Trade Exposure, Fragmentation, and Labor Market Flows

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Abstract. Statistics on production fragmentation based on input-output tables suggest that production methods changed in tandem with exposure to foreign competition. At the same time, OECD-labor markets have witnessed major disruptions. The paper proposes a model of endogenous fragmentation in which technology implementation is associated with spill-over effects. This trade-induced technical change goes along with labor flows in excess of net sectoral employment changes. The model can also account for a number of stylized facts of OECD-labor markets, including the bimodal growth of high and low-skilled services employment, and the recent concentration of demand for skill in management and business-service occupations.

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1. Introduction

For the last two decades OECD-labor markets have been characterized by considerable disruptions. Some countries experienced a rising gap in compensation between skill groups; others suffered from high and rising unemployment. This experience initiated a debate among researchers as to whether these changes can be traced back to trade or technology. Though some studies do find considerable trade-induced labor effects,[1] it turned out to be hard to find evidence in support of the trade hypothesis.[2] At any rate, empirical evidence is mixed at best, with the debate still unsettled. However, until recently, most of the analysis concentrated on wages and/or unemployment effects and to a much lesser extent on labor flows. To the extent that these have gone unreported, the impact of trade may have been underestimated.

A flow perspective may yield a different picture for two reasons. First, it is a well known fact from the empirical labor economics literature that flows in and out of various states in the labor market are much larger than net changes in sectoral employment shares or unemployment rates for that matter.[3] Second, as the matching literature points out, changes in relative wages may differ from flows on the labor market. For instance, if a sector is negatively affected by a shock, workers may be laid off or move out of that sector, who are not that good a match, leaving the others behind, thereby pushing up average compensation in the declining sector.[4] Hence, flows may provide additional information about the links between trade and labor as well as adjustment costs.[5]

[1] See, for instance, Hijzen/Görg/Hine (2003).

[2] See Gaston/Nelson (forthcoming) for an overview.

[3] According to Haltiwanger/Schuh (1999) in the period 1972-93 one out of five of all jobs in US manufacturing was involved in job reallocation.

[4] See for instance, Burda/Wyplosz (1994); Greenaway/Upward/Wright (2000), 66.

[5] Klein/Schuh/Triest (forthcoming) provide a survey of recent findings.

A flow perspective may also be warranted since any convincing explanation has to allude to some stylized facts concerning the shifts in the sectoral and occupational composition of employment: in the US, manufacturing's share of employment fell from 22.1% in 1980 to 18.0% in 1990 to 14.0% in 2001, in the U.K. from 25.2% in 1980 to 18.0% in 1990 to 13.5% in 2002, in Germany from 33.9% in 1980 to 31.6% in 1990 to 24.1% in 2000. At the same time, all of these economies have witnessed a bimodal increase in services employment (high and low skilled as well as business and consumer services). Worker reallocation occurred not only between sectors though, but also at the firm or industry level. In addition, major shifts in employment among occupations took place, in particular in the nineties. In the period March 1995 to March 2001, 31% of net US employment growth occurred in occupational categories "administrative and managerial"; 39.4% came in the category "professional, technical and related". During the same period, the groups "production and related, transport equipment, operators and laborers" accounted for only 9.2% of new net job growth. In Germany, the two groups "professionals and managers" were responsible for 73% of total employment growth while employment of "craft workers, plant and machine operators" declined. In the U.K., shifts were somewhat less pronounced, but still observable.[6]

On the face of it these changes are not related to trade. Rather, they seem to result from a shift in either demand or technology. According to Berman/Bound/Machin (1998) changes in technology implied shifts in the composition of the workforce, in particular an upskilling of the labor force at the level of the firm and an increase of non-production workers at the expense of production workers. Yet, since their approach does not take openness into account they may

[6] On changes in employment by industry see ILO Bureau of Statistics (Table 2B), OECD (2001) and U.K. Office for National Statistics (Workforce Jobs by Industry) for the US, Germany and the U.K. respectively. Employment by occupation has been taken from the ILO Bureau of Statistics (Table 2C).

ascribe changes to technology which in fact are trade- or trade-cum-technology related.

