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Fragmentation, Productivity and Relative Wages in the UK
A General Equilibrium Approach

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Abstract

This paper re-examines the trade-based explanation for the increase in UK wage inequality in the 1990's by focussing on the role of international outsourcing. The use of recent data is thought to be crucial as fragmentation is considered to be primarily a phenomenon of the last decade. In order to account for both the factor and the sector bias of outsourcing and SBTC a general equilibrium approach is adopted following Feenstra and Hanson (1999). Regressing the sum of TFP and prices on outsourcing and SBTC allows one to assess their total net impact on factor prices. The method is extended by estimating the TFP and prices regressions simultaneously using three-stage least squares in order to obtain additional insight in the relative importance of sector bias and factor bias. Both methods yield qualitatively similar results. The results indicate that outsourcing has significantly contributed to the rise in the domestic wage inequality accounting for approximately 11% of the increase in the UK in the 1990s, while no significant effect was found for SBTC. Import prices mandated a significant reduction in the relative wage of skilled labour. Decomposing the total effect of outsourcing in the effect of factor-biased outsourcing and sector-biased outsourcing yields that factor-biased outsourcing was largely responsible for the increase wage inequality. However this result is entirely driven by the estimate of the pass-through rate.

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1. INTRODUCTION

One of the main consequences of the process of globalisation is the increasing international fragmentation of production, that is, the splitting up of production processes into separate components so that they can be produced in different locations (Jones and Kierzkowski, 2001). This phenomenon is likely to have important implications for both the composition and the pattern of international trade. International fragmentation of production leads to the establishment of international production networks, which are associated with trade in intermediates.

In this paper fragmentation (or outsourcing) is related to the debate on trade and wages. The theoretical framework to assess the impact of trade on wages is provided by the Stolper-Samuelson theorem, which relates product prices to relative factor prices through the zero-profit conditions.

In a previous study Görg, Hijzen, and Hine (2001) use a partial equilibrium framework, which focuses on the factor bias by estimating the relative demand for labour. The paper presents mixed results with respect to the role of trade on domestic wage inequality.[1]

Obviously, a partial equilibrium framework employed does not pick up the expansion and decline of industries in response to foreign competition. General equilibrium effects similarly apply to the impact of technological change and outsourcing. Haskel and Slaughter (2002b) find evidence indicating that the sector-bias of skill-biased technological change is important. That is, the factor bias of technological change or outsourcing matters to relative factor prices to the extent that relative industry prices are affected. This can only be the case when those developments are unequally distributed across industries. Thus, a general equilibrium framework is necessary in order to account for both factor and sector bias of various structural forces.

Empirical studies that employ a general equilibrium approach by directly applying the Stolper-Samuelson theorem, generally take the form of so-called mandated wage regressions in which the change in industry prices is regressed on the factor-cost shares in that industry. The coefficients reflect the implied factor price changes following the change in industry prices.

However, Feenstra and Hanson (1999) argue that if fully specified the regression becomes an identity and can no longer be used to make inferences about the implied factor price changes. In order to solve this problem Feenstra and Hanson propose to endogenise prices and total factor productivity (TFP). They therefore develop a two-stage procedure. In the first stage industry prices and TFP are regressed on expenditure on computers and outsourcing.[2] In the second stage the estimated

[1] Unweighted regressions fail to confirm the expected positive relationship between foreign competition and outsourcing. Instead, foreign competition has a significant and negative effect. However, when the estimations are weighted in order to account for differences in industry size, thereby emphasising large industries, the results indicate a positive and significant effect of foreign competition on wage inequality.

[2] By including productivity in the price regression they effectively impose the 'large country assumption'.

coefficients from the first stage regressions are inserted as the dependent variables in the mandated wage regressions. In fact Feenstra and Hanson estimate a reduced-form in which they jointly estimate the direct and indirect effect of the structural variables on value-added prices and TFP. The indirect effect is the impact of the structural variables on productivity that is passed-through on value-added prices.

Haskel and Slaughter (2001) adopt a similar methodology using UK data for the 1970s and 1980s. They do not allow for pass-through from TFP on prices as the UK is considered to be small relative to the world economy. As a result they have a separate set of structural variables for both prices and TFP. Most importantly, they find that price effects (and not technology) were the main force behind the increase in relative wages during the 1980s. However, they do not consider the impact of foreign competition on productivity, or the impact of productivity on prices.

The contribution of the present paper is to apply the two-stage method introduced by Feenstra and Hanson (1999) to UK manufacturing for the period 1993-1998. It is the first study to apply the mandated wage methodology to the 1990s. In addition, the use of recent data is thought to be crucial as fragmentation is considered to be primarily a phenomenon of the last decade.

A further innovation is that this paper addresses explicitly the relative importance of factor and sector bias (or the direct and indirect effect) of skill-biased technological change and outsourcing. The sector bias captures the relative cost-saving effect, while the factor bias captures changes in total factor-use. The relative importance of those effects has been the topic of an intensive debate in the theoretical literature. Leamer (1995) emphasises that in small-open economy the sector bias is all that matters. Krugman (2000) argues that it is justified to emphasise the factor bias of technological change when technological change is global. However, no study seems to have addressed the issue empirically.

This paper investigates this empirically dividing the empirical section into two parts. In the first part the method introduced by Feenstra and Hanson is employed, which involves estimating the impact of SBTC and outsourcing on the sum of productivity and value-added prices. This method allows one to estimate the sum of the direct and the indirect effect of the structural variables on factor prices. This specification is interesting as it includes the indirect effect of outsourcing and SBTC on factor prices, but does not require a consistent pass-through coefficient for TFP on prices (TFP and value added prices are correlated by construction).

The second part estimates the two first-stage regressions for productivity and price with TFP growth included in the price regression. In order to account for the endogeneity of TFP the regressions are estimated simultaneously using three-stage least squares. As a result it is possible to decompose the impact of each structural variable on relative wages into its direct and indirect effect, which represents an improvement compared to the earlier literature.

Finally, the dataset used allows one to define skill groups on the basis of the Major Groups of the Standard Occupational Classification instead of using the crude distinction between manual and non-manual workers used elsewhere in the literature. The SOC Major Groups are based on qualifications, training, skills, and experience.

Thus, the data allow an improvement on the existing literature by using a more refined measure of skill.

The paper is structured as follows. Section 2 presents a discussion of the theory linking trade and fragmentation to relative wages. Special emphasis is given to the issue of sector versus factor bias. Section 3 gives an overview of the empirical literature. Section 4 presents some descriptive statistics on labour market trends and other variables that may play a role in the observed rise in relative wages in the UK. Section 5 sets out the methodology employed in the econometric analysis while highlighting the key differences in the methodology used in Feenstra and Hanson (1999) and Haskel and Slaughter (2001). Section 6 presents the results. Finally, Section 7 concludes.

2. THEORY

The theoretical foundation for empirical studies analysing the impact of trade on wages is provided by the Stolper-Samuelson theorem. With many goods and factors the most appropriate version states that for any vector of goods-price changes, the accompanying vector of factor-price changes will be positively correlated with the factor-intensity-weighted averages of the goods-price changes.[3] Allowing for productivity growth and accounting for the use of intermediate inputs yields:

$$\hat{p}_i - \sum_k \theta_{ik} \hat{p}_k = \sum_j \theta_{ij} \hat{w}_j - T\hat{F}P_i \qquad (2.1)$$

The term on the left-hand side reflects value-added prices which equal final good prices, p_i, minus the sum of the cost shares, $\theta_{ik,}$ of intermediate inputs $k=1,\ldots,K$ times p_k. In equilibrium value-added prices equal the sum of the primary cost shares, $\theta_{ij,}$ times factor prices, w_j with $j=1,\ldots J$. Hats indicate proportional changes. Note that for factor prices the industry subscript is omitted as factor prices are equalised throughout the economy due to the assumption of perfect factor mobility across industries. As such an assumption is only warranted over a sufficiently large time horizon this should be reflected in the empirical analysis.

Equation (2.1) is derived from the zero-profit conditions equating prices to average costs resulting from the assumption of perfect competition. In the presence of imperfect competition the Stolper-Samuelson theorem remains valid in two cases. First, when the market is characterised by monopolistic competition the zero-profit conditions are still satisfied (Krugman and Helpman, 1985). Second, even when the zero-profit condition are no longer satisfied the Stolper-Samuelson theorem remains valid as long as mark-ups are constant over time.[4]

[3] For a discussion of different versions of the Stolper-Samuelson theorem see Deardorff (1994).

[4] Haskel and Slaughter (2002a) find suggestive evidence that changes in industry-specific rents account for 15% of the changes in wages. They do this by decomposing wage changes in economy-wide changes and industry-specific changes. They conclude that the pattern is fairly stable over time. This is also in line with Katz and Summers (1989). A study that relaxes the assumption of constant mark-ups is presented by Fontagne and Mirza (2001). They actually link foreign competition to labour markets via its impact on industry-specific rents.

In a small-open economy factor price changes can only result from a change in the relative profitability (short-run) across sectors. From (2.1) it follows that the relative profitability can change as a result of either a change in relative prices or productivity growth. In a small-open price-taking economy domestic price changes are solely due to changes in world prices. By the factor-price insensitivity theorem (Leamer, 1995) changes in relative factor endowments leave relative factor prices unaffected. The change in factor endowments will instead be accommodated by a magnified change in output quantities. The implications of this theorem are far-reaching. Any change affecting the relative demand or relative supply for primary factors, whether due to skill-biased technological change, fragmentation of production or an increase in the relative supply of skilled labour, also leave relative factor prices unaffected as long as those changes do not affect the relative profitability across sectors. The fact that even within a small open economy SBTC and fragmentation are generally not neutral in their effect on relative factor prices comes entirely from their sector bias of the associated saving in production costs (reflected by higher productivity growth).

