INTERNATIONAL PRODUCTION FRAGMENTATION AND THE IMPLICATIONS FOR RELATIVE LABOUR DEMAND: THE MALAYSIAN CASE

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ABSTRACT:

Trade developments in Malaysia, point to a rapid expansion in international production fragmentation, which translates into the rising importance of trade in parts and components. The nature of such trade particularly the international procurement of parts and components is believed to have a greater impact on the labour market than trade in final goods. The paper therefore addresses the effects of fragmentation on relative labour demand in the Malaysian manufacturing sector given the recent rise in skill differentials. The study is confined to one perspective of international production fragmentation, by disentangling component trade from total trade and focusing on the import side.

The effects of imports of parts and components on relative labour demand are estimated using a partial-equilibrium approach based on a translog cost function. The estimations are conducted for a balanced panel data set, comprising six selected manufacturing industries spanning the period 1983 to 2000.

The results suggest that fragmentation has significantly shifted labour demand in favour of the skilled. The possible explanation for the widening impact of fragmentation on skill differentials in an unskilled abundant country like Malaysia is that the "knife-edge comparative advantage" of the former necessitates skill upgrading of industries. The factor bias towards skills inherent in imports of parts and components are deemed to be of more relevance to growing skill differentials as opposed to imports of final goods.

In total, though fragmented imports in the Malaysian manufacturing sector is significantly important in explaining the rise in skill differentials, it cannot explain all of the increase. However, the study points out that the concerns that imports displace skilled labour for an unskilled abundant country may be misplaced, given the role of imports of parts and components. Skilled labour in the Malaysian case does not necessarily lose out from increasing fragmentation in imports.

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1. INTRODUCTION

Trade developments in the East Asian region in particular point to a rapid expansion in international production fragmentation[1] (Ng and Yeats, 2003; Athukorala and Yamashita, 2005) throughout the 1990s (Kimura and Ando, 2003), which translates into the rising importance of trade in parts and components. In fact, trade in *parts and components* ('middle products,' 'intermediates' or 'fragments of final products') have grown at a faster pace than trade in final manufactured goods (Athukorala and Yamashita, 2005; Jones and *et al*., 2005).

In 2003, parts and components accounted for 43 per cent and 56 per cent of total Malaysian manufacturing exports and imports respectively. Component trade is found to be heavily concentrated in electronics[2] and electrical industries, whereby semiconductors and other electronic components (SITC 776) accounted for 66 per cent (68 per cent) of parts and component exports (imports) from Malaysia (Athukorala and Yamashita, 2005). The international procurement of parts and components is believed to have a greater impact on the labour market[3] than trade in final goods (see Sakurai and Moriizumi 2000; Egger and Egger 2003). The study thus approaches one perspective of fragmentation (focusing on the import side) by estimating the relative demand for labour. The empirical questions addressed: Is fragmentation sufficiently large to account for significant labour demand effects in Malaysia?

This paper is structured in the following manner. Section 2 provides the background for the empirical analysis and selectively surveys the empirical literature. Section 3 discusses the data employed for the study and analyzes the trends in component trade and the labour market. Section 4, the core section, details the econometric analysis and presents the results. Finally Section 5 concludes.

2. FRAGMENTATION AND LABOUR DEMAND

The issue that has received recent amount of attention is trade in goods that belong to the same sector, intra-industry trade or IIT (Grubel and Lloyd, 1975). The assumptions of the models explaining IIT are that consumers love variety and there are increasing returns to scale in the production of the differentiated good. The original impression seemed to be that IIT does not affect the relative demand for skilled labour. However recent contributions to trade literature have showed that this type of trade can lead to increased inequality within sectors. Assuming skilled workers determine the quality of final goods produced and that the opportunities for greater trade rests with industries that are basically producing high quality

products (differentiated in a vertical and horizontal way), the demand for high skilled labour would increase much faster (see Manasse and Turrini, 1999).

Duranton (1999) however explains labour demand effects based on trade in *intermediate goods* (fragmentation) instead of final goods. Final good producers who desire for advanced production technology will resort to trade to acquire the *high quality intermediates* abroad dues to the scarcity of skilled labour locally. Based on this argument, the attraction of fragmentation at an international level may be reflected in different requirements for labour skills thereby causing a new international division of labour. One country may contain labour skills more appropriate to one fragment and another labour-abundant country may be relatively more productive in the other fragment.

Theoretically it is conceived that unskilled labour intensive stages of production are shifted to unskilled labour abundant countries while more technologically advanced stages remain in skilled abundant countries. The argument is that fragmentation will lower the demand for unskilled labour in developed countries (see Hijzen *et al.* 2004), leading to a fall in employment of unskilled. However Feenstra (1998) points out that the reduction in demand for unskilled labour is also possible for developing countries if the fragmented activity received is relatively more skilled intensive than the home country. Thus skill differentials may increase in both developed and developing countries.