This paper examines the role of trade exposure in generating changes in employment between sectors, industries and occupations in a model of trade-induced technology choice related to fragmentation. Though the paper does not explicitly consider labor turnover due to frictions, the model suggests that net changes in employment arising from labor reallocation across sectors may fall short of total trade-induced worker and job flows as substantial shifts may take place between and within firms. In an increasingly fragmented production process firms increase their demand for management skills – at the expense of unskilled employment in direct production. Total firm-level employment may well increase (or remain unaffected) though, despite job destruction and workers being laid off. In the framework presented in this paper, the trade-induced reallocation of labor stems from two sources: (*i*) due to learning and experimentation, cost effectiveness of fragmentation is larger the more firms make use of new technology. Therefore, fragmentation changes endogenously with respect to trade integration and so do job and worker flows; (*ii*) costs of coordinating and supervising a fragmented production process change endogenously as barriers to trade are removed. Via these channels trade-induced fragmentation may have important effects on job and worker flows. In fact, the model is able to generate endogenous job and worker flows which match the stylized facts, including the bimodal growth of high and low skilled services employment observed in OECD countries, as well as the recent concentration of demand for skill in management and business services occupations.

The paper is organized as follows. Section 2 offers a brief review of how the paper relates to the literature. Section 3 sets out the basic model of endogenous production technique and illustrates the central role of spill-overs and labor markets in determining the cost and benefits of fragmentation. Section 4 presents results for employment stocks and flows when opening up to trade. Finally, Section 5 dicusses results in light of empirical findings.

2. Contribution to the Literature

To date, research adopting a flow perspective of labor markets has mainly focused on their cyclical behavior, on product market competition, job tenure, labor market institutions, matching and learning, asymmetric information, firm size, and the skill composition of the work force as determinants of job creation and destruction or, more generally, worker reallocation.[7] Trade-induced reallocation of labor has received considerably less attention. According to pioneering work by Davis/Haltiwanger/Schuh (1996) data on U.S. job creation and destruction does not suggest that job turnover and trade are correlated. However, their results were largely due to the fact that they compared 14-year averages of trade exposure and job flows in five categories of industries (classified according to import penetration ratios and share of output devoted to exports) at the 4-digit SIC level. Year-to-year movements in trade exposure and labor flows yield a much richer picture of the links between trade and labor flows (Klein/Schuh/Triest (forthcoming)).

One link advanced by Davidson/Martin/Matusz (1999) is that firms must compensate workers for the risk of higher break-up rates as well as search costs. As far as labor turnover is costly,[8] it has a number of consequences, in particular for the net gains from trade, but also for trade patterns. Davidson/Matusz (2002) find that trade patterns across industries are correlated with worker turnover in the sense that different rates of turnover, both, across industries

[7] See Davis/Haltiwanger (1999) for an overview.

[8] Magee/Davidson/Matusz (2002) examine the impact of high turnover in US import competing industries versus low turnover in US export sectors on factor prices and trade policy.

and countries, give rise to comparative advantage.[9] By increasing labor unit costs they affect net exports of industries. Yet, since the authors adopt an inter-industry perspective, they are unable to account for the part of job turnover that recently took place within OECD-industries (in particular the shift in employment among occupations and the upskilling of the workforce).

In order to capture labor flows within industries we employ a north-north perspective using an intra-industry framework rather than a north-south perspective for which an inter-industry framework may be appropriate. In addition, we take up the fact that statistics on trade and production fragmentation (within and across countries) suggest that production methods changed in tandem with the exposure of local firms to foreign competition (e.g. Campa/Goldberg (1997); Baldone/Sdogati/Tajoli (2001); Hummels/Ishii/Yi (2001), Yi (2003)). In doing so we build on previous work by Burda/Dluhosch (2002). We apply the microfoundations of fragmentation as developed in their paper to the Krugman (1980) intra-industry trade model,[10] add spillover effects, and explicitly consider the labor flows induced thereby. Thus far, both of these approaches were unable to account for simultaneous job creation and destruction of firms due to trade-induced changes in technology. The latter considers technology as invariant to integration, while the former treat technology as endogenous, but do not consider trade nor spillover effects from implementing new fragmentation technologies. In fact, in Burda/Dluhosch (2002) employment ratios remain unaffected unless cost effectiveness of fragmentation changes endogenously,

[9] On the empirical relationship between import penetration (defined as the ratio of imports to new supply), competition and employment (risk) see Clark/Herzog/Schlottmann (1998).

[10] With Francois (1990), Jones/Kierzkowski (1990), Feenstra/Markusen (1994) and Francois/Nelson (2000) the model stresses the role of services and skills in a fragmented production process. However, these authors employ a framework much different from the Krugman setup, and without reference to recent job and worker flows or spillovers with respect to the cost effectiveness of fragmentation. In applying the microfoundations of fragmentation to the Krugman setup, it also differs from most contributions to the theory of fragmentation which primarily focus on the international allocation of intermediates production, governed either by the love-of-variety mechanism or by differing factor intensities of production steps. On this see for instance, Ethier (1982), Venables (1999), Deardorff (2000).

a possibility which they did not consider.

