Openness, Technological Change and Labor Demand

in Pre-Crisis Indonesia*

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Abstract

This paper examines the impact of export orientation, import competition, foreign ownership, and the rate of capital accumulation on the relative demand for skilled and unskilled labor in pre-crisis Indonesia. Estimates from an interrelated factor demand analysis indicate that openness and foreign ownership, by themselves, acted to raise the relative demand for unskilled workers in the pre-crisis period, while the newness of capital was associated with increased relative demand for skilled workers. Overall, the relative demand for unskilled workers increased yet their relative wage position weakened. These contrasting relative employment and wage changes are consistent with the examined demand shocks and the greater elasticity of supply of Indonesian unskilled relative to skilled labor.

1. Introduction

Flows of goods, services and capital between developing and industrialised countries intensified in the two decades prior to the mid 1990s.[1] Apparently related to this intensification was a deterioration in the performance of low skill workers in industrial countries. In regulated labor markets unemployment increased while elsewhere there tended to be a widening of wage inequality between skilled and unskilled workers.[2] In developed countries, as this trade expands, import competing industries that are intensive in unskilled labor shrink, while exporting industries that are intensive in relatively abundant skilled labor and capital expand. The demand for unskilled labor therefore decreases relative to that for skilled labor, raising the skilled to unskilled wage ratio.[3] Where the wage of unskilled labor is at an administrative minimum or where the wage setting process renders relativities rigid, the contraction in demand causes unemployment.[4] Although there is considerable evidence that this contraction in unskilled labor demand has also been due to spontaneous technological change,[5] there is little disagreement that trade has played an important role.

If globalization and technology change have important implications for developed countries, then they clearly have important implications for developing countries too. The

[1] The movement of goods and services across borders grew from 23 percent of world Gross Domestic Product (GDP) in 1970 to 40 percent in 1990 (World Bank, 1995a).
[2] For evidence, see Freeman and Katz (1995), Katz et al. (1995), World Bank (1995a) and Davis (1998).
[3] That, by this mechanism, the increased trade was a substantial contributor to the observed labor market changes is argued by Leamer (1994), Sachs and Shatz (1994) and Wood (1994, 1995).
[4] For analyses of the effects of rigid wage relativities, see Bertola and Ichino (1995) and Krugman (1995).
[5] See Baldwin (1994), Berman *et al* (1994), Johnson (1997), Krugman and Lawrence (1994), and Lawrence and Slaughter (1993).

standard international trade theorems, derived from the Heckscher-Ohlin-Samuelson (HOS) model, predict that openness should be beneficial for unskilled labor in developing countries. The decline of barriers to trade has allowed these countries to realize their comparative advantage, usually in unskilled labor intensive goods. The combination of trade reforms and improved infrastructure allow the domestic terms of trade to shift in favor of unskilled labor intensive industries and so, by the Stolper-Samuelson theorem (Stolper and Samuelson, 1941), the wage of unskilled labor rises relative to product prices and the wage of skilled labor. The search for this pattern in the numbers has thus far yielded mixed results, however.[6] Wood (1997), for example, finds that although trade liberalization in the East Asian countries during the 1960s and 1970s appeared to reduce wage inequality, the experience of the Latin American countries in the 1980s and early 1990s offers contradictory evidence.

This paper examines these issues for the case of Indonesia. We concentrate on the manufacturing sector, which has been at the forefront of increasing openness in the Indonesian economy since the mid 1980s. Our analysis establishes the trends in employment and wages of skilled relative to unskilled labor in this sector and then accounts for the effects on them of openness and technological change. The results show that, after Indonesia shifted its commercial policy regime from import substitution to export orientation in the mid 1980s, the employment of unskilled relative to skilled labor increased while the unskilled relative to the skilled wage decreased. The greater openness facilitated accelerated capital accumulation in manufacturing, combined with increased foreign participation. Overall, the changes appear to have raised the relative demand for unskilled labor in Indonesia. Skill-using technologies embodied in the new capital, however, tended to offset this effect somewhat, though not completely, by increasing the relative demand for skilled labor. This pattern of changes in relative labor demand contrasts with the corresponding experience of the developed and some other developing countries. Yet, because the supply of unskilled labor remained relatively elastic in Indonesia, this net increase in its relative demand nonetheless saw the wage of skilled labor increase faster than that of the unskilled, resulting in widening wage inequality.