At this point it is useful to clarify some of the terminology that will be used throughout this paper. It was stated that in a small-open economy everything that matters is the relative profitability across sectors. Technological change (whatever its source) only matters to the extent that it changes total factor costs between sectors. This will be referred to as the sector bias of technological change. In Jones (1965) this was called the 'differential sector effect'. In the 2x2 case the cost change, γ_i in industry $i=1,2$ as a result of technological change can be represented as in equation (2.2) where l stands for labour, k for capital and θ reflects the respective factor cost shares.

$$\gamma_i = \theta_{li}\hat{c}_{li} + \theta_{ki}\hat{c}_{ki} \tag{2.2}$$

However technological change may also, as does a change in endowments, alter factor market equilibrium. Jones referred to this as the 'differential factor effect' and in this paper it will be referred to as the factor bias of technological change. Formally for factors $j=L, K$, equation (2.3) gives the total change in factor use.

$$\gamma_j = \lambda_{j1}\hat{c}_{j1} + \lambda_{j2}\hat{c}_{j2} \tag{2.3}$$

Equation (2.3) is derived by fully differentiating the full-employment conditions equating total endowments of factor j to the sum of its use across all sectors (unit input requirements times output). Changes in factor endowments or technological change can only be accommodated by adjustments in the relative size of industries. In the small-open diversified economy any change in relative demand will leave relative factor prices unaffected. Changes in relative outputs do not affect goods prices as those are exogenously determined by world prices. The relative factor demand curve is therefore infinitely elastic.[5]

[5] Note that most studies on SBTC use a partial equilibrium framework thereby emphasising the factor bias. The factor bias affects relative product prices through its sector-biased impact on goods prices. From a trade perspective the crucial difference between partial and general equilibrium studies resides

The relative importance of the factor bias versus sector bias is subject to considerable. disagreement. Leamer (1995) emphasises that in small-open economy the sector bias is all that matters. Krugman (2000) argues that it is justified to emphasise the factor bias of technological change when technological change is global. Several issues play a role for the importance of factor bias. First of all, it depends on the relative size of the country compared to world markets. Related is the argument presented by Krugman (2000) that technological change (or any other structural force) at home *and* abroad has a similar effect as technological change in a closed economy. In a closed economy it is solely the factor bias of technological change that determines what happens to relative factor prices. In addition, the relevance of factor bias depends on the production technology (Xu, 2001), and the relative size of the non-tradables sector where goods prices are endogenous by definition (Leamer, 1996).[6] Second-order effects may be important whenever technological change is finite (Leamer, 1995; Findlay and Jones, 2000). Finally, the factor bias matters whenever countries are completely specialised.

In addition to the role of trade in general the present paper particularly focuses on trade in intermediates resulting from the increasing international fragmentation of production processes. The literature on international fragmentation is predominantly characterised by perfect competition.[7] Fragmentation in those models is generally driven by the presence of cross-border differences in relative factor prices. Fragmentation takes the form of moving unskilled intensive manufacturing processes from a developed country to a developing country. It is argued that fragmentation has a similar effect as skill-biased technological change.

Arndt (1997) analyses the impact of fragmentation in a small open developed economy in a standard 2x2x2 Heckscher-Ohlin model. Consequently, Arndt emphasises the sector bias of outsourcing. He concludes that outsourcing of labour-intensive components in the labour-intensive industry actually reduces wage inequality whereas outsourcing of labour-intensive components in the capital/skill-intensive industry increases wage inequality. Jones and Kierzkowski (2001) confirm these possibilities, but also stress the radical nature of outsourcing for which the Heckscher-Ohlin framework may be ill equipped. A priori, therefore, it is very difficult to predict how fragmentation will actually affect relative wages.

Deardorff (2001) analyses fragmentation across cones, i.e. in the absence of factor price equalisation. He argues that the impact of fragmentation on relative factor prices depends crucially on the relative factor-intensity of the fragment being moved abroad and the average factor intensity in the economy. The difference with Arndt resides in the fact that Arndt considers an open-diversified economy, while Deardorff considers a completely specialised economy. Consequently, in the analysis conducted by Arndt relative factor demand is infinitely elastic and only the sector bias matters. In

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in the assumption of perfect factor mobility. For a theoretical treatment of fragmentation in a specific-factors model see Kohler (2001).

[6] In a n-good economy with tradables and non-tradables the labour-demand curve has flats and downward-sloping parts. The flats as in the 2x2 case reflect the small-diversified economy. On the downward-sloping parts the economy is specialised in the production of a single tradable with the rest of its resources being absorbed in non-tradable sectors (Leamer, 1996).

[7] For a model on fragmentation with imperfect competition see Burda and Dluhosch (2002).

Deardorff's analysis the relative demand curve is downward-sloping. The adjustment of the economy depending on the relative factor-intensity of the fragment and the average factor-intensity in the economy is reflected in a change in relative factor prices. Deardorff also notes that in an economy with many industries and fragmentation being possible only in some of them, its impact on relative factor prices is greatly reduced in comparison to the simple 2x2 case.

Fragmentation is only viable if it brings sufficient savings in factor costs to cover the cost of fragmentation. The net cost saving effect appears in the data as productivity growth. In all likelihood this productivity growth has often been attributed to domestic SBTC instead of outsourcing.

3. EMPIRICAL LITERATURE

The empirical literature analysing the impact of international fragmentation of production on domestic wage inequality is still fairly limited. In this section a brief survey of the literature is given. Besides taking into account studies that explicitly relate wage inequality to outsourcing, the survey also includes some studies of the broader wage inequality debate that are important from a methodological perspective.

The first study to put to the test the Stolper-Samuelson theorem in relation to the debate on relative wages is presented by Bhagwati (1991). Bhagwati analyses aggregated data on import and export prices for the period 1982-1989 in order to check whether those were consistent with the trade-based explanation of increased wage inequality. He concludes that the trade-based explanation of increasing wage inequality 'carries little plausibility' as import prices rose on average more quickly than export prices (based on the assumption that the US primarily exports skill-intensive goods and imports unskilled-intensive goods).

Lawrence and Slaughter (1993) significantly improve the methodology by using industry-level data and explicitly relating prices to a measure of factor use. As the US is assumed to be a small-economy economy domestic prices track foreign prices.[8] They test whether prices of skill-intensive industries rose faster than prices in unskilled-intensive industries by regressing price changes on the employment ratio of skilled to unskilled workers. Instead of a positive relationship as predicted by HOS the data indicate a negative relationship for the period 1980-1989.

Sachs and Shatz (1994) use a similar methodology but account for the special nature of computer prices. Consequently they regress foreign prices on the ratio of unskilled to total employment and a computer dummy. Sachs and Shatz document a fall of 16% in the value-added price of the unskilled-import-competing sector relative to the value-added price of skilled-intensive export industries over the period 1979-1990. They interpret this as evidence in support of the trade-based explanation of increased wage inequality. However, they note that the quantitative effect is small. Moreover, they assert that TFP moved in the wrong direction as implied by the technology-based

[8] "This is a weaker assumption than the law of one price: it allows prices to differ across countries by some fixed constant. Presumably due to US trade barriers (Slaughter, 1999, p.138)".

explanation of increased wage inequality; TFP growth was less on average in high-skill industries than in low-skill industries during 1978-1989.

In the context of outsourcing the analysis by Sachs and Shatz of trade by multinationals is interesting. They investigate whether the presence of multinationals increases trade by facilitating an international division of labour among production affiliates of multinationals. They estimate a standard gravity equation that predicts the volume of trade as a function of the partner country's GDP per capita, population, distance, a regional dummy (trade barriers) and an index for intra-firm trade trade. Indeed the presence of multinationals seems to stimulate international trade (in both directions). They also find evidence for the hypothesis that low-wage countries act as an export platform of low-skill products.

Desjonqueres, Machin and Van Reenen (1999) use a similar methodology as Lawrence and Slaughter (1993) and Sachs and Shatz (1994). They do not find strong evidence for the trade-based explanation analysing a number of countries over the period 1970-1990.

A major improvement to the methodology is presented by Baldwin and Cain (2000). They are the first to try to apply strictly the Stolper-Samuelson theorem in order to infer the mandated factor prices changes as a result of relative product price changes.[9] Where the price studies discussed above adopt an intuitive approach (provide 'consistency checks'), Baldwin and Cain introduce a methodology that estimates the structural equation implied by the Stolper-Samuelson theorem. This type of study has become very popular and is commonly referred to as 'mandated wage regressions'.

Mandated wage regressions are particular in the sense that the "exogenous variable is the regressand rather than the regressor, while the dependent variable of interest (factor-price changes) is estimated rather than the regressand (Slaughter, 1999, p. 151)". This is due to the lack of invertibility of the data (more goods than factors). Therefore, mandated wage regressions should be considered as an accounting methodology "rather than identifying causation in the way regressions are usually presumed to (Slaughter, 1999, p.151)". Consequently, one can have only one exogenous force per regression. Typically mandated wage regressions estimate the relationship between changes in value added-prices (producer prices minus the cost share of intermediate inputs) on the primary factor cost shares (two or three types of labour and capital).[10]

Baldwin and Cain (2000) analyse the relative importance of trade, technology and factor endowments on relative wages in the U.S. for three periods ranging from the late 1960s to the early 1990s. Baldwin and Cain find that initially the increase in the relative supply of skilled workers was the main force enacting wage convergence. In the 1980s wage inequality rose quickly. They conclude that technology and not import competition was the dominant force behind this trend.

[9] The methodology was actually first employed by Baldwin and Hilton (1984) in order to estimate relative differences in factor prices across countries which used to predict changes in trade patterns.
[10] "Changes in industry prices are effectively regressed on the industries' technology, which varies across industries and is assumed to be exogenously determined (Baldwin and Cain, 1997)".