However, Geishecker and Gorg (2005) point out that the consequences of fragmentation for local labour markets are not clear-cut, particularly when there is labour mobility between industries. Fragmentation in one industry may affect labour in other industries as workers move from the affected industries. Thus fragmentation may not just be confined to changing demand between industries but relative demand within industries (see also Feenstra, 1998 and Hijzen *et al*., 2004). Geishecker and Gorg (2005) also point out that even without labour mobility, fragmentation effects on labour depend, among other things, on whether it complements or substitutes which type of labour.

A few recent papers that examined the impact of fragmentation on relative demand for skilled labour find significant results attesting to the importance of trade of such a nature for the latter. Most of these studies are based on European countries, such as the United Kingdom (Anderton and Brenton, 1999; Hijzen *et al.,* 2004), Austria (Egger *et al*., 2001; Egger and Egger 2003), Italy (Helg and Tajoli, 2004) and Germany (Geishecker and Gorg, 2005).

The above discussion ultimately rests on the fact that industries that depend on imported parts and components are likely to incur some adjustments in the relative labour demand *within* industries. Such a relationship is put to test for the Malaysian case in Section Four.

3. TRENDS IN PRODUCTION FRAGMENTATION AND LABOUR MARKET

3.1 Data

The empirical analysis is based on labour data drawn from manufacturing surveys conducted annually by the Department of Statistics (DOS) Malaysia. Malaysia is an interesting case to analyze given the increase in skill differentials (share of skilled to unskilled labour) in the recent past and prior evidence of greater component trade.

The study will only consider full-time paid employees (N), which excludes working proprietors, active business partners, unpaid family workers and part-time paid employees. Similarly, only the wages and salaries of full-time employees are considered for the study. The wage variable (W) refers to the average yearly earnings per full-time employee in each industry. All wage variables are deflated by the Malaysian consumer price index (at constant 1980 prices).

The definition of skills used for the study is solely based on occupational groupings governed by the availability of data from the manufacturing surveys. Skilled workers (S) refer to the number of employees in the managerial, professional, technical and supervisory categories. Unskilled workers (U) comprise production/operative workers. The real average wages for skilled and unskilled workers are constructed based on their average yearly earnings. Other industry measures employed comprise real value-added (Q), the share of foreign direct investment in total capital investment (FDI/CI) and the share of foreign workers in total employment (FW/N).

The data on exports (X) and imports (M) are derived from the *Malaysia: External Trade Statistics* publications. The data is compiled for industries at the 3-digit Standard International Trade Classification (SITC) level. Exports are valued f.o.b. while imports c.i.f. Total manufacturing exports and imports are deflated with the export price and import price index (1980 =100) for the entire economy respectively.

Since imports[4] based on the SITC scheme do not separate fragmentation trade from final goods, the study adopts Ng and Yeats (1999) classification of intermediate goods inferred from trade statistics for a total of six industries (furniture and fixtures, machinery

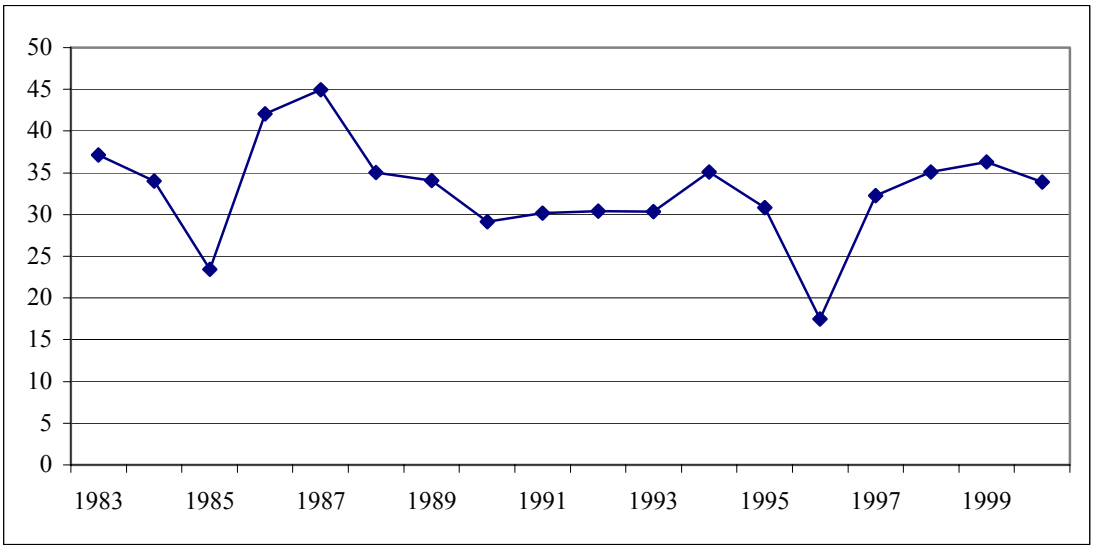
manufacturing, electrical and electronic products, transport equipment, scientific and measuring equipment and miscellaneous goods) in sections SITC 7 and 8[5] (industries in which fragmentation is relevant). For the study, only items termed as "parts and accessories" at the 4-5 digit level SITC[6] are counted as fragmented products while others are treated as finished goods (see Appendix 1). Thus the fragmentation intensity variable (F) in this study is defined as the share of component imports in total imports.