A brief review of corresponding results from the developed and other developing countries is offered in Section 2, along with a supply and demand labor market analysis. Section 3 sets out the observed labour market outcomes in Indonesia during the boom period.

[6] See Diwan and Walton (1997), González and McKinley (1997), Pissarides (1997), Robbins (1996a and b), Tan and Batra (1997) and Wood (1997).

An interrelated factor demand model is then introduced in Section 4 and used to analyse the determinants of the observed relative labour demand changes. Section 5 offers conclusions.

2. Openness, Technology and Labor Market Outcomes in Developing Countries

2.1 The stylised facts

Labor market behavior varies widely across developing countries, though broadly similar behavioural patterns are clustered within regional country groups. The early development of the newly industrializing countries (NICs)[7] appeared to be characterised by inward looking economic policies and an associated Lewis (1954, 1958) style "labor surplus" phase during which GDP expanded but real wages grew little.[8] This pattern changed markedly in the 1980s, by which time all these countries had adopted outward looking commercial policies and wages of unskilled workers not only grew but grew relative to those of the skilled.[9]

The South-East Asian countries, particularly Thailand, Malaysia, the Philippines, and Indonesia share a different set of similar characteristics, including larger populations and rural hinterlands than the NICs. In general, they made the transition from inward-oriented commercial policies later[10] and the real wages of their unskilled workers remained low for longer. This has been explained in terms of their comparatively rapid overall population growth, their larger rural labor forces and the seasonality of rural labor demand.[11] As their openness increased, however, the employment of unskilled labour in manufacturing began to grow rapidly.[12] Robbins (1996b), who focussed on Malaysia and the Philippines, found that this surge in labor demand was associated with the opening of their economies to trade. Moreover, the result predicted by elemental trade theory, that the wages of low skill workers would rise relative to those of the skilled, was borne out during the 1970s and 1980s. He attributes the declining skill premium to supply factors, however; in particular to a rise in the growth rate of the supply of skilled labor. Indeed, he concludes that the effect of openness, in

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[7] These are Hong Kong, South Korea, Singapore, and Taiwan.
[8] See Fields (1984 and 1994).
[9] See Horton *et al* (1991), Kim and Topel (1995) and Wood (1997).
[10] An exception is Thailand, which had always maintained relatively open capital and current accounts since it started to modernize its economy in the 1960s (Krongkaew, 1995).
[11] See Manning and Pang (1990).
[12] Employment growth in the Malaysian manufacturing sector was 24 percent per annum during 1968-73 and 12 percent during 1973-81 period. In Thailand, manufacturing employment grew at a rate of over 10 percent per annum in this period (Addison and Demery, 1988).

the absence of supply shifts, would have raised the relative demand for skilled labor, and hence its relative wage, mainly due to higher imports of skill-using machinery.

The experience of most Latin American economies differed substantially from that common in East and Southeast Asia primarily because labor markets there were more heavily regulated and labour-management relations were more confrontational.[13] In spite of this, the wages of low skill workers have tended to fall relative to those of skilled workers throughout Latin America. Although Feenstra and Hanson (1996) find that the wage of skilled relative to unskilled workers declined in Mexico from the early 1960s to the mid 1980s, thereafter wage inequality rose. They attribute this change of direction in wage inequality to the dramatic increase in foreign capital inflows experienced by Mexico during the 1980s. This boom in foreign direct investment (FDI) is attributable to policy reform and trade liberalization during the 1980s, and hence to substantially greater openness. They argue that such capital inflow increases the demand for skilled workers relative to unskilled workers and causes the relative wages of skilled workers to rise. Similar conclusions are reached by Revenga (1995) and Robbins (1996a and b).[14]

2.2 Synthesising the underlying shocks to relative labor demand

The pattern that emerges from these studies appears to confirm the result from trade theory, that increased openness and the associated realisation of a developing country's comparative advantage in labor-intensive goods does raise the demand for relatively abundant unskilled labor. The elemental trade theory from which this result emerges, however, assumes fixed factor supplies. In the experience of developing countries, both factor demand and factor supply shocks have been important. For example, in many developing countries the capital stock has been growing very rapidly. Although this is a factor supply shock, its effect is to shift the demand for labor. A key question is the shape of the labor supply curve mapped by this shift. Where it is steep, as assumed in the trade theory, the result is a wage rise. Where it is elastic, the primary impact of the shock is a large increase in the quantity of labor. The experience of a number of countries in the 1980s, however, appears to have been that

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[13] The right to strike in Latin American countries was recognized as early as the 1920s (Banuri and Amadeo, 1991). Most Latin American countries legislated minimum wages, mandatory cost of living allowances and mandatory bonuses and there were comparatively high costs of dismissal and high payroll taxes (World Bank 1995b).