Leamer (1995) also analyses the explanatory power of globalisation versus productivity growth on relative wages. Interestingly, in contrast to many studies that attributed the unexplained residual of wage inequality to SBTC, Leamer uses a reversed approach. He assumes a fixed pass-through rate of productivity to prices of either zero or one. Subsequently, price changes net of productivity pass-through are attributed to globalisation. He argues that during the 1970s globalisation was the main force driving relative wages, although productivity also played a role, while in the 1980s he does not find evidence in favour of the trade-based explanation as producer prices worked in favour of low-skilled workers.[11] A possible explanation for the lack of a strong Stolper-Samuelson effect in the 1980s when the increase in relative earnings was most pronounced, could be that the relative price changes only work through the economy very slowly, that is, labour market developments in the 1980s reflect price changes in the 1970s (Leamer, 1996).

The paper presented by Krueger (1997) is interesting because it relates to relatively recent developments in the US (1989-1995). As a result it should be interesting to compare the results in the present paper with the results found by Krueger. Krueger labels the lack "of a strong, positive relationship between price growth and skill intensity" the 'price puzzle', "because it is inconsistent with increased international competition, declining unions, as well as many forms of technological change". Krueger obtains "fairly robust evidence that price growth was relatively lower in less-skill intensive industries between 1989-1995" which is consistent with the HOS explanation of increased wage inequality. However, in trying to replicate Krueger's results, while broadening the sample Slaughter (1999) shows that Krueger's results are driven by the sample of industries. For the full sample of manufacturing industries, price developments did not induce increased wage inequality.

The paper presented by Feenstra and Hanson (1999) contributes importantly to the literature in three ways. First, Feenstra and Hanson (1999) focus on outsourcing instead of trade in final goods. Outsourcing differs importantly from import penetration in final goods in the sense that it explicitly takes into account the extent to which firms move production activities abroad. Moreover, labour demand is affected not only in import-competing industries, but in all industries that use foreign inputs. Whereas Feenstra and Hanson (1996) solely analyse the impact of outsourcing on relative labour demand within industries, Feenstra and Hanson (1999) account for changes in the relative demand for labour within and between industries.

Second, Feenstra and Hanson (1999) endogenise prices and productivity. They argue that if fully specified the mandated wage regression (like the ones discussed previously) becomes an identity and can no longer be used to make inferences about the implied factor price changes.[12] In order to solve this problem Feenstra and Hanson

[11] Leamer argues that productivity improvements may have forward and backward linkages if one accounts for the presence intermediate inputs. It could therefore be interesting to disentangle pass-through to final and intermediate goods prices (see bottom p. 25).

[12] Feenstra and Hanson (1999) argue that the error term is the standard price regressions equals 'the average deviation of industry-specific factor price changes from their mean levels (p. 911)'. Inter-industry factor price differentials can derive from either the unobserved inter-industry variation in factor quality or from industry-specific rents. As the underlying model takes a long-run perspective by assuming perfect factor mobility across industries Feenstra and Hanson argue that inter-industry factor price differentials solely reflect factor quality differences as is consistent with the neo-classical model.

propose to endogenise prices and total factor productivity (TFP). They therefore develop a two-stage procedure. In the first stage industry prices and TFP are regressed on expenditure on computers and outsourcing (where prices also depend on productivity), thereby effectively imposing the large country assumption. In the second stage the estimated coefficients from the first stage regressions are inserted as the dependent variables in the mandated wage regressions.

Third, Feenstra and Hanson do not make any assumptions with regard to the pass-through rate of productivity to prices. They estimate a pass-through rate of –1, which implies that all TFP growth, is neutralised by final goods price changes, that is, the sector bias of technological change is irrelevant. However, they do not seem to have great confidence in their pass-through estimate, acknowledging the problems encountered elsewhere in this literature.[13] Instead, Feenstra and Hanson estimate a reduced-form in which they jointly estimate the direct and indirect effect of the structural variables on value-added prices and TFP. The indirect effect is the impact of the structural variables on productivity that is passed-through on value-added prices.

They find that computers explain approximately 35% of the increase in wage inequality in the 1980s in the US while outsourcing accounts for 15% of the increase. Instead of attributing price effects to international trade they actually find an important role for a concrete aspect of globalisation. It is not clear whether outsourcing affects relative factor prices through their impact on productivity or whether outsourcing also has a direct effect on prices.

Dell'mour et al. (2000) analyse the impact of outsourcing on labour markets for the case of Austria over the period 1990-1998. They estimate both relative labour demand (partial equilibrium) and mandated wage (general equilibrium) regressions. For their measure of outsourcing they distinguish by the origin of imports by multiplying imported intermediates by the share of a region's imports over total imports. They adopt the approach introduced by Feenstra and Hanson (1997, 1999) which accounts for endogeneity of prices and TFP. However, instead of using weighted OLS, they apply panel data techniques. It is not clear to what extent this is compatible with the long-run nature of the underlying model. Nevertheless, they find a positive and significant effect for outsourcing on the relative wage of skilled workers. Results indicate that the direct effect of outsourcing on prices is relatively small compared to its indirect effect through productivity growth.

Haskel and Slaughter (2001) apply the Feenstra and Hanson-method to UK data for the 1970s and the 1980s. However, they do not take up the large country assumption. As a result they do not allow for pass-through from TFP on prices as the UK is considered to be small relative to the world economy. Instead they concentrate on the impact of foreign price changes and changes in trade barriers on industry prices. As a result they have a separate set of structural variables for both prices and TFP. Most importantly, they find that price effects (and not technology) were the main force behind the increase in relative wages during the 1980's. In particular, import prices from OECD countries and UK tariffs seem to account for the price effects found.

Therefore they include inter-industry factor differences in their measure of TFP which they label effective TFP.

[13] For more on pass-through see Feenstra (1989) and Dixit (1989).

Haskel and Slaughter (2002a) analyse the role of tariffs and transportation costs in explaining price developments in the US. They do not find strong evidence that reduced tariffs and transport costs have contributed to US wage inequality in the 1970s and 1980s despite the suggestive evidence that these cost reductions were concentrated in the unskilled-sectors of the economy (1974-1988). The results for 1974-1979 indicate that reduced trade costs worked against actual wage changes. For the period 1980-1988 falling trade costs contributed to rising wage inequality in the US although none of the coefficients is statistically significant. In addition to tariffs and transportation costs they also include world output (captures some determinants of world prices), exchange rates, capital-labour-ratios, and four-firm concentration ratios (imperfect competition). [14]

The first study to analyse the sector bias of SBTC is presented by Haskel and Slaughter (2002b). Typically studies analysing the impact of SBTC adopt a partial equilibrium framework emphasising the factor-bias of SBTC. Haskel and Slaughter distinguish between sector-specific and sector-pervasive SBTC. Sector-specific technological progress is concentrated in one sector, whereas sector-pervasive SBTC occurs in all sectors although not necessarily to the same degree. The latter changes the factor intensity of the economy as whole and changes the factor intensity ranking of sectors. Haskel and Slaughter limit themselves to sector-specific SBTC as most studies so far have limited themselves to studying sector-pervasive SBTC.

They estimate the sector bias of SBTC using data for ten OECD countries for the 1970s and the 1980s. Their main measure of SBTC is obtained by taking the residual from the trans-log cost function methodology (see Section 3.1). SBTC is consequently regressed on a measure of skill-intensity as in Lawrence and Slaughter (1993). Their findings suggest that the sector bias of SBTC could be important. SBTC tends to be concentrated in unskilled-intensive sectors in countries that experienced decreasing wage inequality and in skill-intensive sectors in countries with rising wage inequality. It should be noted that their measure of SBTC could include outsourcing.

4 DATA AND TRENDS

This section describes the data, analyses trends and provides some suggestive evidence by linking key variables to factor intensity. First, it will discuss wage inequality in UK manufacturing. Consequently, several key variables are related to skilled labour use in order to gain some insight in the causes of increased wage inequality.

4.1 Labour Market Trends in UK Manufacturing (1993-1999)

For the analysis of labour market developments earnings data for the UK are obtained from the Quarterly Labour Force Survey (QLFS). Two observations should be made

[14] The two-stage methodology assumes uniform pass-through of structural variables across all industries. Feenstra (1989) shows that pass-through rates are industry-specific. Haskel and Slaughter (2002a) therefore allow trade barriers to interact with market structure in order to obtain industry-specific pass-through rates. Moreover, they argue that the coefficient estimates are very sensitive to the exact specification and therefore supportive evidence is required to back-up the qualitative changes.

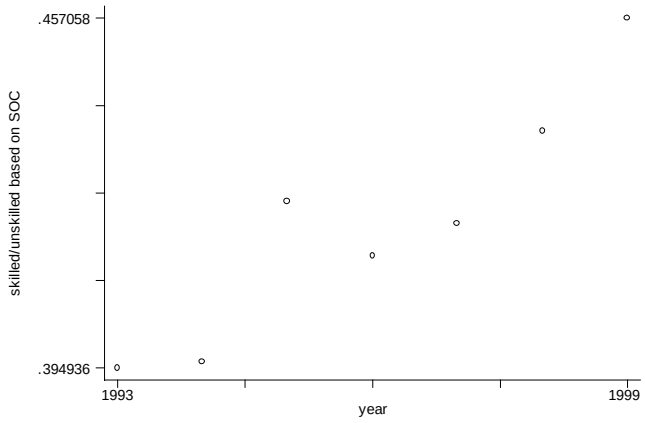
with regard to the QLFS. First, in each quarter approximately 60.000 households are interviewed. However, only for 20% of the households at the start of the sample period and 40% later on are asked to answer questions on wages. To obtain sufficient observations per industry and skill category several quarters are grouped together.[15] The first quarter for which data are classified according to SIC92 is December-February 1993.