Yet, there is suggestive evidence that cost effectiveness changes as markets are opened up. The productivity effect is presumably related to the productivity of business services necessary for fragmentation. In particular business software applications are crucial for managing a fragmented production and thus for the cost effectiveness of fragmentation. Yet, the market structure of this industry as well as the nature of the software development and implementation suggest that the effectiveness in cost reduction is larger the more firms make use of new technology. First, there is considerable empirical evidence of the importance of external sources (in particular customers) in the business software development process (Segelod/Jordan (2002)). Second, the supply side of the corporate software industry is fairly concentrated. One firm serves many customers,[11] making knowledge spillovers with respect to customers and the productivity of the software likely: Due to multifirm experience software is more to the problem, i.e. productivity increases with the number of firms served. As a consequence of these productivity effects trade may result in substantial job and worker turnover. By endogenizing technology and tracking job destruction and creation induced thereby the paper also challenges the common view[12] that adjustment costs of intra-industry trade are (generally) low.

3. The Model

Let there be two groups of final goods for consumption which enter utility of a representative consumer according to a Cobb-Douglas function with expenditure shares $(1-\mu)$ and μ respec-

[11] Based on worldwide license revenues for business software applications, the largest firm, SAP, had, according to financial analysts and company data (SAP (2003)), an estimated market share of 54% (Q2 2002-Q1 2003), followed by Oracle (14%), Siebel (13%), PeopleSoft (11%), JD Edwards (5%) and I2 (3%).

[12] See, for instance, Brühlhart/Murphy/Strobl (2003) for a critical assessment.

tively, namely (i) homogenous consumer services x_0 and (ii) differentiated manufactures x_i (with $i = 1, ..., n$) along the lines of Dixit/Stiglitz (1977).

$$U = x_0^{1-\mu} \left(\sum_{i=1}^{n} x_i^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta\mu}{\eta-1}} \tag{1}$$

For given income Y, utility maximization for the representative household gives rise to the familiar demand functions (with consumer services serving as numéraire):

$$x_i = \left(\sum_{j=1}^{n} p_j^{1-\eta} \right)^{-1} \mu Y p_i^{-\eta} \tag{2}$$

$$x_0 = (1-\mu) Y \tag{3}$$

so that for n large, the elasticity of demand for manufactures is approximately η.

3.1. Product Markets: Supply and Demand

Direct production of each of the differentiated goods is considered an intermediate sector within manufacturing. Production in this sector takes place by use of high- and low-skilled labor, H_P and L_P, according to a constant returns production function $f(H_P, L_P) = H_P^{\theta} L_P^{1-\theta}$. The associated costs are modeled to represent payments for the output of a perfectly competitive intermediate sector sold at price p_c.[13]

Though for given technology production is constant returns, the specific technology used

[13] This makes the cost function consistent with a primal problem in two factors of production. One way of thinking about this is to regard the input as being supplied by a perfectly competitive manpower industry to the manufacturing sector in the form of a composite of the two labor types at minimum cost conditions, given factor prices. Yet, fragmentation of production processes in manufacturing allows to reap economies of scale (see next paragraph).

depends on market size. In order to realize economies of scale as markets expand, production processes in manufacturing may be fragmented into an (endogenous) number (z) of production steps. This production fragmentation is associated with variable cost savings according to the following function $v(z) = \overline{v}z^{-\psi}$, with ψ denoting the effectiveness of fragmentation in cost reduction. Ceteris paribus, a finer division of labor in manufacturing thus yields lower costs. Net cost savings, however, depend on (i) the number of firms that make use of these cost saving technologies and on (ii) the costs associated with implementing and employing a more fragmented production.

Ad (i): the number of firms in the market (and therefore market size) matters if technologies are more adapted to specific tasks the larger the group of producers who make use of these technologies. The reason for this may be some indivisibility associated with the technology which in turn may be due either to spill-over effects in the sense that there is more learning and more experience the larger the number of users for any given technology so that solutions are more taylored to problems or in the sense that it pays to develop technologies which weren't sustainable before (at smaller market size). In both of these cases cost savings increase with market size, competition – and trade exposure. For reasons of traceability we will assume that the effectiveness of fragmentation in cost reduction increases with the number of firms n according the following specific function $\psi = \alpha \ln(n+1)$. Below we will impose restrictions on parameter α so that fragmentation is not too effective in cost reduction to make sure that the model yields economically feasible results. On the one hand production fragmentation thus yields benefits in the sense that it lowers marginal production costs.

