parameter ρ_c in the regression for an individual country by π_c $(c=1,2\ldots,C)$. Following Fisher (1932), Maddala and Wu *op cit.* note that $\lambda = -2\ 3_c \ln(\pi_c)$ is distributed $\chi^2(2C)$. Chi-squared (28) critical values are 1% : 48.2782; 5% : 41.3372; 10% : 37.9159.

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