Second, due to the survey nature of the QLFS it has to be combined with total labour earnings in order to be able to derive the factor cost share by skill category.

$$\frac{W_{is} N_{is}}{\left(W_{is} N_{is} + W_{iu} N_{iu}\right)} E_{i,tot} = E_{is} \tag{4.1}$$

Labour earnings (E) of skill category *s* in industry *i* equals the hourly wage (W) of that group times the number of workers (N) over total earnings from the LFS times the total wage bill obtained from the ONS. It is assumed that all workers work the same number of hours. In the analysis below relative wages are defined in terms of earnings by skill category over the total wage bill. [16]

Graph 4.1: Cost Share of Skilled Workers, 1993-1999



Source: QLFS, own calculations

Graph 4.1 depicts relative earnings of skilled workers relative to semi-skilled and unskilled workers.[17] The data confirm the trend of increased wage inequality. The share of skilled labour in the total wage bill increased from 39% in 1993 to 46% in

[15] Observations for 1993 are based on eight quarters and for 1998 on four quarters. Data for 1998 cover only four quarters because by that time questions on wages are asked twice to the same individual (in the first and the fifth wave).
[16] For a more detailed description of the definition of skill groups see the Appendix.
[17] Gorg et al (2001) use the same measure but the data are obtained from the New Earnings Survey. Comparing the trend in wage inequality shows that the trend is the same whether the data are obtained from the NES or the LFS.

1999. There is no evidence of any levelling off of this trend as suggested in Autor et al. (1997) for the US.[18]

4.2 In Search of an Explanation

In this section the remainder of the data will be briefly discussed. Production data are obtained directly from the ONS. Data on technology and outsourcing are obtained from the Input-Output Tables. The trade data are provided by EUROSTAT. The period under consideration is limited to 1993-1998. The first year for which data are classified according to SIC92 is 1993, while 1998 is the most recent year for which trade data are available.

Table 4.1 represents summary statistics with respect to factor prices and factor cost shares. Changes in factor prices are measured as the average annual change in the log of factor earnings. Factor cost shares reflect the average of the start and end of period factor cost shares. The data confirm the increase in wage inequality. Skilled labour wages increased at an annual average of 4.2% over the period 1993-1998, while unskilled labour wages only increased by 2.9% a year. A recurrent element is that it is actually semi-skilled labour that experienced the lowest wage increases. Concerning the factor cost shares one should note that factor cost shares are relatively stable over time. The factor cost share of intermediates seems to be an exception which might indicate the increasing importance of outsourcing.

Table 4.1: Summary Statistics, 1993-1998

	Average (%)	Annual change
Change in log factor prices (based on quantities)[19]		
- Skilled labour		4.211
- Semi-skilled labour		2.200
- Unskilled labour		2.884
- Intermediates		5.030
- Capital		3.012
Factor cost shares[20]		
- Skilled labour	6.99	-0.002
- Semi-skilled labour	6.22	-0.127
- Unskilled labour	3.78	-0.051
- Intermediates	55.88	0.438
- Capital	27.14	-0.257

Calculations are based on all 74 manufacturing industries according to availability. Averages are computed over 1993 and 1998. Changes in factor prices are measured as the average annual change in the log of factor earnings. Factor cost shares reflect the average of the start and end of period factor cost shares.

[18] See the Appendix for similar graphs using two alternative definitions of skill. Besides the traditional measure based on the distinction between manual and non-manual workers the classification based on social class is used. Both graphs reflect a qualitatively similar pattern as Graph 4.1.
[19] The annual change in the earnings of semi-skilled and unskilled workers together amounts 2.459. The annual increase in wage inequality was then 1.71%.
[20] In Feenstra and Hanson (1999) factor cost shares do not sum up to unity.

The next step is to link some key variables to factor intensity. Two definitions of factor intensity will be considered: 1) the cost share in value-added, and 2) the cost share in the wage bill.

Table 4.2a depicts the trends in a number of variables by skill-intensity. Skill-intensity is defined as the skilled labour cost share in value-added based on the summary statistics reported in Table 4.1. Value-added prices in skill-extensive industries increased by 1.9% a year while value-added prices decreased by 2.7% a year in skill-intensive industries. The relative value-added price of skill-intensive industries actually fell by 4.6% a year. One may therefore conclude that price effects cannot explain the increase in wage inequality in the UK. However, value-added prices may reflect productivity pass-through. TFP growth was considerably higher in skill-intensive industries amounting to 5.5% a year compared to 0.7% in skill-extensive industries. One should therefore focus on the price effect net of productivity pass-through to see whether the trade-based explanation can be rejected.

Looking at import prices may offer some insight therein. From Table 4.2a it follows that import prices rose faster overall in skill-extensive industries. However, it should be noted that the relative price rise of skill-extensive imports is driven by the rise in the price of imports from developed countries. The relative price of skill-extensive imports from developing countries fell significantly.[21]

In sum, price effects can reflect two complementary developments. First, productivity pass-through may be responsible for a large part of the observed price effects. The part of TFP growth that is not transmitted through lower prices affects relative factor prices. Second, prices of imports from developed countries had a positive effect on the relative price of skill-intensive products, whereas prices of imports from developing countries had a negative impact. Overall Stolper-Samuelson effects should have induced a reduction in wage inequality. The remaining explanation for the increase in wage inequality should therefore come from TFP growth not passed through to prices.

Table 4.2a: Summary Statistics by Use of Skilled Labour, 1993-1998

	Prices	Value-added prices	TFP	Import prices (all imports)	Import prices (developing countries)	Import prices (developed countries)
Skill-extensive, log(X)	1.99	1.88	0.72	9.14	12.47	4.79
Skill-Intensive, log(Y)	-2.49	-2.74	5.45	4.37	18.79	-1.69
Relative change, log(X)-log(Y)	4.48	4.62	-4.73	4.37	-6.32	6.48

The reported values are the annualised percentage changes of the log of the variable concerned. For ease of calculation value added prices were calculated simply by $(1-\theta_M)*p$, that is, one minus the cost share of intermediates times gross producer prices. Skill-intensity is based on the cost share of skilled labour in value-added.

[21] Import prices are based on unit values and are therefore likely to reflect much more than pure price developments. A very close relation in terms of magnitude may therefore not be expected.

Table 4.2b depicts similar information but with skill-intensity being defined as part of the wage bill instead of value-added. Value-added prices in skill-extensive industries decreased by 1.4% a year while value-added prices increased by 1.4% a year in skill-intensive industries. Thus, the relative value-added price of skill-intensive industries actually increased by 2.8% a year. With skill-intensity being defined as part of the wage bill, price effects are therefore likely to have contributed to increased wage inequality.

Although not all price effects can be attributed to international trade, TFP growth cannot account for this change in relative prices, as TFP pass-through would imply the opposite sign. Relative import prices from both developed and developing countries show the same sign as domestic value-added prices. Especially the relative price of imports from developing countries has fallen significantly.

With skill-intensity based on the wage bill it is suggested that trade has contributed to the increase in wage inequality in the UK. Price effects are consistent with the trend in import prices, whereas sector-biased TFP is inconsistent with the observed price effects.

Table 4.2b: Summary Statistics by Use of Skilled Labour, 1993-1998

	Prices	Value-added prices	TFP	Import prices (all imports)	Import prices (developing countries)	Import prices (developed countries)
Skill-extensive, log (X)	-1.22	-1.43	1.70	7.38	15.18	2.08
Skill-intensive, log(Y)	1.52	1.37	7.20	8.99	21.07	2.89
Relative change, log(X)-log(Y)	-2.74	-2.80	-5.50	-1.61	-5.89	-0.81

The reported values are the annualised percentage changes of the log of the variable concerned. For ease of calculation value-added prices were calculated simply by $(1-\theta_M)*p$, that is, one minus the cost share of intermediates times gross producer prices. Skill-intensity is based on the cost share of skilled labour in the total wage bill.

Thus, the value-added specification leads to a price pattern inconsistent with the trade-based explanation, while the wage bill specification is consistent with the trade-based explanation (as is the production specification). In a multi-factor setting it is not straightforward which specification is to be preferred. The difference between the two specifications resides in the role of capital. The capital share is defined as the residual after subtracting the labour cost share and the cost share of intermediates from producer prices. It may therefore reflect industry-specific rents when imperfect competition is important. Were one to use a direct and more precise measure of capital the issue raised above may not have been so important as capital and skilled labour are likely to be complements. From a theoretical point of view the value-added specification is preferable, but in the absence of a reliable measure of capital the wage bill specification may be preferable.

Tables 4.3a and 4.3b relate percentage increases of openness (import penetration) and outsourcing to skill-intensity. Import penetration is measured by the total percentage increase of imports over value-added. Outsourcing is measured by the total percentage change of total intermediate purchases times imports over sales.[22]

Generally, openness and outsourcing in skill-intensive industries has been increasing more rapidly than in skill-extensive industries (except for outsourcing to developing countries). Outsourcing has risen much more quickly than import penetration. Surprisingly outsourcing is growing most rapidly in low-skill intensive industries to developed countries. The relative importance of developed countries to developing countries in terms of imports and outsourcing is still increasing.

Table 4.3a: Summary Statistics by Use of Skilled Labour, 1993-1998

	Imports (all)	Imports (developing countries)	Imports (developed countries)	Outsourcing (all)	Outsourcing (developing countries)	Outsourcing (developed countries)
Skill-extensive	75.27	5.94	108.36	137.09	43.31	181.85
Skill-intensive	107.07	107.55	106.90	164.06	164.67	163.39

The reported values are the percentage changes of the variable concerned over the sample period. Imports reflect changes in the import penetration ratios (imports over value added). Outsourcing is constructed as the broad measure in Feenstra and Hanson (1999). Outsourcing equals the total intermediate purchases times the share of imports over sales. Skill-intensity is based on the cost share of skilled labour in value-added.

Table 4.3b: Summary Statistics by Use of Skilled Labour, 1993-1998

	Imports (all)	Imports (developing countries)	Imports (developed countries)	Outsourcing (all)	Outsourcing (developing countries)	Outsourcing (developed countries)
Skill-extensive	99.60	13.07	144.28	109.33	18.59	156.20
Skill-intensive	80.03	117.35	69.86	234.28	303.60	215.41

The reported values are the percentage changes of the variable concerned over the sample period. Imports reflect changes in the import penetration ratios (imports over value added). Outsourcing is constructed as the broad measure in Feenstra and Hanson (1999). Outsourcing equals the total intermediate purchases times the share of imports over sales. Skill-intensity is based on the cost share of skilled labour in the total wage bill.