Ad (ii): on the other hand, the more fragmented production technique implies more effort in terms of coordinating, supervising and designing production processes. The latter activities require the input of high skilled business services (which compete for high-skilled labor with direct production). We will assume that these business services can be bought at market price p_Z, so that the trade off between these two cost components is a matter of relative prices. Relative prices in turn will be determined inter alia by labor markets, an issue to be dealt with more explicitly in subsection 3.2.

If production is subject to fixed $(\overline{F})$ and variable costs $(v(z))$ as well as costs for business services (p_Z), total production costs for firm i are given by

$$\overline{F} + \overline{v} z_i^{-\psi} x_i + p_Z z_i \tag{4}$$

Costs in direct production $\overline{F} + \overline{v} z_i^{-\psi} x_i$ for n firms thus equal costs of the composite of the two labor types at minimum cost conditions $p_c f(H_P, L_P)$, supplied by the intermediate manpower industry. Ignoring the integer problem, the equality holds for a sequence of production modes, each for given output, number of firms and extent of fragmentation. Profits π_i of the representative firm in manufacturing are

$$\pi_i = p_i x_i - \left(\overline{F} + \overline{v} z_i^{-\psi} x_i + p_Z z_i \right) \tag{5}$$

Optimal behavior of firms in symmetric product market equilibrium (with $p_i = p$; $x_i = x$; $z_i = z$; $\forall\ i = 1, .., n$) then yields scale (6), price (7), and extent of fragmentation (8) of each firm in the differentiated goods sector in partial equilibrium (given low skilled services employment

L_S and price of business services p_Z).

$$x = \frac{\overline{F}(\eta-1)}{(1-(\eta-1)\alpha\ln(n+1))\,\overline{v}}\left(\frac{\overline{F}(\eta-1)\alpha\ln(n+1)}{p_Z(1-(\eta-1)\alpha\ln(n+1))}\right)^{\alpha\ln(n+1)} \tag{6}$$

$$p = \frac{\eta}{(\eta-1)}\left(\frac{(1-(\eta-1)\alpha\ln(n+1))\,p_Z}{\overline{F}(\eta-1)\alpha\ln(n+1)}\right)^{\alpha\ln(n+1)}\overline{v} \tag{7}$$

$$z = \frac{\overline{F}(\eta-1)\alpha\ln(n+1)}{(1-(\eta-1)\alpha\ln(n+1))\,p_Z} \tag{8}$$

To limit attention to economically meaningful equilibria, it is assumed that α is small enough: $\alpha < 1/((\eta-1)\ln(n+1))$. Free entry implies that profits are driven to zero. The zero profit condition provides information about the relationship between the number of firms n and low skilled services employment L_S (9).[14]

$$n = \left(\frac{\mu}{1-\mu}\right)\frac{L_S(1-(\eta-1)\alpha\ln(n+1))}{\eta\overline{F}} \tag{9}$$

Before modeling labor markets and closing the model we have to take a look at business services and consumer services production.

If firms fragment production, economy-wide demand for business services is given by $nz = Z$. These business services are supplied at price p_Z by competitive, profit maximizing firms which use skilled labor H_S according to the constant returns technology $Z = H_S$, so that the derived demand for labor in business services is infinitely elastic at p_Z, which, in a competitive labor market, will equal the equilibrium wage. The market price for business services p_Z also equates

[14] Equation (9) may be solved for n: $n = \frac{\mu}{(1-\mu)}\frac{(\eta-1)}{\eta}\frac{\alpha L_S\,\mathrm{ProductLog}\left(\frac{\eta}{(\eta-1)}\frac{(1-\mu)}{\mu}\frac{\overline{F}}{\alpha L_S}\,e^{\frac{\mu L_S+\eta\overline{F}(1-\mu)}{\mu(\eta-1)\alpha L_S}}\right)}{\overline{F}} - 1$. However, it is more convenient to work with (9).

demand for business services z from n manufacturing firms with total supply:

$$\frac{\mu}{(1-\mu)}\frac{(\eta-1)}{\eta}\frac{\alpha\ln(n+1)}{p_Z}L_S = H_S \tag{10}$$

Finally, consumer services are supplied under conditions of perfect competition, employing unskilled labor and using the technology

$$x_0 = L_S \tag{11}$$

Since consumer services serve as numéraire, labor demand originating in this sector is infinitely elastic at 1, the value marginal product of unskilled labor in these services. To summarize: manufactures are produced by use of high and low skilled labor, consumer services by low skilled labor only. Production of manufactures, however, requires the input of high-skilled business services to coordinate fragmented production processes.