[14] González and McKinley (1997) also assert that the rise in the skill premium in Mexico was due to policy interventions that weakened labor union power.

rapid growth in the capital stock meant the use of imported capital that embodied technologies that were more skill using than those associated with indigenous capital. This apparently biased technical change shifted labor demand in favour of skilled workers. Although they need not be dominant, changes of technology associated with rapid capital accumulation do appear to have been influential over relative labor demand shifts in some developing countries.

Even without this skill-biased technical change, however, it is possible that openness can greatly increase the relative demand for unskilled labor and yet cause the wage of unskilled workers to fall relative the skilled wage. This result can emerge under particular labor supply conditions. In the case of Indonesia, the rural sector is comparatively large and a vast employer of unskilled workers. A small transfer from its work force to manufacturing need not necessarily change the unskilled wage by much yet it would cause a large proportional increase in the manufacturing work force. This implies that unskilled labor is comparatively elastic in supply to manufacturing. Hence, despite the relative rise in the demand for unskilled labor, the increase in the skilled labor wage may still be greater than that in the unskilled wage. This situation is illustrated in Figure 1.

Let W denote the wage, N the employment level, S labor supply and D labor demand. The superscripts H and L indicate skilled labor and unskilled labor respectively, the initial equilibrium in this bifurcated labor market is at A. Now imagine that trade and investment liberalization increases the demand for both skilled and unskilled labor, reflected by rightward shifts in both skilled labor demand (from D_0^H to D_1^H) and unskilled labor demand (from D_0^L to D_1^L). The magnitude of the shift in unskilled labour demand is larger than that in skilled labour demand and the new equilibrium is at B. The wage of skilled labor increases from W_0^H to W_1^H while corresponding employment increases from N_0^H to N_1^H. Similarly, the wage of unskilled labor increases from W_0^L to W_1^L while unskilled employment increases from N_0^L to N_1^L. Because the supply elasticities are different, however, $(W_1^H-W_0^H)/W_0^H$ is greater than $(W_1^L-W_0^L)/W_0^L$, which implies that the relative wage of skilled to unskilled labor has increased. On the other hand, $(N_1^H-N_0^H)/N_0^H$ is less than $N_1^L-N_0^L)/N_0^L$, which confirms that equilibrium relative employment of unskilled to skilled labor has increased.

We take labor supply conditions as given and focus on the role of labor demand in determining market outcomes. The key demand side factors that influence labor market change in a developing country are then (i) openness of the current account, which creates import competition and export expansion, (ii) technological change, possibly associated with the use of imported capital goods that embody skill using technology, and (iii) capital account openness giving rise to foreign participation and outsourcing.

2.3 Methods and magnitudes

Here we offer a brief review of the methods adopted in previous studies of the demand for skilled and unskilled labor and of the strength of their results. This provides a reference against which our subsequent results for Indonesia might be compared. We group prior studies according to the principal explanation they consider, whether it be import competition, export expansion, technological change, or outsourcing and foreign investment.

To begin with import competition, Grossman (1987) estimates its effects on labor demand by regressing reduced form equations for employment and wages on their shift variables, including the price of imports. These reduced form equations are derived from a complete specification of supply and demand for industry products. Applied separately to nine US manufacturing industries, Grossman finds little dependence of wages on import competition. Revenga (1992), however, shows that similar reduced form equations for employment and wages can be derived from a simple competitive labor market model, where wages adjust to equate labor demand and supply. She estimates the model using panel data from 38 US manufacturing industries for 1977-87. Again the results identify only weak links between trade and average wages, with most of the adjustment occurring through employment. Lee (1995) uses the same model but incorporates skilled and unskilled labor as distinct factors of production. He is therefore able to derive reduced form equations for the relative employment and wages of skilled to unskilled labor. He estimates the model for a panel of 21 Canadian manufacturing industries for the period of 1970-90 and concludes that both technological change and import price changes have had positive effects on skilled workers' relative wages.