5 METHODOLOGY

In order to investigate more formally the link between outsourcing, factor prices and TFP a two-stage methodology based on Feenstra and Hanson (1999) and Haskel and Slaughter (2001) is employed.

[22] The measure of outsourcing will be refined when the data will become available from the ONS. The ONS publishes Input-Output Tables approximately every five years in which it distinguishes between imported intermediates (imports-use matrix) and domestically produced intermediates (domestic-use matrix).

Feenstra and Hanson (1999) argue that estimating equation (2.1) in a fully specified regression yields an identity and cannot be used to make inferences about the implied factor price changes. In order to solve this problem Feenstra and Hanson propose to endogenise prices and total factor productivity (TFP). They therefore develop a two-stage procedure. In the first stage industry prices and TFP are regressed on expenditure on computers and outsourcing. In the second stage the estimated coefficients from the first stage regressions are inserted as the dependent variables in the mandated wage regressions.

Haskel and Slaughter (2001) adopt a similar methodology using UK data for the 1970s and 1980s. The essential difference resides in the scope of pass-through from TFP to prices in the first stage of the regression analysis. Feenstra and Hanson allow for such a pass-through whereas Haskel and Slaughter do not. The idea of pass-through is plausible whenever the factor bias plays a role (see Section 2 for a discussion on the importance of factor bias).[23] Haskel and Slaughter argue that only changes in world markets can affect prices on the basis that the UK is a small-open economy and therefore ignore the possible impact of domestic (internationally shared) developments.[24]

Haskel and Slaughter (2001) therefore separately estimate a price and a TFP-regression in the first-stage.

(5.1a) $$\Delta \ln p_i^{VA} = \delta' \Delta z_i + \omega_i$$

(5.1b) $$\Delta \ln TFP_i = \alpha' \Delta z_i + \varepsilon_i$$

When productivity pass-through is allowed for this is reflected in the price regression where the change in value-added prices is regressed on TFP plus a vector of structural variables. Feenstra and Hanson (1999) therefore start off with the following set of equations.

(5.2a) $$\Delta \ln p_i^{VA} = \lambda \Delta \ln TFP_i + \beta' \Delta z_i + \upsilon_i$$

(5.2b) $$\Delta \ln TFP_i = \alpha' \Delta z_i + \varepsilon_i$$

[23] First, Feenstra and Hanson analyse the US which is considered to be sufficiently large to have an impact on world prices. Second, Krugman (2000) argues that if technological progress is global its impact is similar to that in a closed-economy. Third, in a world of complete specialisation each country can affect world prices as they are the only suppliers (or whenever there are no perfect substitutes). Complete specialisation could be the rationale for cross-country factor price differentials, although incomplete integration may be more plausible.

[24] When allowing for price-effects (large country assumption, pass-through and factor bias) sector-biased TFP only has an impact on factor prices when pass-through is incomplete. In the presence of complete pass-through sector-biased TFP growth leaves relative factor prices unaffected.

Whenever λ is negative one should allow for pass-through from TFP to prices. When one does not do so even with negative λ and when TFP *and* prices have common explanatory variables (as in Feenstra and Hanson) the vector of β's will reflect both the direct effect of the structural variables on value-added prices and the indirect effect via productivity. In particular, in equations (5.1a and b) δ equals $\lambda\alpha+\beta$ and ω_i is equal to $\lambda\varepsilon_i+\upsilon_i$. Consequently, using the estimated coefficients of the structural variables from (5.1a) in the second-stage regressions will lead to an underestimation of their impact on relative factor prices. Conversely, using the estimated coefficients from (5.1b) leads one to overestimate the mandated impact on relative factor prices. Only as long as the small-country assumption is justified (i.e. λ=0), are Haskel and Slaughter (2001) right to use the estimated coefficients of the TFP regression directly for the mandated wage regressions. If the pass-through rate is significantly less than zero the estimated impact of the structural variables on relative factor prices via productivity will be overestimated.[25]

Including TFP in the price regression (Eq. 5.2a) accounts for the pass-through of the sector bias of technological change. Its effect on goods prices equals $\lambda\alpha$, while its effect on factor prices equals $(1+\lambda)\alpha$. The factor bias comes into play when output affects goods prices. If one believes in pass-through one should also account for the factor bias. The factor bias is given by β. Thus, the total effect of technological change (factor and sector bias) on goods prices equals $\lambda\alpha+\beta$, while its effect on factor prices equals $(1+\lambda)\alpha+\beta$. Note that the factor bias only matters to the extent that it affects prices! In addition price effects may come from exogenous forces affecting prices without affecting TFP, ϕ (such as reductions in tariff and transportation costs). See Table 5.1 for a comparison of the methodology used in Haskel and Slaughter (2001) and Feenstra and Hanson (1999).

Table 5.1: Methodological Overview

	Dependent Variable in First-Stage Regressions	Assumptions /estimates pass-through rate (λ)	Technological change (SBTC and Outsourcing, X)		Foreign changes (Tariffs and Transportation Costs, Z)	Total
			Sector bias	Factor bias	Sector bias	
Haskel and Slaughter (2001)	TFP	λ=0 (est.: -0.6, t=11,5)	α	-	-	α'X
	Prices	λ=0	-	-	φ	φ'Z
Feenstra and Hanson (1999)	TFP + Prices	Unspecified (est.: -1.01)	α+λα = (1+λ)α	β	-	[(1+λ)α+β]' X

Note that λ will be negative.

[25] Both Feenstra and Hanson (1999) and Haskel and Slaughter (2001, 2002a) estimate that the pass-through rate is significantly different from zero. Applying the F-test for TFP equal to equation (5.1) is rejected, whereas the F-test TFP equal to -1 cannot be rejected (95% confidence interval). However as Baldwin and Cain (1997) note the empirical measurement of TFP is endogenous to the price setting process.

In fact Feenstra and Hanson estimate a reduced-form in which they jointly estimate the direct and indirect effect of the structural variables on value-added prices and TFP reflected by (5.3), which is obtained by adding TFP to both sides of (5.2a). The indirect effect is the impact of the structural variables on productivity that is passed-through on value-added prices.

(5.3) $$\Delta \ln p_i^{VA} + \Delta \ln TFP_i = \gamma' \Delta z_i + \eta_i$$

where $\gamma=(1+\lambda)\alpha+\beta$ and $\eta_i=(1+\lambda)\varepsilon_i+\upsilon_i$. Feenstra and Hanson thus regress several structural variables on effective prices, i.e. the sum of price changes and TFP growth. The advantage of their specification is that they only have to estimate a single parameter, γ. Adding TFP to both sides of the equation singles out the net effect of technological change on relative factor prices.

However, it could be interesting to decompose the direct effect (factor bias) and indirect effect (sector bias) of factors such as outsourcing and SBTC on wage inequality. Not only does this contribute to the academic debate, but it may also have some interesting policy implications.[26]

Decomposing direct and indirect effects involves the estimation of the three parameters α, λ and β in equations (5.4a) and (5.4b):

(5.4a) $$\Delta \ln TFP_i = \alpha' \Delta z_i + \varepsilon_i$$

(5.4b) $$\Delta \ln p_i^{VA} = \lambda \Delta \ln TFP_i + \beta' \Delta z_i + \upsilon_i$$

The inclusion of TFP as an explanatory variable in equation (5.4b) implies that OLS estimates would suffer from simultaneity bias. One has to simultaneously estimate both equations in order to deal with the endogeneity problem associated with TFP (TFP and error term will be correlated) in (5.4b). It is proposed to overcome this problem by using three-stage least squares (3SLS).

In the second-stage the components explained by each structural variable, *k*, in the first-stage is regressed on the average factor shares, V_{ji}. Note that γ in equation (5.5) either reflects γ in (5.3) or the sum of α, λ and β from (5.4a) and (5.4b).

[26] In the case that globalisation affects relative wages primarily through its effect on productivity (outsourcing), liberalisation of trade in intermediates and final goods could exacerbate wage inequality. In the case the factor bias is most important, liberalisation of trade in final goods will reduce the impact of factor-biased outsourcing on value-added prices, although restructuring may take longer. Liberalisation of trade in intermediate goods will increase outsourcing and its impact on wage inequality. Although this discussion is oversimplified it shows that decomposing the factor and sector bias may yield some valuable information for policy-makers.

(5.5) $$\gamma_k' \Delta z_{ik} = \delta_k' V_i + \nu_i$$

The econometric analysis consists of two parts. In the first part equation (5.3) will be estimated using weighted least squares. In the second part equations (5.4a) and (5.4b) will be estimated using three-stage least squares. Both estimation techniques are applied to several specifications. For the exact construction of value-added prices and TFP see the Appendix. Three sets of exogenous variables will be used.

First, two measures of outsourcing will be used. Outsourcing I measures the extent to which production is moved towards developing countries. It is assumed that this type of outsourcing is driven by the presence of factor price differences. Therefore outsourcing is expected to be strongly cost-reducing which would be reflected in an important role for sector-biased TFP on relative factor prices. At the same time it is expected to have a strong factor bias effect as outsourcing will importantly affect the relative factor demand. Primarily the unskilled-intensive stage of production will be moved abroad. Outsourcing II reflects the extent to which intermediates are imported from developed countries. From the descriptive statistics it followed that outsourcing to developed countries was not subject to a strong sector bias. Therefore, one would expect a significant and positive impact of this type of outsourcing on productivity, without necessarily a strong impact on factor prices.

Second, two proxies for SBTC will be used. First, R&D reflects the relative importance of spending on external R&D as a share of total intermediate purchases.[27] Second, computer intensity measures expenditure on computers plus externally provided computer services as share of total intermediate purchases.

Third, import prices are expected to play an important role in explaining the rise in domestic wage inequality as domestic prices are importantly determined by foreign prices. In some cases a distinction is made between the prices of imports from developed and developing countries. Together with TFP pass-through import prices determine the change in value-added prices.[28]

6 RESULTS

This section presents the results of the regression analysis. Two estimation techniques are used to explain the increase in wage inequality in the UK during the period 1993-1998. First, equation (5.3) is estimated with OLS and results are compared to those obtained by Feenstra and Hanson (1999). Second, 3SLS will be applied to equations (5.4a) and (5.4b) in order to gain additional insight in the relative importance of the direct and indirect effects of technological change.

