Trade Exposure, Fragmentation, and Labor Market Flows

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June 3, 2003

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-skill services employment, and the recent concentration of demand for skill in management and business-service occupations.

JEL-Classification: F16, J21, J63, O33

Keywords: intra-industry trade, technology choice, labor markets, occupational change, job and worker flows

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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 various 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. Second, flows need not be associated with considerable movements in wages or unemployment. As the matching literature points out, changes in relative wages may differ from net flows on the labor market: if a sector is negatively affected by a shock, workers may be laid off or move out of

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

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

that sector, who are not that good a match, leaving the others behind, thereby pushing up average compensation in the declining sector (see for instance, Burda/Wyplosz (1994); Greenaway/Upward/Wright (2000), 66). Hence, flows may provide additional information about the links between trade and labor as well as the costs associated with frictions and restructuring in the economy.

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 other services). Worker reallocation occurred not only between sectors though, but also at the firm or industry level. In addition, major shifts in employment among various 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" actually declined. In the U.K., these shifts were somewhat less pronounced, but still observable.[3]

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/Griliches (1994), Berman/Bound/Machin (1998) and Machin/Van Reenen (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, due to adopting a partial equilibrium perspective without taking openness into account they may ascribe changes to technology which in fact are trade-related 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 numbers on 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

[3] On the 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).

skills in particular – 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 and possibly geographically dispersed production process change endogenously with labor market conditions as barriers to trade are removed.

Via these two (qua labor markets related) channels trade-induced fragmentation may have important effects on job and worker flows, and occupational mobility in particular. 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 the 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 while 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 behaviour, on technology diffusion, 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.[4] Trade-induced reallocation of labor has received considerably less attention. Davidson/Martin/Matusz (1988) and Hosios (1990) examine labor market imperfections, in particular due to matching and search costs, in a Heckscher-Ohlin framework. According to Davis/Haltiwanger/Schuh (1996) data on U.S. job creation and destruction does not suggest that job turnover and trade are correlated though.

Davidson/Matusz (2001) in a more detailed analysis based on microdata on job *and* worker turnover, however, find that trade patterns across industries are correlated with worker turnover. Though, according to their study, different degrees of import penetra-

[4] See Davis/Haltiwanger (1999) for an overview of the labor economics literature on this issue.

tion do not give rise to different rates of turnover across industries,[5] different rates of turnover, both, across industries and countries, give rise to comparative advantage. Following Davidson/Martin/Matusz (1999) firms must compensate workers for the risk of higher break-up rates as well as search costs. Hence, turnover is costly.[6] It increases labor unit costs and thereby affects net exports of industries. Yet, since Davidson/Matusz (2001) adopt an interindustry perspective, they are unable to account for the part of job turnover that recently took place within OECD-industries. Brülhart/Murphy/Strobl (2003) find evidence that the share of intra-industry job turnover in total turnover is related to measures of marginal intra-industry trade (i.e. changes rather than levels of trade flows). According to them, labor reallocation takes place within rather than between industries whenever the latter is more costly than the former.

Work by Greenaway/Upward/Wright (2000) on the U.K. economy casts doubts on gross flows providing information about the extent of economy-wide structural change (trade- as well as technology-induced). They find gross flows to move much closer in line with business cycles than net flows. These findings are interpreted by them that it is the latter that mirror structural changes. Though a considerable amount of net flows took place between manufacturing and services in the U.K., they are uncertain about what

[5] 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).

[6] Magee/Davidson/Matusz (2001) examine the impact of high turnover in US import competing industries and low turnover in US export sectors on labor mobility, real wages as well as trade policy.

trade implies for flows of skilled and unskilled workers in particular.[7] 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 in particular, they find that the job destruction-job creation ratio is considerably higher for unskilled and medium skilled workers than it is for instance for professionals, engineers and management,[8] which may also explain simultaneous entry and exit of workers into and out of firms.

This paper takes a different tack. It takes 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)) and analyses the implications for labor. In doing so it builds on previous work by Burda/Dluhosch (2002a,b). It applies the microfoundations of fragmentation as developed in their paper to the basic Krugman (1980) intra-industry trade model,[9] adds

[7]For the US of the 1980s there is some empirical evidence though 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 on flows in and out of employment well as between jobs 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.

[8]Though they find evidence that investment in IT in particular resulted in lower ratios for skilled workers, while the other two groups where more negatively affected (p. 18). Caroli/Van Reenen (2001) find similar results for the U.K. and France.

[9]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 set up, and without reference to recent job and worker flows or spill-overs with respect to the cost effectiveness of fragmentation. In

spill-over effects, and explicitly considers the trade and labor flows induced thereby. Thus far, both of these approaches were unable to account for simultanous job creation and destruction of firms due to trade-induced changes in technology. The latter considers technology as constant and invariant to integration, while the former treat technology as endogenous, but do not consider trade nor spill-over effects from implementing new fragmentation technologies.[10]

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 respectively, namely

(i) homogenous consumer services x_0 and

(ii) differentiated manufactures x_i (with $i = 1, ..., n$) along the lines of Dixit/Stiglitz (1977).

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applying the microfoundations of fragmentation to the Krugman set up, it also differs from most of the 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).