Turning to export orientation, Bernard and Jensen (1995, 1997) use plant level US manufacturing data to assess how export oriented firms perform, in terms of employment and wages paid, compared to non-exporting firms. They do this by regressing wages or benefits on exporter status, plant characteristics, industry characteristics, and location characteristics, finding strong evidence for an "exporter wage premium" for both skilled and production workers. Further analysis of the "between plant" effects of export orientation reveal a comparatively strong association with higher skilled wages.

The potential role of skill biased technical change in recent changes in US relative labor demand was pointed out by Lawrence and Slaughter (1993). In a subsequent econometric analysis, Berman *et al* (1994) find that technological change is the main reason for increased relative skill demand in US manufacturing. They disaggregate the changes in industry's relative employment of non-production workers into "between" and "within" industry changes, finding that the "within" industry component dominates the "between" component, and they conclude that biased technological change played a dominant role in the increased share of non-production employment. They then estimate a non-production wage share equation derived from a translog cost function.[15] Each industry employs three inputs: production labor, non-production labor, and capital, with the latter assumed fixed. By interpreting the residuals they attribute the rise in the non-production labor cost share to biased technical change. Later, they add two explicit variables representing technological change: the ratio of computer investment to total investment and the ratio of R&D expenditure to sales. Both variables have positive and significant coefficients, supporting their conclusion that biased technological change is an important contributor to within industry skill upgrading.

Mishel and Bernstein (1996), who estimate a model where wage inequality in the US is explained by technology indicators, such as the accumulation of equipment per worker, computers per worker, and R&D, offer contrary evidence on the role of technological change. They find insignificant the coefficients of interaction terms between time period and technology indicator variables, implying that technology within particular plants has not become more or less skill biased over time. In a related study, Doms *et al* (1997) also arrive at contradictory conclusions as to the effects of technology on wages in US manufacturing. They regress the average wage on the average characteristics of workers and plants, including technology indicators, in a cross sectional sample. The more technologically advanced plants appear to employ more skilled workers and pay higher wages. They then use panel data to try to capture how the effects of technology evolve over time. Consistent with Mishel and Bernstein, they then find that technology has little effect on skill upgrading. The most technologically advanced plants already pay their workers higher wages prior to adopting new technologies. Hence, they argue that the observed cross-sectional correlation between

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[15] This approach is similar to that employed here for the case of Indonesia.

technology use and worker wages may be due to time-invariant unobserved worker quality differences.

Turning to foreign investment and outsourcing, Feenstra and Hanson (1996) posit that capital movement from developed to developing countries increases wage inequality between skilled and unskilled labor in both regions. To test their model empirically, first they reestimate the non-production wage share model for US manufacturing used by Berman *et al* (1994), but they add another regressor representing outsourcing. They find that the outsourcing variable has positive and significant coefficients in various model specifications. This leads them to conclude that, in developed countries, outsourcing has an important role in the shift of relative demand toward the skilled labor. To test their hypothesis regarding developing countries, they study wages and employment in Mexico. They regress the relative wages and the changes in relative wages on regional dummy variables and find that the Mexican regions bordering the US have both the highest relative wages in any given year and experienced the largest increase in relative wages since the mid 1980s. Since foreign direct investments in Mexico are concentrated in these border regions, their hypothesis is supported.

Aitken *et al* (1996) investigate the effects of foreign investment on wages in Mexico, Venezuela, and the US. They regress wages on foreign participation indicators, including foreign investment, the scale of which is measured by the share of employment in enterprises with foreign equity investment. They find that foreign investment raises wages in all three countries. In Venezuela and Mexico, however, they find that there are no positive wage spillovers from foreign investment to domestically owned enterprises. They also run separate wage regressions for skilled and unskilled labor in these countries. The results for both indicate consistently that the effect of foreign investment in raising wages is greater for skilled labor than for unskilled labor, with a much higher differential reported in the case of Mexico.

3. Indonesia During the Boom

3.1 The policy transition

In the decade ending in the mid 1980s, Indonesia adopted an inward-looking import-substitution policy regime. Awash with revenue from oil exports, the government was eager to build capital intensive industries to replace imports and its manufacturing sector was almost entirely domestically oriented.[16] By the mid 1980s, however, oil prices had declined and the government faced a serious external imbalance.[17] In 1986, the import substitution strategy was therefore discarded and replaced with export orientation, followed by a devaluation of the exchange rate along with widespread deregulation in the domestic economy.[18] By the late 1980s, Indonesia appeared to be following the East Asian pattern of rapid growth in labor intensive manufactured exports.[19] Indeed, by 1995, non-oil exports made up 77 percent of all Indonesian exports, while the manufacturing sector provided 24 percent of GDP. The manufacturing sector was therefore the principal beneficiary of the change in policy regime and it grew to be particularly diverse in product variety, technology, and capital intensity, while providing unskilled labor intensive products such as textiles, as well as sophisticated machinery such as motor vehicles. If openness has affected wage inequality between skilled and unskilled workers in Indonesia, it should be reflected in this sector.