6.1 Ordinary Least Squares

Table 6.1 reports the results of the estimation of equation (5.3) with weighted least squares for five different specifications.

[27] Disaggregated data for total R&D spending are not available.
[28] It should be noted that foreign and domestic prices may well be driven by the same structural forces.

Outsourcing to developing countries is positive and statistically significant in all specifications.[29] Outsourcing to developed countries is also positive and highly significant (regressions II and IV). Technology is negative but insignificant in all specifications. Intuitively, this may be unexpected as SBTC is generally considered the dominant force behind the rise in wage inequality.[30] Import prices are positive as expected but only weakly significant (see regressions III-IV). Distinguishing between import prices from developing and developed countries did not yield any significant results.

Table 6.1: Stage-I-Regressions with OLS
Dependent Variable- Change in Value-Added Prices plus TFP

	(1)	(2)	(3)	(4)	(5))
Outsourcing I (developing countries)	2.37e-07 (4.05) ***	1.94e-07 (3.44) ***	2.28e-07 (4.55) ***	1.94e-07 (3.78) ***	4.27e-07 (2.42) **
Outsourcing II (developed countries)		3.58e-08 (6.15) ***		3.04e-08 (4.86) ***	
R&D Intensity (external)	-0.590 (-0.76)	-0.527 (-0.69)	-0.455 (-0.63)	-0.440 (-0.60)	
Computer Intensity					-0.96 (-1.34)
Import prices			0.038 (1.90) *	0.028 (1.45)	
Constant	0.021 (3.83) ***	0.018 (3.55) ***	0.022 (4.40) ***	0.020 (4.02) ***	0.018 (5.26) ***
R^2	0.13	0.19	0.18	0.22	0.17
N	57	56	57	56	54

Robust T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by sales.

The second stage involves estimating the impact of each structural force on relative factor prices. The component explained by each structural variable serves as the dependent variable of the mandated wage regressions. On the right-hand side the

[29] The sector bias of outsourcing, that is, the cost-reducing effect on outsourcing reflected by TFP growth is expected to be positive. The role of factor bias may be limited as the change in relative demand is dictated by the desire of firms to cut costs. In the case that outsourcing would move production abroad reducing the relative demand for unskilled workers without actually reducing its costs, unskilled intensive sectors will have to absorb the excess supply of unskilled labour. The sign of the factor bias of outsourcing on prices is expected to be negative.

[30] Probably, this result can be explained by the methodology. It was positive and significant when it was regressed solely on TFP and negative and significant when regressed solely on value added prices. When SBTC is regular, that is, both sector and factor prices affect goods prices in the same direction, they have opposite effects on factor prices (Jones, 1965).

average cost share over 1993-1998 of skilled and unskilled labour are included.[31] The estimated coefficients are interpreted as the implied average annual factor price changes resulting from the structural variable under consideration. The difference between the coefficients on skilled and unskilled labour are interpreted as the total mandated change in domestic wage inequality. The results are shown in Table 6.2. The exercise is repeated for regressions I-III in Table 6.1.

Table 6.2: Stage-II-Regressions
Mandated wage changes, 1993-1998

	(1.1) R&D	(1.2) Outs. I	(2.1) R&D	(2.2) Outs. I	(2.3) Outs. II	(3.1) R&D	(3.2) Outs. I	(3.3) Import Prices
Skilled cost share	0.021 (0.80)	0.061 (1.67) *	-0.004 (-0.80)	0.033 (1.64)	-0.011 (-0.44)	-0.004 (-0.80)	0.059 (1.67) *	-0.097 (-5.05) ***
Unskilled cost share	-0.101 (-5.83) ***	-0.065 (-2.70) **	0.021 (5.83) ***	-0.032 (-2.45) **	-0.13 (-0.78)	0.018 (5.83) ***	-0.079 (-2.70) **	0.025 (1.99) *
Constant	0.025 (12.45) ***	0.006 (2.09) **	-0.005 (-12.45) ***	0.001 (0.81)	0.005 (2.73) ***	-0.004 (-12.45) ***	0.006 (2.09) **	0.002 (1.61)
R^2	0.39	0.11	0.39	0.05	0.02	0.39	0.11	0.30
N	64	64	64	64	64	64	64	63
Mandated change	0.10	0.13	-0.02	0.07	-	-0.02	0.14	-0.12

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by sales.

The first set of results relating to regression I is reported in columns (1.1-1.2). Outsourcing to developing countries is estimated to have increased the wage of skilled workers by on average 0.06% a year over the period 1993-1998, while it is estimated to have reduced the wage of unskilled workers by approximately the same amount 0.07% a year. The total mandated change in domestic wage inequality as a result of outsourcing therefore was 0.13 percent a year. R&D had a positive but insignificant effect on skilled wages, while it had a negative highly significant impact on unskilled wages. R&D reduced unskilled wages by 0.1 percent a year. However, R&D intensity was insignificant in the first-stage regressions. Thus, from regression I it follows that both outsourcing had importantly contributed to the increase in the relative wage of skilled workers. With the actual annual increase in wage inequality around 1.7% (see Table 4.1), the proportion explained by outsourcing amounts to 8%. Feenstra and Hanson find that (narrow) outsourcing accounts for 15% of the annual increase in wage inequality in the US.

The results related to regression II are reported in columns (2.1-2.3) and the results relating to regression III in columns (3.1-3.3). In both specifications with outsourcing

[31] On the right-hand side only the skilled and the unskilled cost share are included. A linear test equating the coefficients of semi-skilled and unskilled labour could not be rejected. See the Appendix for the results with the three labour cost shares. Including the capital cost share does not significantly change the results. Generally, the coefficients on capital were very small and insignificant.

to developing countries as the dependent variable the coefficients are significant and in line with an important role for outsourcing in explaining the increase in domestic wage inequality. The total mandated change in relative factor prices varies between 0.07% and 0.14% a year. Outsourcing to developed countries cannot be associated with any change in relative factor prices (column 2.3). Import prices are associated with a reduction of wage inequality of 0.12% a year. This result is consistent with Table 4.2a. In both specifications R&D induced a significant rise in the wage of unskilled workers, without a significant impact on skilled wages. Thus the impact of R&D is highly sensitive to the specification. This may not come as a surprise as R&D was insignificant in the first-stage regressions.

6.2 Three-Stage Least Squares

Table 6.3 represents three sets of results obtained by applying 3SLS to equations (5.4a) and (5.4b) in three different specifications.[32] The first two specifications exclude the factor bias of outsourcing and SBTC. Instead it concentrates solely on the sector bias of outsourcing, SBTC, and foreign prices.

The specification of the TFP component is kept the same in all specifications. TFP is regressed on outsourcing and R&D. All three sets of results give a similar picture, although coefficients and significance levels are subject to change. Generally, a positive sign is found for both R&D and outsourcing, although R&D is not statistically significant.

TFP is negative and significant in all three specifications indicating that pass-through from productivity to value-added is important. The estimated pass-through is in the range of –0.74 and -1.06. It should be noted though that the empirical measurement of TFP is likely to drive this result.

In the first set of results value-added prices are regressed on overall import prices in addition to TFP. Foreign prices have a positive but insignificant impact on value-added prices. In the second set of results a distinction is made between the price of imports from developing countries and developed countries. Both are positive, but insignificant.

In the third specification it is tried to account for the total effect of outsourcing and SBTC. In principle this would imply incorporating outsourcing and R&D in both the value-added and the TFP regressions. However, due to identification problems this is not possible. Instead the price regression incorporates computer-intensity together with outsourcing and overall import prices. Outsourcing is positive, but insignificant. Computer intensity is negative, but insignificant. One may conclude therefore that the factor bias of technological change did not induce any price effects. Finally, the coefficient on import prices is positive, but insignificant.

[32] See the Appendix for the results obtained weighting regressions by employment.

Table 6.3: First-Stage Regressions with 3SLS

Dependent Variable	(1) Value-added Prices	(1) TFP	(2) Value-added Prices	(2) TFP	(3) Value-added Prices	(3) TFP
TFP	-0.742 (-6.08) ***		-0.757 (-6.55) ***		-1.059 (-4.47) ***	
Outsourcing I (developing countries)		7.73e-07 (3.55) ***		7.51e-07 (3.30) ***	4.02e-07 (1.60)	6.54e-07 (2.83) ***
R&D Intensity (external)		0.982 (0.42)		1.674 (0.58)		4.757 (1.44)
Computer Intensity					-0.066 (-0.94)	
Import prices (all)	0.037 (1.64)				0.032 (1.32)	
Import prices (developing countries)			0.029 (1.46)			
Import prices (developed countries)			0.024 (1.14)			
Constant			0.021 (5.23) ***		0.019 (5.56) ***	-0.028 (-1.37)
R^2	0.85	0.18	0.86	0.19	0.92	0.21
N	56	56	53	53	54	54

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by sales.

The mandated wage regressions are conducted for all three specifications. As the results are qualitatively similar across specifications only the third is discussed. For the results obtained from specifications (1) and (2) see the Appendix.[33]

[33] As the pattern across industries of the dependent variables does not depend on the specification significance levels tend to be the same. However, the level of the dependent variable differs across specifications. The magnitude of the mandated changes in relative wages differ therefore as well. It is interesting to compare the results from the different specifications in order to get an idea of the sensitivity of the mandated wage changes to a change in the coefficients obtained from the first-stage regressions.