Integrating trade, labour market and industrial statistics, the empirical analysis involves a small panel data set of 6 major industrial groups, spanning the period 1983 to 2000. The data is a balanced panel of 108 observations.

3.2 Fragmentation

Figure 1 shows the development in fragmentation over the period 1983 to 2000 for the six selected manufacturing industries. The share of parts and components in total imports had declined marginally from 37 per cent in 1983 to 34 per cent in 2000. However, parts and components recorded a higher average annual growth rate of 22 per cent as opposed to 19 per cent for total imports for the entire period. The higher import growths of parts and components vis-à-vis that for total imports signify the importance of fragmented imports in the Malaysian manufacturing sector.

Figure 1: Share of Parts and Components in Total Imports (in per cent)



Note: The share of parts and components only refers to the six selected industries.

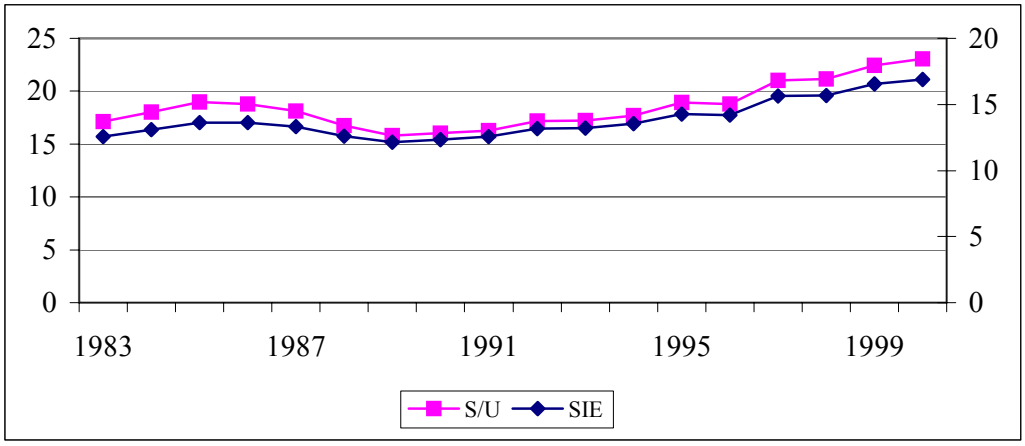
Source: Calculated from *the Malaysia: External Trade Statistics*, various issues.

Figure 2 however shows that the fragmentation is of very different importance for the six selected industries. Industries that show significant increase in the shares of imports of parts and components between 1983 and 2000 are furniture and fixtures (25 per cent to 57 per cent), machinery manufacturing (21 per cent to 41 per cent) and scientific and measuring equipment (4 per cent to 19 per cent). Though the import share of parts and components in total imports had declined by 46 per cent in the electrical and electronics industry, it remained relatively high at 37 per cent in 2000.

3.3 Labour Market

Most countries experienced a shift in labour demand towards skilled. The Malaysian manufacturing sector is no exception in this respect. Figure 3 presents skill differentials (the ratio of skilled to unskilled labour, S/U) and skill intensity (the ratio of skilled labour to total employment, SIE) for the manufacturing sector.

Figure 3: Skill Differentials and Skill Intensity in Manufacturing (in per cent)