With labor demand derived from product market conditions we are able to describe labor markets in more detail and determine prices in general equilibrium before opening up to trade and considering trade-induced job and worker flows.

3.2. Labor Markets: Supply and Demand

Let the economy be populated with high and low skilled labor in proportion $\kappa = L/H$, with each type of labor supplied inelastically by households in the two forms, skilled H and unskilled L, to perfectly competitive labor markets. Since the focus of the paper is on the effects of market size proper and to keep the model as simple as possible we will abstract from factor proportions driven specialization effects and assume that both skills are supplied in proportion $\kappa = 1$. In addition, we will assume that mobility between sectors is costless, so that the demand curve for each type of labor in each sector is the "supply price" to the other. Due to worker and job heterogeneity with respect to skills and occupations, this model-economy generates labor flows in addition to net sectoral employment changes, despite the fact that reallocation of labor is considered frictionless.

With these assumptions, the relevant labor market equilibrium conditions are the equality of wage and value marginal product in direct production and services (business and consumer) for both types of labor

$$1 = p_c (1-\theta) \left(\frac{H - H_S}{L - L_S} \right)^{\theta} \tag{12}$$

$$p_Z = p_c \theta \left(\frac{L - L_S}{H - H_S} \right)^{1-\theta} \tag{13}$$

Since p_Z is endogenous, it will be influenced by conditions prevailing in labor markets, which in turn affect the extent of fragmentation (z). The model is closed using the market clearing condition that the value of demand for the direct cost input in manufacturing from n firms equals supply:

$$\frac{\mu}{(1-\mu)} \frac{(\eta - (\eta - 1)\, \alpha \ln (n+1))}{\eta} L_S = p_c (H - H_S)^{\theta} (L - L_S)^{1-\theta} \tag{14}$$

4. The Allocation of Labor Pre-integration and in Trading Equilibrium

The model thus consists of a system of ten equations ((3) and (6)-(14)) in ten unknowns x_0, x, p, z, n, p_Z, p_c, Y, L_S and H_S. It can be reduced to the following three equations in three unknowns L_S, H_S and n

$$H = \frac{n\overline{F}\left(\eta\left(1-\mu\theta\right)-\mu\left(1-\theta\right)\left(\eta-1\right)\alpha\ln\left(n+1\right)\right)}{\mu\left(1-\left(\eta-1\right)\alpha\ln\left(n+1\right)\right)} \tag{15}$$

$$\frac{H_S}{H-H_S} = \frac{\mu n\overline{F}\left(1-\theta\right)\left(\eta-1\right)\alpha\ln\left(n+1\right)}{\theta\left(\mu H\left(1-\left(\eta-1\right)\alpha\ln\left(n+1\right)\right)-n\left(1-\mu\right)\eta\overline{F}\right)} \tag{16}$$

$$\frac{L_S}{L-L_S} = \frac{\left(1-\mu\right)}{\mu}\frac{\eta}{\left(1-\theta\right)\left(\eta-\left(\eta-1\right)\alpha\ln\left(n+1\right)\right)} \tag{17}$$

Equations (16) and (17) yield ratios of services to direct production employment of high- and low-skilled workers. The system may be further reduced to a system in two equations (17) and (18) by eliminating H in (16):

$$\frac{H_S}{H-H_S} = \frac{\left(\eta-1\right)\alpha\ln\left(n+1\right)}{\theta\left(\eta-\left(\eta-1\right)\alpha\ln\left(n+1\right)\right)} \tag{18}$$

Alternatively, we can take the inverse function of (15) and eliminate n in (16) and (17) to obtain employment ratios as a function of the (exogenous) supply of labor H.

In order to examine the impact of trade on technology and labor flows we introduce a second country and denote variables of the foreign country with an asterix. Furthermore, we distinguish values of variables ex ante and ex post integration by using superscript ie when referring to the integrated economy. Factor endowments for the integrated economy are thus $H^{ie} = H + H^{*}$.