Table 6.4: Second-Stage Regressions for Specification (3)

	Import prices (sector bias)	Computer Intensity (factor bias)	TFP	Outs. I (total)	R&D (sector bias)	Outs. I (sector bias)	Outs. I (factor bias)
Skilled cost share	-0.081	-0.053	-0.584	0.094	-0.002	-0.010	0.104
	(-5.05)	(-2.08)	(-1.66)	(1.67)	(-0.80)	(-1.67)	(1.67)
	***	**		*		*	*
Unskilled cost share	0.021	0.055	0.172	-0.099	0.011	0.011	-0.110
	(1.99)	(3.26)	(0.76)	(-2.71)	(5.83)	(2.70)	(2.70)
	*	***		***	***	***	***
Constant	0.002	-0.004	0.014	0.009	-0.003	-0.001	0.010
	(1.61)	(-2.00)	(0.54)	(2.09)	(-12.45)	(-2.09)	(2.09)
		**		**	***	**	**
R^2	0.30	0.17	0.05	0.11	0.39	0.11	0.11
N	63	62	56	64	64	64	64
Mandated change	-0.10	-0.11	-	0.19	-0.01	-0.02	0.21

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by sales. The dependent variable for outsourcing and R&D takes pass-through into account and includes factor bias, i.e. $(1+\lambda)\alpha+\beta$.

Table 6.4 reports the results for the mandated wage regressions for specification (3) of the First-Stage Regressions. The dependent variable for outsourcing is obtained by adding the factor bias and the sector bias of outsourcing together while accounting for pass-through effects on prices according to $(1+\lambda)\alpha+\beta$. Outsourcing to developing countries has a favourable effect on the wage of skilled workers inducing an annual increase of 0.09%. Unskilled workers in contrast suffer a decline of almost 0.1% a year. The total increase in the relative wage of skilled workers mandated by outsourcing amounted to 0.19% a year, which is considerably higher than the role attributed to outsourcing in the OLS regressions. According to 3SLS-results accounts for 11% of the increase in domestic wage inequality.

With 3SLS it is possible to decompose the total effect of outsourcing into the effect due to the factor and sector bias respectively. The results are reported in the last two columns of Table 6.4. It follows that factor-biased outsourcing mandated an increase in the relative wage of skilled workers of 0.21% a year, while sector-biased outsourcing mandated a marginal reduction of 0.02% a year. Obviously, these results should be interpreted with caution. The results are entirely driven by the estimated pass-through rate. If $\lambda=-1$ only the factor bias matters, if $\lambda=0$ only the sector bias matters. The estimated coefficient on TFP in the price regression in Table 6.4 equals -1.06 explaining the result that the factor bias exceeds the total effect. It is very likely that the estimated pass-through seriously overestimates the actual pass-through rate as a result of the construction of TFP. It is therefore interesting to see how the relative importance of the factor and sector bias changes with λ. The results are summarised in Table 6.5.

Table 6.5: Summary results outsourcing by constrained 3SLS

λ	Sector bias	Factor bias	Total mandated change
0	0.39	-0.21	0.18
-0.50	0.19	0	0.19
-1	0	0.19	0.19

The first column reflects the imposed values on the pass-through rate. With zero pass-through as is the case for a small open economy the total mandated change in relative wages is driven by the sector bias. For the intermediate case with $\lambda=-0.5$ the sector bias solely matters. For the extreme case where pass-through is complete it is only that the factor bias that matters. The results confirm the idea that the relative importance of factor and sector bias is entirely driven by the pass-through rate. Further research is needed to look into the actual level of the pass-through rate. The total mandated change is constant for the different imposed values of λ, which implies that the OLS results are independent of an implicit pass-through rate.

The sector bias of SBTC, measured by R&D according to $(1+\lambda)\alpha$, is estimated to have reduced wage inequality by 0.01% a year. This result as in the case of outsourcing is highly sensitive to the estimated value of the pass-through rate. The factor bias of SBTC measured by computer intensity is estimated to have played an important role in dampening the increase in wage inequality, i.e. computer intensity is associated with a reduction in wage inequality of 0.11% a year. This result contradicts the standard result in the literature that attributes a dominant role to SBTC in explaining the rise in wage inequality. It should be noted however that SBTC was insignificant in all cases in the first-stage regressions. In addition the sign on SBTC may be sensitive to the inclusion of import prices as it was in the OLS regressions.

The result that TFP is highly significant in explaining prices without inducing any change in relative factor prices is consistent with Haskel and Slaughter (2001). It may not appropriate to conclude, however, that sector-biased TFP growth did not affect relative factor prices. As a matter of fact the total impact of sector-biased TFP growth is estimated to have reduced relative wages by 0.03% a year (the sum of R&D and outsourcing). The coefficient on TFP in the first-stage regressions reflects to what extent sector-biased productivity growth is neutralised by a sector-biased price change. It should therefore not come as a surprise that TFP pass-through did not induce any change in relative factor prices.

Finally, import prices induced a reduction in the relative wage of skilled labour of 0.1% a year. The result is consistent with the OLS estimates as well as the picture reflected by Table 4.2a. Nevertheless, the net effect of globalisation defined as the sum of foreign price competition and outsourcing, points at a significant role for globalisation in explaining the rise in domestic wage inequality accounting for an annual increase in the relative wage of skilled workers of 0.09%.

7 CONCLUSION

This paper analysed the impact of trade and in particular the impact of trade in intermediate goods resulting from the increasing international fragmentation of production processes on the increase in wage inequality in UK manufacturing for the period 1993-1998.

Theoretically relative factor prices can be affected by the factor bias and the sector bias of structural change. The factor bias captures the impact of changes in the relative demand and supply for factors on relative factor prices through the impact of restructuring on relative goods prices. The sector bias reflects changes in the relative profitability across sectors due to foreign price competition or productivity growth.

In order to account for both the factor and the sector bias a general equilibrium approach is adopted following Feenstra and Hanson (1999). They develop a two-stage method in which they endogenise prices and productivity in the first stage. Regressing the sum of TFP and prices on outsourcing and SBTC allows one to assess their total net impact on factor prices. The coefficients on the structural variables obtained in the first-stage regressions are used to construct the dependent variable for the second stage in which the mandated change in factor prices is estimated.

The results obtained in the present study using the Feenstra and Hanson approach indicate that outsourcing has significantly contributed to the rise in the domestic wage inequality in the UK in the 1990s. With the actual annual increase in wage inequality around 1.7%, the proportion explained by outsourcing amounts to 8%. The impact of SBTC is subject to the specification, but in all cases insignificant. In contrast to what is generally assumed import prices turn out to have reduced domestic wage inequality.

In order to get additional information on the relative importance of sector bias and factor bias the TFP and prices regressions are simultaneously estimated using three-stage least squares. The analysis yields qualitatively similar results to the OLS regressions. Outsourcing is estimated to have mandated an annual increase in the relative wage of skilled labour of 0.19% which amounts to about 11% of the actual increase in domestic wage inequality.

Decomposing the total effect of outsourcing in the effect of factor-biased outsourcing and sector-biased outsourcing yields that factor-biased outsourcing mandated an increase in the relative wage of skilled workers of 0.21% a year, while sector-biased outsourcing mandated a marginal reduction of 0.02% a year. In other words the factor bias of outsourcing is responsible for the increase in wage inequality. This result is to be expected when the rate of pass-through approximates –1. As it is hard to have confidence in the pass-through estimates obtained in this and other studies, constrained 3SLS is applied imposing different pass-through rates. The results confirm the idea that the relative importance of factor and sector bias is entirely driven by the value of the pass-through rate. The question concerning the actual level of the pass-through rate is left open for future research. Therefore it is not possible to make any statements concerning the relative importance of factor and sector bias at this stage.

Finally, import prices mandated a reduction in the relative of skilled labour of 0.1% a year in the 3SLS regressions which is similar in size as the results obtained from the OLS regressions. Nevertheless, the net effect of globalisation defined as the sum of foreign price competition and outsourcing points at a significant role for globalisation in explaining the rise in domestic wage inequality accounting for an annual increase in the relative wage of skilled workers of 0.09%.

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APPENDIX

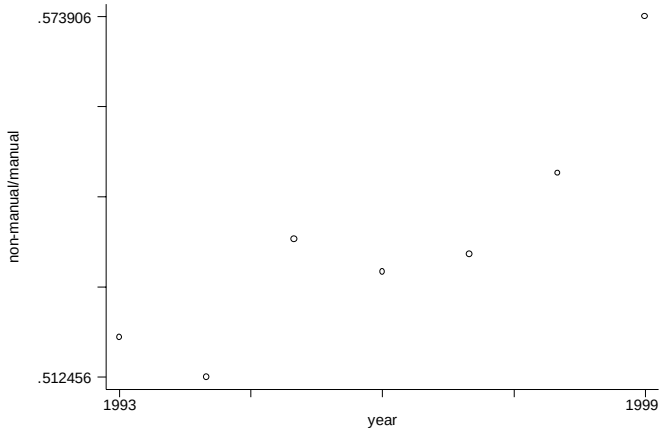
I LABOUR MARKET DATA

The Labour Force Survey allows one to construct numerous skill measures. In this paper skill is defined on the basis of the Standard Occupational Classification (SOC), which allows one to construct a more accurate measure of skill than the one based on the distinction between manual/non-manual workers generally used in the literature. In the QLFS workers are classified according to 9 Major Groups. The SOC Major Groups are based on qualifications, training, skills, and experience. Therefore, distinguishing skill groups on the basis of their Major Group Codes allows one to construct a very accurate measure of skill. For the determination of skill groups the approach taken by Gregory, Zissimos and Greenhalgh (2001) is adopted. Apart from providing a more accurate measure of skill, this approach allows one to distinguish three skill groups: skilled, intermediate, and unskilled.[34] As a result it is possible to see to what extent wage inequality is a phenomenon of the tails or instead affects the whole labour force. Wood (1998) for example states that the semi-skilled workers face the strongest relative reduction in wages.