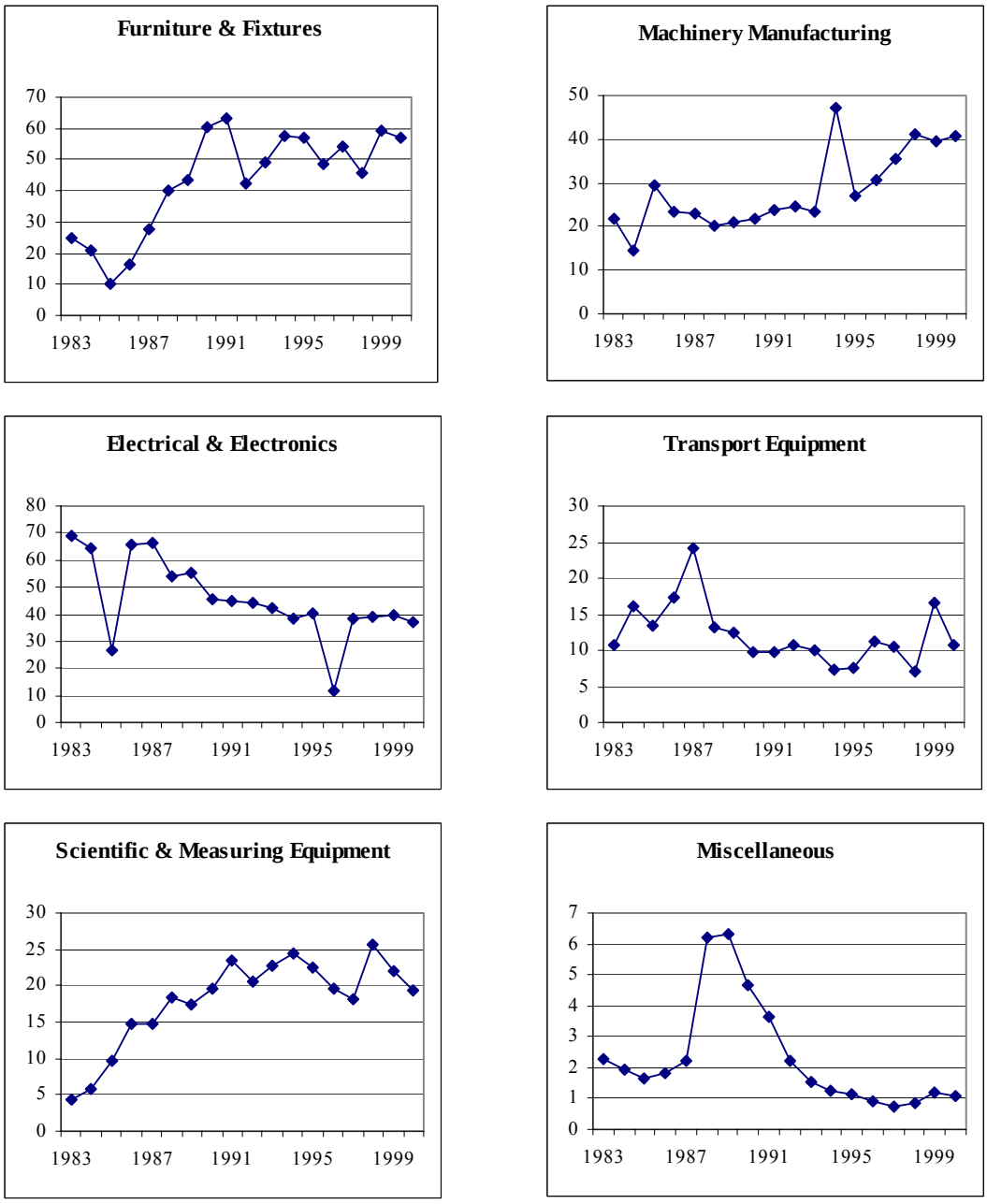


Note: The left axis measures skill differentials (S/U) while the right axis measures skill intensity (SIE).

Source: Calculated from unpublished data obtained from the Department of Statistics, Malaysia.

The 1980s see a marginal decline in skill differentials (from 17 per cent in 1983 to 16 per cent in 1990) in manufacturing. The 1990s however is characterized by a reversal in the relative quantity decline of the 1980s. Explanations based on the increases in the relative supplies of unskilled labour are compatible with the skill differential trends observed in the 1980s since unskilled labour increased by 9 per cent per annum while skilled labour increased merely by 8 per cent per annum. In the 1990s, the reverse occurs with a higher growth rate of

Figure 2: Import Share of Parts and Components, by Industry (in per cent)



Source: Calculated from *the Malaysia: External Trade Statistics*, various issues.

10 per cent per annum for skilled labour vis-à-vis 6 per cent per annum for unskilled labour. The rise in skill intensity in the 1990s is thus characterized to be demand-driven relative to the 1980s.

At the industry level, a similar upward trend in skill differentials and skill intensity is observed in the 1990s (see Figure 4). Such upward trend is not just confined to the modern expanding industries such as electrical and electronics, machinery manufacturing and scientific and measuring equipment, but also to the traditional sectors such as furniture. The asymmetric experience of the 1980s and the 1990s seems to be an industry wide syndrome as shown in Figure 4.

4. ECONOMETRIC ANALYSIS

4.1 Specification

The translog function is commonly used in the literature and is considered appealing in that it provides a second order approximation to any cost function and it does not impose any restrictions on the substitutability of imports. The variable cost function in translog form that assumes capital to be a fixed factor of production is as follows:

$$\ln C_i = \alpha_0 + \alpha_q \ln Q_i + \tfrac{1}{2}\,\alpha_{qq}\ln(Q_i)^2 + \beta_k \ln K_i + \tfrac{1}{2}\,\beta_{kk}\ln(K_i)^2 + \Sigma_j \gamma_j \ln W_{ij} + \tfrac{1}{2}\,\Sigma_j\Sigma_k \gamma_{jk}\ln W_{ij}\ln W_{ik} + \Sigma_j \delta_{Qj}\ln Q_i \ln W_{ij} + \Sigma_j \delta_{qj} K_j \ln K_i \ln W_{ij} + \Sigma_j \delta_{Kj}\ln K_i \ln W_{ij} + \rho \ln Q_i \ln K_i + \lambda_T T_i + \tfrac{1}{2}\,\lambda_{TT}(T_i)^2 + \lambda_{QT} T_i \ln Q_i + \lambda_{KT} T_i \ln K_i + \Sigma_j \varphi_{iWj} T_i \ln W_{ij}$$

where

C_i = variable costs in industry i

Q_i = output in industry i

K_i = capital stock in industry i

W_{ij} = price of variable factor j

T_i = technology in industry i

Cost minimization of the above generates the following linear equations for the factor shares (L):

$$L_{ij} = \alpha_j + \delta_{Qj}\ln Q_i + \delta_{Kj}\ln K_i + \Sigma_k \gamma_{jk}\ln W_{ik} + \varphi_{iWj} T_i$$