Due to the endogeneity of the cost effectiveness in fragmentation, fragmentation in this model is driven by the size of the economy (or the integrated economy in trading equilibrium), as are employment flows. The larger is the market, the larger is the number of users of new technology, and the higher is the effectiveness of fragmentation in cost reduction so that for any given relative price of business services firms adopt a more fragmented production technology. Consequently, they reduce skilled and unskilled employment in direct production while increasing their demand for skill in management and business services.[15]

What sort of worker and job flows as well as net sectoral changes in employment can we expect if economies open up to trade? When focusing on trading equilibrium, we will assume that FPE holds (i.e. $w_H^T = w_H^{*T} = w_H^{ie}$; $w_L^T = w_L^{*T} = w_L^{ie}$, with the superscript T denoting values in trading equilibrium). In addition, we will assume that trade only takes place with respect to final goods. One could also think of the possibility of specialization augmented fragmentation with parts of direct production shifted to Foreign due to differences in factor intensities and endowments (as Feenstra/Hanson (forthcoming) for instance do). However, there are two reasons for concentrating on the labor market effects of intra-industry trade in final goods. First, horizontal trade can to a large extent accommodate for international differences in factor pro-

[15] Note that the first derivative of (15) with respect to n is positive within the economically feasible and relevant parameter range $0 < \alpha < \frac{1}{(\eta-1)\ln(n+1)}$:

$$\frac{\partial\left(\frac{n\overline{F}(\eta(1-\mu\theta)-\mu(1-\theta)(\eta-1)\alpha\ln(n+1))}{\mu(1-(\eta-1)\alpha\ln(n+1))}\right)}{\partial n} = \frac{\overline{F}}{\mu(n+1)(1-\alpha(\eta-1)\ln(n+1))^2} \times \left(\begin{array}{c} (n+1)(1-(\eta-1)\alpha\ln(n+1))\left(\begin{array}{c}\eta(1-\mu\theta)\\ -\mu(1-\theta)(\eta-1)\alpha\ln(n+1)\end{array}\right) \\ +n\alpha(\eta-1)(\eta(1-\mu\theta)-\mu(1-\theta))\end{array}\right) > 0$$

As $\eta > \mu$ and $(1-\mu\theta) > (1-\theta)$ both terms in brackets are larger than zero. Hence, the derivative is positive. Therefore, the number of firms n strictly increases with market size H. Yet, if n increases with market size so does the share of services employment in total employment, both for low and high skilled labor $\frac{\partial\left(\frac{L_S}{L-L_S}\right)}{\partial n} = \eta\alpha\frac{(1-\mu)(\eta-1)}{\mu(1-\theta)(n+1)(\eta-\alpha(\eta-1)\ln(n+1))^2} > 0$ and $\frac{\partial\left(\frac{H_S}{H-H_S}\right)}{\partial n} = \frac{\alpha(\eta-1)\eta}{\theta(n+1)(\eta-\alpha(\eta-1)(\ln(n+1)))^2} > 0$ respectively. These results differ from traditional intra-industry models à la Krugman (1980) in which both the scale of operation as well as prices of manufactures neither depend on factor endowments nor on market size, but remain unchanged despite (trade-)integration. In those models, the extent of the market is only relevant for the equilibrium number of firms.

portions. When adding vertical trade the pattern of production and labor flows would therefore depend on (arbitrary) assumptions about the division of trade into a vertical and a horizontal component. Second, the aim of the paper is to examine the labor-flow consequences of market size and enlargement proper. Therefore, we abstract from differences in factor proportions and focus on the extent of fragmentation.

In order to examine the labor market consequences of trade exposure consider the benchmark case of two identical economies that open up to trade, $H = H^*$. Since both economies are identical in terms of size and factor proportions, Home's (as well as Foreign's) value of gross exports equals her value of gross imports in differentiated goods. With trade in fact only in differentiated goods, the equilibrium condition on the trade balance reduces to

$$Hn^{*T} = H^* n^T \tag{19}$$

so that $n^T = n^{T*}$ for $H = H^*$. Since cost effectiveness in fragmentation is driven by the (total) number of firms adopting a technology, firms will choose a more fragmented production technology as the trading area expands at any given relative price of management services. Therefore, the number of firms in the trading area rises less then in proportion with factor endowments. Figure 4.1 shows the consequences of trade for the number of firms and occupational employment ratios for high- and low-skilled labor in Home and in Foreign with the following parameter values used in the calibration exercise

Parameter	μ	θ	η	α	$\overline{F}$	$\kappa = \kappa^* = \kappa^{ie}$	H=H^*
Value	0.5	0.5	2	0.5	1	1	50