Table A1: SOC Major Groups

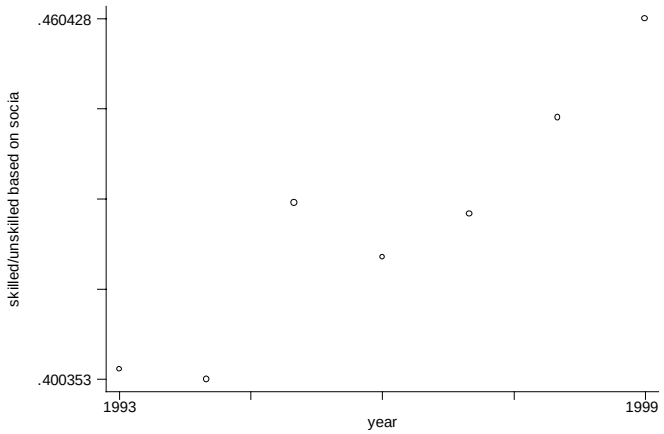
1	Managers and Administrators
2	Professional Occupations
3	Associate Professional and Technical Occupations
4	Clerical and Secretarial Occupations
5	Craft and Related Occupations
6	Personal and Protective Service Occupations
7	Sales Occupations
8	Plant and Machine Occupations
9	Other Occupations

For comparison with Graph 4.1 the relative earnings are shown based on 1) manual and non-manual workers; 2) social class.



Source: QLFS, own calculations

[34] Unskilled workers are those classified in Major Groups 1 to 3, semi-skilled workers in Major Groups 4 to 7, and skilled workers in Major Groups in 8 and 9.



Source: QLFS, own calculations

II Data

Value-added prices are constructed as follows:

$$\text{(A.1)} \qquad \Delta \ln p_i^{VA} = \Delta \ln p_i - \sum_j (x_{ij97} / X_{i97}) * 1/2(X_{it} / Y_{ti} + X_{it-1} / Y_{ti-1}) \Delta \ln p_j^I$$

Value added prices are obtained by subtracting the value of the sum of intermediate purchases. The weights are obtained from the combined-use matrix for 1997. The weights sum up to unity across manufacturing industries excluding services.

Total factor productivity is measured by the primal Tornqvist Index:

$$\text{(A.2)} \qquad \Delta \ln TFP_i = \Delta \ln VA_i - (\Delta \ln E_{1i} * V_{1i}) - (\Delta \ln E_{2i} * V_{2i}) - (\Delta \ln E_{3i} * V_{3i}) - (\Delta \ln K_i * V_{ki})$$

The factor cost shares are based on sales. The capital cost share is defined as the residual after subtracting the labour cost share and the intermediate cost share from unity.

$$\text{(A.3)} \qquad V_{ki} = 1 - V_{1i} - V_{2i} - V_{3i} - V_m$$

Capital payments are defined as:

$$\text{(A.4)} \qquad K_i = V_{ki} * Y_i$$

All variables are deflated using producer prices where necessary except capital payments for which the capital formation deflation was used.

All production data are obtained from the ONS from either the Census of Production or the Input-Output Tables. Producer prices indices are taken from the Business Monitor M22. QLFS data were obtained from the National Data Archive. Trade data are obtained from EUROSTAT. The correspondence between SITC Rev.3 and SIC(92) was kindly provided by Mauro Pisu. Import prices are measured by calculating the unit values of UK imports.

It is envisaged that once the import-use matrix for 1995 is made available by the ONS the measure of outsourcing will be refined by distinguishing between narrow and broad outsourcing according to Feenstra and Hanson (1999). The broad definition of international outsourcing captures all imported intermediates within a given industry, that is,

$$S_O^B = \frac{\sum_{i=1}^{i} O_{ijt}}{VA_{jt}} \qquad \text{(A.4)}$$

The narrow definition of international outsourcing only considers imported intermediates in a given industry from the same industry (which corresponds to diagonal terms of the import-use matrix), i.e.,

$$S_O^N = \frac{O_{i=j,t}}{VA_{jt}} \qquad \text{(A.5)}$$

III RESULTS

Table A6.1: Second-Stage Regressions, 1993-1998 (1)

	(1.1) R&D	(1.2) Outsourcing	(3.1) R&D	(3.2) Outsourcing	(3.3) Import Prices
Skilled cost share	0.028	0.071	-0.006	0.069	-0.089
	(0.92)	(1.69)	(-0.92)	(1.69)	(-3.98)
		*		*	***
Semi-skilled cost share	-0.112	-0.082	0.026	-0.079	0.012
	(-3.67)	(-1.93)	(3.67)	(-1.93)	(0.55)
	***	*	***	*	
Unskilled cost share	-0.088	-0.045	0.020	-0.043	0.041
	(-2.60)	(-0.96)	(2.60)	(-0.96)	(1.59)
	**		**		
Constant	0.025	0.005	-0.004	0.005	0.002
	(11.31)	(1.74)	(-11.31)	(1.74)	(1.19)
	***	*	***	*	
R^2	0.39	0.11	0.39	0.11	0.30
N	64	64	64	64	63

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by sales.

Table A6.2: First-Stage Regressions with 3SLS

Dependent Variable	(1) Value-added Prices	(1) TFP	(2) Value-added Prices	(2) TFP	(3) Value-added Prices	(3) TFP
TFP	-0.792		-0.806		-0.930	
	(-4.81)		(-5.51)		(-3.88)	
	***		***		***	
		5.65e-07		4.63e-07	8.95e-08	4.87e-07
Outsourcing I (developing countries)		(2.05)		(1.59)	(0.45)	(1.61)
		**				
		5.253		8.277		6.200
R&D Intensity (external)		(1.67)		(2.10)		(1.78)
		*		**		*
					0.018	
Computer Intensity					(0.21)	
	0.028				0.029	
Import prices (all)	(1.21)				(1.21)	
Import prices (developing countries)			0.042			
			(1.77)			
			*			
Import prices (developed countries)			0.018			
			(0.88)			
	0.019	-0.026	0.019	-0.040	0.017	-0.030
Constant	(4.52)	(-1.38)	(4.61)	(-1.83)	(4.54)	(-1.53)
	***		***	*	***	
	0.84	0.12	0.85	0.14	0.88	0.13
R^2						
	56	56	53	53	54	54
N						

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by employment.

Table A6.3: Second-Stage Regressions for specifications (1) and (2) in Table A6.3

	Import prices	TFP	Outs. I	R&D	Import prices I	Import prices II	TFP	Outs. I	R&D
Skilled cost share	-0.091 (-6.12) ***	-0.169 (-0.65)	0.008 (0.55)	0.002 (0.19)	-0.037 (-1.21)	-0.056 (-5.14) ***	-0.172 (-0.65)	0.006 (0.55)	0.001 (0.19)
Unskilled cost share	0.014 (1.37)	0.153 (0.91)	-0.020 (-2.09) **	-0.029 (-3.95) ***	0 (0.00)	0.007 (0.093)	0.156 (0.91)	-0.015 (-2.09) **	-0.011 (-3.95) ***
Constant	.004 (2.21) **	-0.013 (-0.44)	0.003 (1.98) *	0.014 (7.52) ***	0.003 (0.76)	0.002 (1.86) *	-0.013 (-0.44)	0.002 (1.98) *	0.004 (7.52) ***
R^2	0.39	0.02	0.07	0.20	0.03	0.31	0.02	0.07	0.20
N	63	56	64	64	59	63	56	64	64
Mandated change	-0.09	-	0.02	0.03	-	-0.06	-	0.02	0.01

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by employment. The dependent variable for outsourcing and R&D takes pass-through into account, i.e. $(1+\lambda)\alpha$.

Table A6.4: Second-Stage Regressions for Specification (3)

	Import prices (sector bias)	Computer Intensity (factor bias)	TFP	Outs. I (total)	R&D (sector bias)	Outs. I (sector bias)	Outs. I (factor bias)
Skilled cost share	-0.094 (-6.12) ***	0.006 (1.21)	-0.120 (-0.65)	0.008 (0.55)	0.001 (0.19)	0.002 (0.55)	0.001 (0.55)
Unskilled cost share	0.014 (1.37)	-0.009 (-2.62) **	0.180 (0.91)	-0.021 (-2.09) **	-0.011 (-3.95) ***	-0.006 (-2.09) **	-0.015 (2.09) **
Constant	0.004 (2.21) **	0.001 (1.92) *	-0.015 (-0.44)	0.003 (1.98) *	0.004 (7.52) ***	0.001 (1.98) *	0.002 (1.98) *
R^2	0.39	0.12	0.02	0.07	0.20	0.07	0.07
N	63	62	56	64	64	64	64
Mandated change	-0.09	0.01	-	0.02	0.01	0.01	0.02

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by employment. The dependent variable for outsourcing and R&D takes pass-through into account and includes factor bias, i.e. $(1+\lambda)\alpha+\beta$.

Table A6.5: Second-Stage Regressions for specifications (1) and (2) in Table 6.3

	Import prices	TFP	Outs. I	R&D	Import prices I	Import prices II	TFP	Outs. I	R&D
Skilled cost share	-0.093 (-5.05) ***	-0.409 (-1.66)	0.051 (1.67) *	0.002 (0.19)	-0.024 (-1.09)	-0.054 (-3.93) ***	-0.417 (-1.66)	0.047 (1.67) *	0.001 (0.19)
Unskilled cost share	0.024 (1.99) *	0.121 (0.76)	-0.055 (-2.70) ***	-0.029 (-3.95) ***	-0.002 (-0.12)	0.015 (1.64)	0.124 (0.76)	-0.050 (-2.70) ***	-0.011 (-3.95) ***
Constant	.002 (1.61)	0.010 (0.54)	0.005 (2.09) **	0.014 (7.52) ***	0.002 (1.14)	0.001 (0.89)	0.010 (0.54)	0.004 (2.09) **	0.004 (7.52) ***
R^2	0.30	0.05	0.11	0.20	0.03	0.21	0.05	0.11	0.20
N	63	56	64	64	59	63	56	64	64
Mandated change	-0.12	-	0.11	0.03	-	-0.05	-	0.10	0.01

T-statistics in parentheses, *, **, *** indicate significance levels of 10%, 5% and 1% respectively. Observations are weighted by sales. The dependent variable for outsourcing and R&D takes pass-through into account, i.e. $(1+\lambda)\alpha$.