From the mid 1980s to the early 1990s, the Indonesian labor market was relatively undistorted. The government did not intervene in wage determination, nor did it enforce regulations on laying-off workers. It did, however, tightly control the union movement by allowing only one government-sanctioned labor union.[20] Changes on the labour supply side were therefore the result of growth pressure rather than government regulation.

3.2 The Data

This study draws on the Manufacturing Establishments Survey, which is conducted annually by Indonesia's Bureau of Statistics (BPS), from its inception in 1975 through 1993. The survey covers all manufacturing establishments that employ at least 20 workers. It

[16] See Aswicahyono *et al* (1996) and (Hill, 1991).
[17] See Hill (1996, p. 11).
[18] Earlier, in 1983, the government had started deregulating the banking sector by allowing banks to set their own interest rates.
[19] For details, see Hill (1991) and Fane (1996).
[20] Significant changes did occur in the early 1990s, however. First, the government revoked the regulation that banned strikes. Second, the government started to enforce the implementation of regional minimum wage

attempts to enumerate all establishments, except for those in the state-run oil and gas processing industry.[21] The data cover the cost, revenue, and asset structures of each firm included in the survey. Workers are classified as production and non-production workers, with wage costs classified accordingly. Each firm is classified according to the five digit ISIC (International Standard Industrial Classification) code based on its main product. In addition, for data on exports and imports, we use United Nations Commodity Trade Statistics, originally classified as SITC (Standard International Trade Classification) and concorded with the Indonesian ISIC data down to the 4-digit level by the International Economic Data Bank (IEDB) at the Australian National University

3.3 Trends in Relative Wages and Employment

To characterise changes in the relative wages and employment of skilled and unskilled workers we need to subdivide the workforce by skill level. For this purpose we use the ILO-based distinction between non-production and production workers to distinguish skilled and unskilled occupations. It has been argued (Leamer 1994) that the non-production/production split ignores considerable diversity of skills within each worker category due to differences in formal education, experience, on the job training and innate ability. Nonetheless, Bermal et al. (1994) demonstrate that this split closely mirrors that between blue-collar and white-collar occupations, which in turn reflects education levels.[22] For Indonesia, non-production workers are also generally better educated than their production worker counterparts. The 1994 Indonesian labor force survey (Sakernas) indicates that 66 per cent of production workers in the manufacturing sector have primary school education or less, 34 per cent have secondary education and only 1.6 per cent have tertiary education. Meanwhile, for non-production workers, 29 per cent have primary school education or less, 57 per cent have secondary education and 14 per cent have tertiary education.

We adopt two measures of wage dispersion. The first is the non-production to production wage ratio and the second is the coefficient of variation of wages measured across

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regulations, which are updated annually. Third, some independent labor unions were established despite the government's efforts to disband and declare them illegal. See Manning (1994) and Agrawal (1996).

[21] See Aswicahyono *et al* (1996) and Hill (1990a and 1990b) for a critical review of these data. Hill points out, for example, that the survey data prior to 1986 suffer from under-enumeration. To rectify this problem, BPS provided a backcast data base, which extends the coverage of the survey to all establishments, although it includes only a limited number of variables. This backcast database is used in this study wherever appropriate.

[22] Indeed, our use of the non-production/production split conforms with a larger literature. See, for example, Berman et al (1994), Doms et al. (1997), Feenstra and Hanson (1996) and Lawrence and Slaughter (1993).

all manufacturing workers and within worker groups.From 1975 to 1993, the average real wage of Indonesian production workers grew steadily at 4.1 percent per year, while that of non-production workers grew at 4.2 percent per year.[23] Correspondingly, employment growth for production workers was 9.4 percent per year while that for the non-production workers was 9.6 percent per year. Employment growth for production workers did accelerate, however, after 1986, the rate averaging 11.1 percent per year between then and 1993. [24] Meanwhile, non-production employment growth slowed slightly after 1986, averaging 9.5 percent per year in the 1986-93 period.