Panel (a) depicts the inverse function of (15), i.e. the relationship between the number of

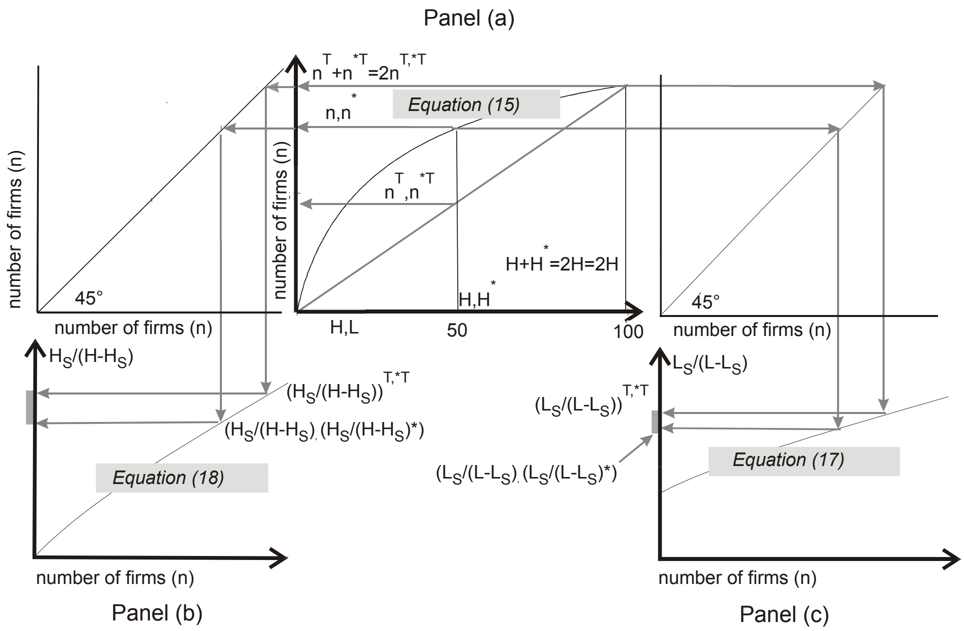

Figure 4.1: The impact of trade exposure on the number of firms (panel (a)) and on occupational employment ratios, i.e. services to production workers, high (panel (b)) and low skilled (panel (c))

firms and the size of the trading area as measured by factor supplies in the integrated economy. The ray from the origin displays the situation of balanced trade (19)), with the benchmark case of two identical economies trading with each other indicated. Panels (b) and (c) display equations (17) and (18), that is the effect on occupational employment ratios for high and low skilled labor when opening up to trade. As can be seen from Figure 4.1, the number of firms in Home and Foreign decreases. At the same time, more high-skilled labor is employed in business service occupations while low-skilled workers are being laid off and find new employment in consumer services. The intersection of each curve in panels (b) and (c) with the y-axis displays labor allocation if there were no fragmentation. Also, if cost effectiveness of fragmentation did not depend on the number of users but were exogenous, employment ratios would remain the same, even when opening up to trade.

5. Net Sectoral Changes in Employment and Labor Flows: Discussion

The model does not provide a full account of gross flows on the labor market. It purely focuses on the effects of trade. In doing so, it abstracts from heterogeneity of firm-level demand as well as worker heterogeneity beyond skill groups or occupations. Both are presumably related to specificity, learning of firms about their true competitiveness and the qualification of their workers, matching, unionization, unemployment insurance, various fixed costs of employment across occupations and skills etc. Only when adding these aspects can one explain simultaneous job creation and destruction within skill groups or occupations for that matter. Notwithstanding the fact that the reallocation of labor is considered frictionsless, the model provides additional information on and to changes in (sectoral) employment shares that result from trade-induced restructuring. Following the classification of Dunne/Roberts/Samuelson (1989), total labor reallocation in our model can be decomposed into three components:

(i) changes in the size and number of firms,

(ii) intraindustry job turnover and firm-level restructuring resulting in different jobs (or occupations) at the same employment level,

(iii) intersectoral employment shifts.

The third category equals net aggregate employment changes across sectors, while with respect to the former gross flows usually will differ from net employment flows due to occupational and skill heterogeneity.

Due to firm level restructuring actual labor turnover may be larger than indicated by net employment changes. The reasons for this difference are twofold:

1. If the expansionary effect of the productivity increase is smaller than the effect of upskilling (which depends on parameters α and η), firms may lay off workers (due to job destruction) while at the same time hiring new ones (for new positions, either because of restructuring or because of expansion).