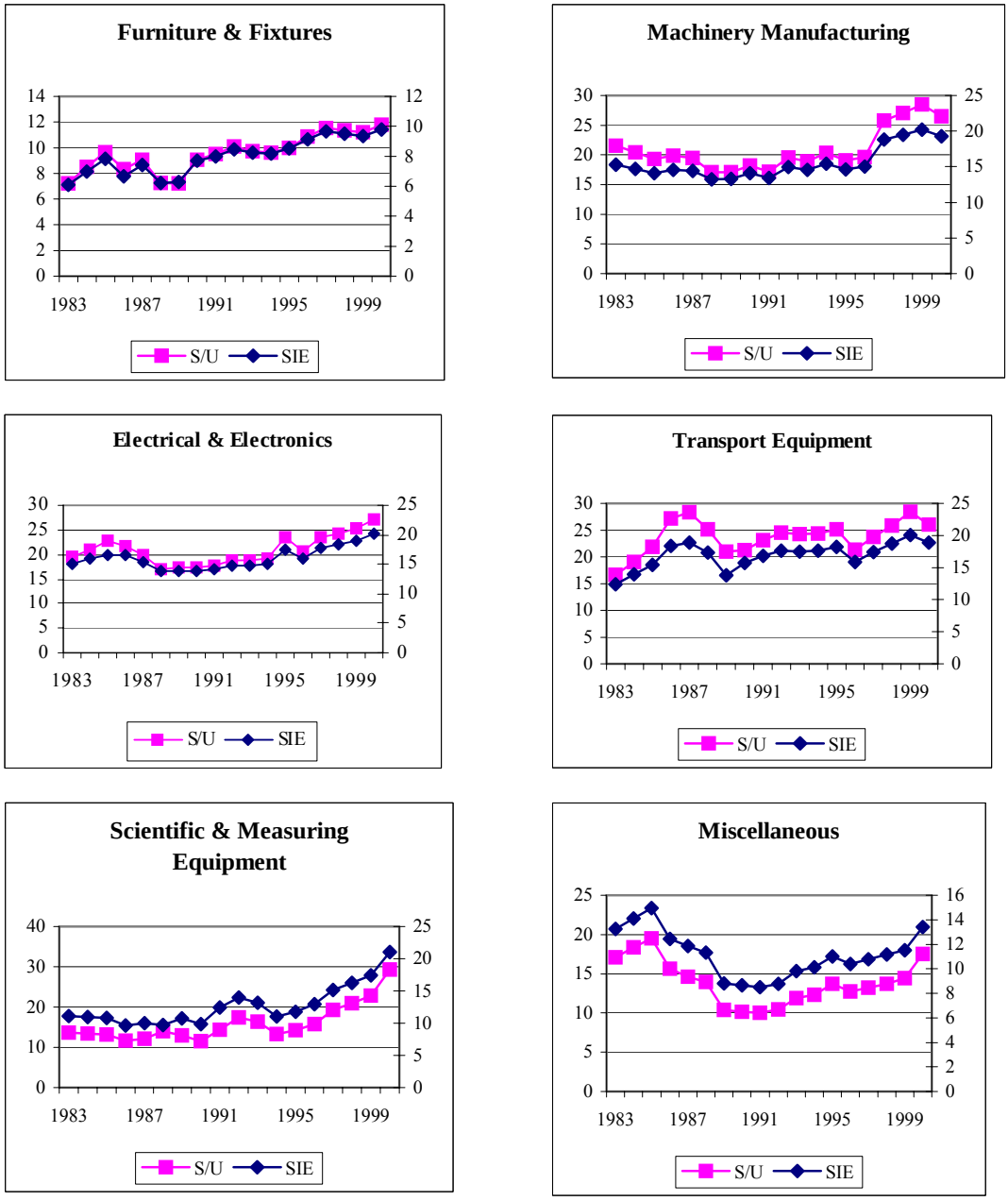
Differencing the above generates:

$$\delta L_{ij} = \varphi_{iWj} dT_i + \delta_{Qj} d\ln Q_i + \delta_{Kj} d\ln K_i + \Sigma_k \gamma_{jk}\ln W_{ik}$$

Assuming homogeneity of degree one in prices imposes:

$$\Sigma_k \gamma_{ik} = \Sigma_j \gamma_{ik} = \Sigma_j \delta_{iK} = \Sigma_j \delta_{Qj} = 0$$

Figure 4: Skill Differentials and Skill Intensity, by Industry (in per cent)



Note: The left axis measures skill differentials (S/U) while the right axis measures skill intensity (SIE).