[10] In the Burda/Dluhosch (2002a,b) model, employment ratios remain unaffected unless cost effectiveness of fragmentation changes endogenously, a possibility which they did not consider. See also Dluhosch (2003) in a trade framework with differing factor proportions.

Consumer services serve as numéraire.

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

For given income Y, utility maximization for the representative household gives rise to the familiar demand functions

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

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

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 of these intermediates 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.[11]

[11] 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.

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

(i) the number of firms that make use of these cost saving technologies and

(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 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) as well as costs for business services (p_Z) depending on the extent of fragmentation (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

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

Free entry implies that profits are driven to zero. 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).

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

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

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

The zero profit condition provides information about the relationship between the number of firms n and low skilled services employment L_S (9).[12]

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

To limit attention to economically meaningful equilibria, it is assumed that α is small enough: $\alpha < 1/\left((\eta - 1) \ln (n+1)\right)$.

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 $Z = H_S$. From the profit function in the production of business services we know that the derived demand for labor in the business services sector is infinitely elastic at p_Z. In a competitive labor market the latter will equal the equilibrium wage. The market price for business services p_Z also equates demand for business services z from n manufacturing firms with total supply:

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

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

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, while consumer services are produced with the use of low skilled labor only. Production of manufactures, however, requires the input of high-skill 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 $\kappa = \overline{L}/\overline{H}$, with each type of labor supplied inelastically by households in the two forms, skilled $\overline{H}$ and unskilled $\overline{L}$, 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 constant 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

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

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

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:

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

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.

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

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

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

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

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

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) variable $\overline{H}$.

In order to examine the impact of trade on technology and on labor flows we introduce a second country. Variables of the foreign country will be denoted with an asterix. Furthermore, we need to distinguish values of variables ex ante and ex post integration.

For this purpose we will use the superscript *ie* when referring to the integrated economy. Factor endowments for the integrated economy are thus $\overline{H}^{ie} = \overline{H} + \overline{H}^{*}$.

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 the market, the larger the number of users of new technology, and the higher the cost effectiveness of fragmentation 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.[13]

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 differentiated goods.[14] If these assumptions

[13] This result differs 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.

[14] This is a limiting assumption. However, otherwise things not only get much more complicated, but they also depend on arbitrary assumptions.

hold true, the equilibrium condition on the trade balance reduces to (19)[15]

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

In order to examine the labor market consequences of trade exposure consider first the benchmark case of two identical economies that open up to trade, $\overline{H} = \overline{H}^{*}$, so that $n^{T} = n^{T*}$. 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 increases at any given relative price of management services. Therefore, the number of firms in the integrated 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	$\overline{H} = \overline{H}^{*}$
Value	0.5	0.5	2	0.5	1	1	$0 < H < 100$	50

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

[15] Recall the assumptions of symmetry and constant factor proportions $\kappa = \kappa^{*} = 1$ in Home and in Foreign in deriving equation (19).

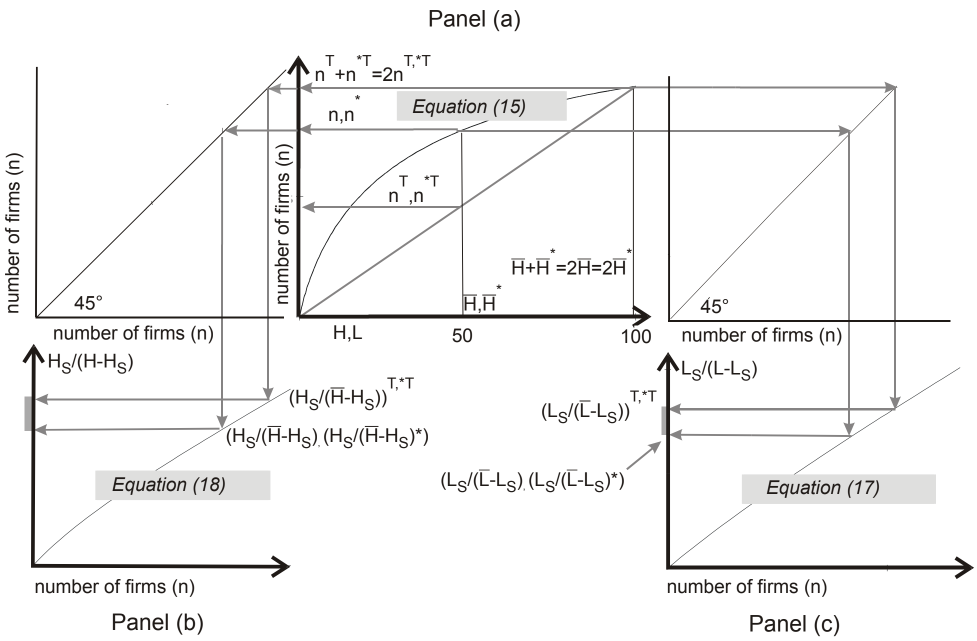

Figure 4.1: The impact of trade exposure on the number of firms (panel (a)) and on occupational employment ratios, i.e. services to production workers, high (panel (b)) and low skilled (panel (c))

(19)), with the benchmark case of two identical economies trading with each other indicated. Panels (b) and (c) of Figure 4.1 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 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.

4.1. 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 if 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 main 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, 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, and it may help to sort out the 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 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. 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.

5. 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 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 which cost effectiveness of fragmentation 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 job and 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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