2. A substantial amount of job turnover and labor reallocation occurs within firms. Since the extent of gross worker flows in excess of net changes in employment also depends on whether supply of business services is vertically integrated or market mediated,[16] one may calculate upper and lower bounds of gross to net changes in employment.

At any rate, net changes in employment surely underestimate the magnitude of turnover in labor demand due to trade. A more comprehensive perspective which also captures labor flows within industries may also help to sort out reasons for high rates of labor turnover. The latter aspect may also be important from a policy perspective since it may make a difference whether the associated costs of gross flows are ultimately related to trade or whether they purely reflect

[16] For the US of the 1980s there is some empirical evidence that displacement was more widespread among workers with low-skill production occupations. See Fallick (1996) for an overview. Greenaway/Upward/Wright (2000, Fig. 8) also present U.K. data which suggests that flows of unskilled workers are larger. This is in line with the model presented in this paper to the extent that occupational reallocation of skilled workers from direct production to management takes place within industries or firms. However, Greenaway/Upward/Wright explain this in terms of higher sector specific human capital which keeps labor attached to industries. Bauer/Bender (2002) use a German employer-employee data set to examine whether job turnover (including intra-firm reallocation) is skill biased. Though their focus is on the impact of organizational change on job turnover, they find that the job destruction-job creation ratio is considerably higher for unskilled and medium skilled workers than it is for professionals, engineers and management, which may imply simultaneous entry and exit of workers into and out of firms. They also find evidence that investment in IT resulted in lower ratios for skilled workers, while the other two groups where more negatively affected (p. 18). Caroli/Van Reenen (2001) obtain similar results for the U.K. and France.

labor market policies and constitutions.

The model highlights a second point: according to the previous literature (see Sections 1 and 2), changes in employment shares have been difficult to reconcile with trade explanations. Yet, this model is able to account for a number of stylized facts of OECD labor markets, including the bimodal growth of high and low skilled services employment, and the recent concentration of demand for skill in management and business services occupations. Recent movements in wages have been in line with the sectoral reallocation of labor and with occupational change as outlined in this paper as well. In particular in the US, average compensation in business services has increased much faster than in manufacturing or in personal services, retail, restaurants and hotels (OECD (2002)). Yet, even an increase in average compensation in manufacturing (compared to personal services, retail, restaurants and hotels) were compatible with trade-induced restructuring. To the extent that the reallocation of labor between high skilled services and direct production takes place within manufacturing, average compensation in this sector increases rather than decreases, as due to the upskilling of the labor force less skilled workers leave manufacturing.

6. Concluding Remarks

In contributions to the theory of intra-industry trade based on the constant technology model, production of each of the varieties is invariant with respect to (trade-)integration and the size of the market. Consequently, the impact of (intra-industry) trade on labor market flows can be expected to be low. There is considerable empirical evidence, however, that technology is not constant in the process of trade integration but changes endogenously, in particular with respect to the extent of fragmentation. At the same time, OECD-labor markets have witnessed substantial changes in employment (ratios) as well as job and worker flows in excess of net changes in employment, both at the level of the firm and at a sectoral level. These changes in employment have thus far been difficult to reconcile with a trade perspective.

The paper proposes a model of fragmentation in the effectiveness of fragmentation in cost reduction is endogenous. Due to learning and experimentation cost savings in this framework depend on the number of users adopting a particular technology. Therefore, fragmentation changes endogenously with respect to trade exposure and so do job and worker flows. This optimizing behavior on the side of the firms with respect to technology has important implications for labor which thus far have not been captured by intra-industry trade with constant technology but are in line with recent labor market developments: employment shifts towards both high- and low-skilled services while the share of employment in direct production of manufactures in total employment declines, and the demand for skill in management and business services increases. Due to worker and job heterogeneity these changes in employment are accompanied by worker and job flows in excess of net sectoral employment changes. The model illuminates that some of this trade-induced labor reallocation takes place within firms and may result in firms laying off workers while at the same time hiring new ones. Also, if market size does matter for technology and if it implies a major reshuffling of the labor force, the usual presumption that intra-industry trade is not associated with major disruptions and structural change (unless it is combined with exogenous trade costs) turns out to be premature as it involves a considerable amount of labor turnover. The model lends itself to a number of extensions of which the introduction of imperfect labor markets and frictions in labor reallocation are the most straight forward.

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