Source: Calculated from unpublished data obtained from the Department of Statistics, Malaysia.

this generates

$dL_{ij} = \varphi_{iWj}dT_i + \delta_{Qj}dlnQ_i + \delta_{Kj}dlnK_i + \gamma dln(W_j/W_k)$

with two variable factors j and k.

Machin *et al.* (1996) and Anderton *et al.* (2001) define the two variable factors of production as skilled (S) and unskilled (U). The relative labour demand equations are examined with the inclusion of trade variables, which are exports (X) and imports (M).

In addition to trade variables, foreign labour (FW) and foreign direct investment (FDI) are also introduced in the equation, due to the importance of foreign presence and foreign participation in the Malaysian manufacturing respectively. Foreign labour is distinguished by skills to capture the differential impact on inequality. Thus foreign migrant components are entered into equations as the share of skilled foreign workers in total employment (FWs/N) and the share of unskilled foreign workers in total employment (FWu/N), while FDI is entered into the inequality equations as the share in total capital investment (FDI/CI).

The relative labour demand equation that is estimated is as follows:

$$ln(SIE)_{it} = \Omega + \varphi_1 ln(SW/USW)_{it} + \varphi_2 lnQ_{it} + \lambda lnK_{it} + \mu_1 lnX_{it} + \mu_2 lnM_{it} + \mu_3 ln(FDI/CI)_{it} + \mu_4 ln(FWs/N)_{it} + \mu_5 ln(FWu/N)_{it} + \nu_{it}$$

where

Ω = constant

SIE = ratio of skilled to total employment

SW/USW = real relative wages (average skilled wages relative to average unskilled wages)

Q = output measured as real value-added

K = capital intensity measured as total fixed assets per output

X = real exports (used interchangeably with export intensity measured as the share of exports in output, EI)

M = real imports (used interchangeably with import penetration measured as the share of imports in domestic consumption, IP)

FDI/CI = share of foreign direct investment in capital investment is a proxy for technology

FWs/N = share of skilled foreign workers in total employment

FWu/N = share of unskilled foreign workers in total employment

The above specification is implemented in the following manner. The study will adopt the more conventional factor demand equation of estimating "relative" labour demand as the share of skilled to unskilled (hereafter referred to as skill differentials or S/U), since Machin

et al. (1996) do acknowledge that the theoretical foundation for estimating relative labour demand regression of the above form is weak. Following the earlier discussion on fragmentation, total imports (M) are disaggregated into imports of parts and components (Mpc) and other imports (Mo). Mpc is also used interchangeably with the fragmentation intensity variable (F).

4.2 Results

Table 1 presents the results of the skill differential equations for the fixed effects model. The Hausman (1978) test reveals that the coefficients of the fixed effects and random effects model do not differ statistically for all specifications. Thus only the fixed effects estimates are presented in Table 1.

The first equation in Table 1 reports the skill differential specification including total imports, while the second equation presents the same specification but distinguishes total imports into Mpc and Mo. The third and fourth equations introduce the fragmented intensity variable with and without Mo respectively. All four specifications are estimated in first differences[7].

In terms of the individual specific variables, statistically significant and negative estimates are found between relative wages and skill differentials, as expected. Similarly, output estimates are significantly negative. The negative sign on the output variable that controls for the scale of production simply means that the employment of unskilled labour increases more rapidly than the increase in skilled labour as output increases. Conversely the significant positive estimates on capital intensity signify complementarity effects between capital and skilled labour as factors of production.

In contrast to the significance of the above variables, FDI does not significantly affect relative labour demand. The evidence seems to suggest that FDI has not brought in skilled labour using technology. Mahadevan (2002) in her study on Malaysian manufacturing between 1981 and 1996 agrees that Malaysia has obtained better technology and equipment *via* FDI, but has undoubtedly failed to learn to use it adaptively. Conversely, another study on the Malaysian manufacturing industry by Oguchi *et al.* (2002) for the period 1992 to 1996 shows that FDI did not come with more efficient technology, as domestic firms were as efficient as foreign firms. The lack of sufficient absorptive capacity (or even efficient FDI-related technology) probably explains why FDI inflows are not translated into higher demand for skills.

Table 1: Skill Differential Equations Across Manufacturing Industries, by Fixed Effects