These trends are reflected in the wage and employment ratios between non-production and production labor tracked in Figure 2. During the period of inward-focused economic policy (1979-1986), non-production employment growth clearly outstripped production employment. Following the policy transition, however, this trend is reversed. This reversal is mirrored by the corresponding wage ratio, suggesting a negative relationship between wage and employment ratios of the type that occurs in the case already discussed, where the shock is accelerated capital accumulation and production labor is in more elastic supply than non-production labor. With wage dispersion crudely measured by the non-production to production wage ratio, wage dispersion does appear to have increased following the policy transition, in spite of a relative surge in the employment of unskilled workers.[25]

Between 1986 to 1991, the wage ratio between non-production and production workers rose by 10 percent from 2.20 to 2.42. This is comparable with the increase in the wage ratio in the US manufacturing sector in the 1980s. There the ratio also increased by 10 percent between 1979 and 1989 (Lawrence and Slaughter, 1993).[26] By contrast, the trend in relative employment between the two groups of workers in Indonesia is the opposite of that in the US. From 1986 to 1991, the employment ratio in Indonesia decreased from 0.26 to 0.22, a reduction by 15 per cent. In the US, meanwhile, from 1979 to 1989 the employment ratio rose from 0.35 to 0.44 (Lawrence and Slaughter, 1993), an increase of 25 percent. The rise in

[23] This continuous growth is consistent with corresponding growth in labor productivity, as demonstrated by Szirmai (1994).
[24] Manning (1994) notes this acceleration, attributing it to rapid growth of the export manufacturing sector.
[25] Using educational level as the proxy for skill, Manning (1994) also finds that there were narrowing wage differentials between more and less educated workers between 1977 to 1982. His data also indicate that, from the mid 1980s through the early 1990s, the trend in the wage ratio increased again, while the employment ratio decreased.
[26] Note that this modest widening in the gap between the average wages of production and non-production workers indicates a more substantial spreading of the overall wage distribution across all skill/occupational categories.

wage dispersion occurring in both countries was associated in the US with a contraction in low-skill labor intensive manufacturing but in Indonesia with an expansion of this sector.

The coefficients of variation of real wages for all manufacturing workers as well as for production and non-production workers are shown in Figure 3. Again, the policy transition sees a change of direction. During the inward-focussed period, the trend in wage variability, both within categories and for all manufacturing workers, is downward. Following the transition, however, it is upward in all cases.[27] Thus, both methods used to examine the trend in wage inequality in the Indonesian manufacturing sector suggest that wage inequality between skilled and unskilled workers has risen since the policy transition while the relative employment of skilled labor has declined.

Some idea of the contribution of supply changes to this shift in relative employment can be obtained from corresponding changes in the skill composition of Indonesia's overall labor force. Figure 4 shows the ratio of high school and above to below high school graduates as well as the ratio of university to below university graduates between 1975 and 1993. Both indicators show a steady increase in the relative supply of more educated workers. Yet the expansion in the supply of tertiary educated workers accelerated after the policy transition. Nonetheless, the educational attainment of the Indonesian labor force remained low, even compared with other South-East Asian countries, and there do not appear to be any changes in overall skilled labor supply that would explain the relative manufacturing employment shifts of Figure 2. Again, the pattern is consistent with a post transitional surge in capital accumulation that shifted out the demand curves for both types of labor and that the relatively elastic source of production workers was Indonesia's substantial hinterland.

3.4 Openness

Measures of openness are of two types depending on whether they are based on incidence or outcomes.[28] Those based on incidence are constructed from data on actual tariff and non-tariff barriers to trade or by comparing domestic and border prices of similar products and deriving nominal or effective rates of protection.[29] Those based on outcomes infer from the variables affected by trade protection instruments, such as prices or trade flows. The

[27] The decline in relative wage variability in 1993 over 1992 is probably the result of the new minimum wage policy.
[28] See Andriamananjara and Nash (1997.)
[29] See Vousden (1990: 53-58).

simplest outcome-based measure of openness is the "trade intensity ratio", which is defined as the ratio of exports plus imports to output.[30] Campa and Goldberg (1997) argue, however, that measures of openness should focus on the particular role played by patterns of trade in the transmission of external shocks.[31] For our purpose, trade intensity is disaggregated by its components into two measures, namely the export intensity ratio and the import penetration ratio. The export intensity ratio is defined as the ratio of exports to output, while the import penetration ratio is the ratio of imports to consumption.[32]