Variables	(1)	(1a)	(2)	(2a)	(3)	(3a)	(4)	(4a)
SW/USW	-0.018*	-0.016*	-0.018*	-0.018*	-0.017*	-0.017*	-0.018*	-0.016*
	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Q	-2.044*	-2.177*	-1.963*	-2.071*	-2.028*	-2.134*	-1.985*	-2.144*
	0.622	0.637	0.619	0.641	0.608	0.630	0.620	0.634
K	0.104*	0.104*	0.103*	0.104*	0.103*	0.104*	0.103*	0.103*
	0.031	0.032	0.031	0.031	0.031	0.031	0.031	0.031
FDI/CI	-0.0002	-0.001	0.001	0.0004	0.001	0.0004	0.001	0.0004
	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
FWs/N	0.799*	0.767**	0.861*	0.850*	0.829*	0.817*	0.848*	0.821*
	0.409	0.403	0.397	0.396	0.390	0.390	0.396	0.391
FWu/N	-0.130	-0.140	-0.140	-0.142	-0.144	-0.144	-0.143	-0.147
	0.101	0.101	0.102	0.101	0.101	0.100	0.101	0.101
X	-0.009	-0.002	-0.228	-0.002	-0.335	-0.002	-0.291	-0.002
	0.847	0.003	0.845	0.003	0.846	0.003	0.853	0.003
M	-0.499	0.0002	-	-	-	-	-	-
	0.973	0.0004						
Mo	-	-	-0.874	-0.872	-	-	-0.472	0.0002
			0.745	0.743			0.990	0.0005
Mpc	-	-	0.303	0.308	-	-	-	-
			0.464	0.460				
F	-	-	-	-	**0.028****	**0.027****	0.020	**0.027****
					0.016	0.016	0.024	0.016
cons	0.778*	0.753*	0.827*	0.803*	0.783*	0.734*	0.831*	0.741*
	0.258	0.188	0.257	0.211	0.236	0.184	0.253	0.185
R-sq	0.411	0.412	0.415	0.418	0.415	0.418	0.417	0.419
DW	1.736	1.704	1.689	1.677	1.648	1.643	1.666	1.642

Note: 1. Specifications (a) include M and X while specifications (b) include IP and EI.
2. DW refers to the Bhargava *et al.* (1982) Durbin-Watson statistics.
3. Figures below coefficient estimates are standard errors.
4. Total number of observations is 96.
* significant at 5% and ** significant at 10%

Though foreign participation in the form of FDI inflows do not matter, the presence of foreign labour has contributed to growing skill differentials. The quality of migrant labour is found to be important for skill differentials. Higher presence of skilled migrants significantly increases relative labour demand while unskilled migrants have an opposite impact, albeit insignificant.

Though both trade terms[8] are insignificant in equations (1) and (1a), exports have employment effects in favour of unskilled labour. Prior evidence indicates a significant shakeout of unskilled labour relative to skilled labour owing to exports due to labour rationalization. As for imports, the negative impact on skill differentials implies slower growth in skilled vis-à-vis unskilled as imports increase (prior evidence also indicates that imports into Malaysia increases both skilled and unskilled labour demand).

It is important to note that the signs of the estimates on other imports differ from imports of parts and components (see equations 2a and 2b in Table 1). Though both Mo and Mpc remain insignificant, Mpc is consistently positive while Mo remains negative. Since the variable of most interest in the study is the measure of fragmentation, the Mpc is substituted with the fragmentation-intensity variable (F) in equations (3) and (4). F is found to positive and significant in most cases.

Fragmentation on the import side appears to be skill-biased, thereby widening skill differentials in the Malaysian case. The views that render support to the widening impact of fragmentation on skill differentials in unskilled abundant countries center on the fact that "knife-edge comparative advantage" of fragmented trade necessitates skill upgrading of industries (Rajan, 2004). The factor bias towards skills inherent in imports of parts and components[9] are of more relevance to growing skill differentials as opposed to imports of final goods.

In total, though fragmented imports in manufacturing is significantly important in explaining the rise in skill differentials, it cannot explain all of the increase. The empirical results of the study should be taken as suggestive instead of conclusive. There is a need to further refine the fragmentation intensity variable to ascertain the robustness of the results. Distinguishing the source of fragmented imports from developed countries vis-à-vis developing countries is also necessary to ascertain the extent of complementary effects with skills.

5. CONCLUSION

The results produce important implications concerning the increase in fragmented imports for the domestic labour market. The concerns that imports displace skilled labour for an unskilled abundant country like Malaysia may be misplaced, given the role of imports of parts and components. Skilled labour does not necessarily lose out from increasing fragmentation in imports. International fragmentation may thus have different implications for labour in different countries.

Further research should account for a broader range of industries such as the chemicals industry, which has witnessed growth in vertical specialization over time. There is also a need to expound further the extent of intermediate goods that are used as inputs to produce export goods.