Nominal and effective rates of protection for Indonesian non-oil manufacturing are given in Table 1. Clearly, by these incidence-based measures, the policy transition saw Indonesia embark on a period of declining manufacturing protection. The corresponding trends in the export intensity and import penetration ratios, together with the index of real output, for Indonesian manufacturing sector from 1975 to 1993 are shown in Figure 5. Following the adoption of Indonesia's export-promotion policy in the mid 1980s, there was a very significant increase in export intensity from 19 percent in 1986 to 27 percent in 1987 and 32 percent in 1988. This change is the more significant considering that the corresponding trend in overall manufacturing output shows a smooth though accelerating increase in this period. Clearly, the policy reforms undertaken, combined with the associated currency devaluation, made Indonesian manufactures more competitive abroad.

Turning to the import penetration ratio, a less than careful look could give a misleading impression of the trend of openness in the manufacturing sector. Between 1975 and 1984, the import penetration ratio remained at about 45 percent. Following that, the ratio dropped from 44 percent in 1984 to 36 percent in 1985. It increased again between 1987 and 1991 increased again, to over 40 percent. The sudden decline in import penetration during the early to mid 1980s, however, was definitely not a result of a declining openness in manufacturing. The reason for it is the drop in oil prices during this period. At that time Indonesia relied heavily on oil exports for foreign exchange earnings, the drop in oil prices resulted in a substantial decline in its ability to import, a real devaluation, and hence the drop in the import penetration ratio. The bouncing back of the import penetration ratio in the

30 Leamer (1988) argues that a better measure of openness is the deviation of actual from predicted trade intensity.

31 Edwards (1998) uses nine alternative measures of openness to test the relationship between openness and total factor productivity growth. His results are robust to the openness indicator used, where all nine measures of openness yield the same conclusion.

32 Consumption is approximated by output plus imports minus exports.

second half of the 1980s, on the other hand, does indicate greater openness. Poot (1991), for example, finds that liberalization of import restrictions in the mid 1980s reversed the process of import substitution, resulting in increasing import shares, especially for intermediate products. Both the export and the import indicators therefore point to greater openness in this sector following the policy transition.[33]

3.5 Capital accumulation and technological change

No direct measures of technical change are available for Indonesian manufacturing on a scale suited to our purpose. In order to construct indirect measures, we note that, in developing countries, most new technologies are foreign sourced, and embodied in imported capital.[34] Also, foreign investment, which is primarily trade in entrepreneurship and ideas, tends to be associated with technical advances whether or not it brings with it imported physical capital.[35] We therefore adopt two indirect indicators of technological change. The first is the proportion of an industry's capital stock that is "new" (defined as less than 5 years old)[36] and the second is the extent of foreign participation, as measured by the proportion of firms in manufacturing that are foreign owned and by their proportion of manufacturing output. During the period under study, the investment regulations required foreign investments to take joint venture form with domestic partners and, after a certain period, the foreign partners were required to divest. Because of this, Hill (1990b) finds that ownership of equity provides a limited indication of effective control. In most cases, foreign partners exert much greater control, irrespective of the level of their equity ownership. Therefore, in this study, a firm which has foreign equity of any proportion is defined as a multinational.

The proportion of investment and new capital in the total manufacturing capital stock is shown in Figure 6. Investment refers to cumulative additions to capital stock over a one year period, while "new capital" refers to cumulative investment over a five year period. The proportion of new capital was relatively stable, at around three percent of the total capital stock, during the late 1970s. During the 1980s, however, there was a substantial acceleration

[33] The drop in the import penetration ratio in the early 1990s is characteristically different from that in the first half of 1980s, where the total value of imports itself was declining. The total value of imports in the early 1990s continued to grow, but consumption grew faster.
[34] Eaton and Kortum (1996) find that even in the most advanced developed countries, foreign sourced technologies constitute a large share in patent applications.
[35] Ruffin (1993) confirms that recipients of foreign direct investment have higher rates of technical change.
[36] The role of new investments in the diffusion and adaptation of new technologies is emphasized by Metcalfe (1990).

in this measure associated with a dramatic increase in new investment, from around two percent of the total capital stock in 1987 to 10 percent in 1991. Meanwhile, the trend in foreign participation, measured first using the proportion of multinational corporations in the total number of manufacturing firms, and second as the proportion of their output in total manufacturing output, is shown in Figure 7.