Appendix 1
Parts and Components of Selected Industries

No.	SITC Rev. 2	SITC Rev. 3	Description
MACHINERY MANUFACTURING			
1	7119	7119	Parts of steam boilers and auxiliary plants
2	71319	71319	Parts of aircraft internal combustion engines
3	7139	7139	Parts of aircraft internal combustion engines, nes
4	7149	7149	Parts of engines and motors, nes
5	7169	7169	Parts of rotating electric motors
6	71889	71819	Parts of water turbines and hydraulic motors
7	72119	72119	Parts of cultivating equipment
8	72129	72129	Parts of harvesting machinery
9	72139	72139	Parts of dairy machinery
10	72198	72198	Parts of wine making machinery
11	72199	72199	Parts of other agricultural machinery, nes
12	7239	7239	Parts of construction machinery
13	72449	72449	Parts of spinning and extruding machinery
14	72469	72467	Parts of looms and knitting machinery
15	72479	72468	Parts of textile machinery, nes
16	7259	7259	Parts of paper making machinery
17	72689	72689	Parts of bookbinding machinery
18	7269	7269	Parts of printing and typesetting machinery
19	72719	72719	Parts of grain milling machinery
20	72729	72729	Parts of food processing machinery
21	72819	72819	Parts of machine tools for special industries
22	72839	72839	Parts of mineral working machinery
23	72849	7285	Parts of machines for special industries, nes
24	7369	7359	Parts of machine tools for metal working
25	73719	73719	Parts of foundry equipment
26	73729	73729	Rolling mill parts
27	74149	74149	Parts of refrigerating equipment
28	7429	7429	Parts of pumps for liquids
29	7439	7439	Parts of centrifuges and filters
30	74419	74419	Parts of fork lift trucks
31	7449	7449	Parts of lifting and loading machines
32	74519	74519	Parts of power and hand tools
33	74523	74529	Parts for packing machinery
34	74999	74999	Parts of non-electric machinery, nes
35	759	759	Parts of office and adding machinery

Appendix 1 Contd.

No.	SITC Rev. 2	SITC Rev. 3	Description
ELECTRICAL & ELECTRONIC PRODUCTS			
36	764	7649	Parts of telecommunications equipment
37	77129	77129	Parts of electric power machinery
38	772	7728	Parts of switchgear
39	77579	77579	Parts of domestic electrical equipment
40	77589	77589	Parts of electrothermic appliances
41	77689	77688	Parts of electronic components, nes
42	77819	77819	Parts of electronic accumulators
43	77829	77829	Parts of electric lamps and bulbs
44	77889	77889	Parts of electrical machinery, nes
TRANSPORT EQUIPMENT			
45	784	784	Parts of motor vehicles and accessories
46	78539	78537	Parts of carriages and cycles
47	78689	78689	Parts of trailers and non-motor vehicles
48	79199	79199	Parts of railroad equipment and vehicles
49	7929	7929	Parts of aircraft and helicopters
FURNITURE & FIXTURES			
50	82119	82119	Parts of chairs
51	82199	8218	Other furniture parts
SCIENTIFIC & MEASURING EQUIPMENT			
52	87429	874240 & 874260	Parts of measuring or drawing machines
53	881190	881140 & 881150	Parts of still cameras, nes
54	88129	881230, 881240, 881340110 881340190, 881340900, 881360000	Parts of cameras, under 16mm
55	88411	88422	Parts of unmounted optical elements
56	88529	8859	Parts of clocks and watches (less time equipment)
MISCELLANEOUS			
57	895218/9	8952199	Parts and accessories of musical instruments
58	8989	8989	Parts and fittings of pens
59	89949	89949	Parts of umbrellas and canes

Source: Adapted from Ng and Yeats, 1999.

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Notes

[1] Alternative terms have been given to reflect the same concept, such as segmentation, integrated production, outward processing (see Lall *et al*., 2004), intra-product specialization, super-specialization (see Helg and Tajoli, 2004), multi-stage production (Hummels *et al*., 2001), de-localization, disintegration (see Hijzen *et al.,* 2003), production sharing, vertical specialization, slicing the value chain and outsourcing (see Feenstra and Hanson, 1996; Athukorala and Yamashita, 2005), kaleidoscope comparative advantage and intra-mediate trade (Rajan, 2004). The term 'fragmentation' refers to the splitting up of production processes into separate components that can be produced in different locations.

[2] Lall *et al.* (2004) argue that electronics is fragmenting faster than automobiles due to the fact that the former has discrete processes, of which several are labour intensive, and more importantly is the high value-to-weigh ratio of components that makes distant locations economical.

[3] Fragmentation 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 not only affected in import-competing industries but in all industries that use foreign inputs.

[4] Imports as pointed out by Lovely and Richardson (1998) may take the following form: (a) finished goods; (b) import of parts and components.

[5] Various ways have been adopted in the literature to identify trade in parts and components. Athukorala and Yamashita (2005) identify 225 products at the 5-digit level SITC as parts and components belonging to sections SITC 7 (machinery and transport equipment) and SITC 8 (miscellaneous goods) while Lall *et al.* (2004) concentrate on the 4-digit SITC 7.

[6] See Lall *et al.* (2004) for the limitations in capturing fragmentation (partially) by merely separating finished goods from parts and components.

[7] The panel unit root tests proposed by Im, Pesaran and Shin (IPS, 1997) are performed and all variables are found to be I(1) process, which is stationary in first differences.

[8] The possibility of a high degree of measurement error is expected when using the trade share series (EI and IP) because the output data used in the denominator comes from the manufacturing census while the trade data used in the numerator comes from the trade statistics. The coverage of the latter is more comprehensive than the coverage of the former as the census omits small-scale industries that may be engaged in trade. It is these inconsistencies in the coverage in manufacturing output and trade data that leads to measurement errors in trade share series.

[9] Robbins (1996) also finds a positive association between the relative demand for skilled labour and imports for capital goods for Malaysia.