For most of the period both indicators moved almost in parallel. In the inward-focussed period through the mid 1980s, the tendency was for foreign participation to decrease. Reflecting the more liberal policy on foreign ownership after the transition, both indicators record an increase in foreign participation by the later 1980s. After 1989, however, there was a tendency for the two indicators to diverge. The firm proportion recorded a massive increase while the output proportion fell back. This reflects the pattern of foreign direct investment coming during that period. After the policy transition, foreign firms participating in Indonesia tended to be smaller manufacturing firms. There was not the same surge in participation by the large multinationals that had tended to work directly with the government in the earlier period. Indeed Thee (1991) finds that most of the surge in foreign investment after the policy transition come from the four NICs and it took the form of "product life cycle" investments in export oriented labor intensive manufacturing. This contrasts starkly with the earlier foreign investment which has strong domestic orientation and took place in capital and technology intensive sectors.

3.6 A preliminary story

Since the policy transition of the mid 1980s, the Indonesian economy opened substantially, both to trade and to capital inflow. As distortions that had restricted the supply of capital and imported inputs were lifted, investment in export oriented manufacturing expanded. The manufacturing capital stock grew at an unprecedented rate as did the volume of manufactured exports. Much of the new investment was in labor intensive processes and, where there was foreign participation, it involved firms from the NICs, where labor intensive processes had become less competitive. The result was a sizeable shift in the demand for manufacturing workers and an increase in the relative demand for unskilled workers. Although some of the new capital would have embodied skill-using technology, it is unlikely that its share was dominant. This explains the post-transition trend in relative labor demand.

On the supply side, for Indonesia as a whole, there were no significant aggregate labor supply shocks that could have caused a relative rise in the skilled wage. Why, then, did the relative wage shift against unskilled workers? Clearly, the answer lies in the different elasticities of supply, as indicated in Figure 1. Manufacturing capital accumulated because of the relative abundance of unskilled labor in Indonesia and the supply of that labor from the very substantial hinterland was sufficiently elastic to ensure that the associated real wage rises were small. The corresponding rise in the demand for skilled labor may have been smaller in magnitude, but these workers could not increase in number quickly enough to keep pace with that demand growth. Their real rewards therefore grew more rapidly than those of unskilled workers.

4. Accounting for the Effects of Openness, Capital Accumulation and Technical Change

In the post-transition period, relative labor demand was clearly affected by increasing openness and technological changes associated with accelerated capital accumulation and foreign ownership. Our objective in this section is to quantify these effects. In focussing on the demand side, we provide only a partial analysis of changes in Indonesia's manufacturing labor market. Our work, however, is in line with the analyses of industrial economies, which address the contributions of the two relative demand shifters in explaining poor market performance by unskilled workers.[37] In particular, we seek to quantify the relative roles of the technical change and foreign participation associated with Indonesia's rapid accumulation of manufacturing capital. Although this appears to have boosted relative demand for skilled labor in some other developing countries, our preliminary story, above, suggests it has favored unskilled workers in Indonesia.

4.1 An interrelated factor demand model

Berman *et al* (1994) and Feenstra and Hanson (1996) analyse the determinants of the demand for skilled relative to unskilled labor using the interrelated factor demand model. This model takes the form of a set of input cost share equations derived from a transcendental logarithmic (translog) cost function. The most general formulation of this cost function is

[37] See, for example, Feenstra (1997).

non-homothetic and it can be thought of as a logarithmic second-order Taylor series approximation to an arbitrary cost function.[38]

Both Berman *et al* and Feenstra and Hanson assume that each industry uses three production inputs: non-production labor, production labor, and capital, where the latter is exogenous. This assumption implies that the decision on the mix of skilled and unskilled labor employed depends only on the relative wage. To make the model more realistic, following Lee (1995), we assume that each industry in the manufacturing sector uses five production inputs: unskilled labor (L), skilled labor (H), capital (K), energy (E), and intermediate materials (I). Firms in each industry maximise profit by choosing output, Y, given an exogenous product price, P_Y, and input price vector (P_L, P_H, P_K, P_E, P_I). To introduce openness and technological change factors into the model, it is assumed that the cost function of each industry is shifted by the industry's export intensity ratio (X), import penetration ratio (M), proportion of new capital in the total capital stock (T), and foreign participation ratio (F). Therefore, the non-homothetic translog cost function in this analysis takes the form:

$$\begin{aligned}\ln C = {} & \ln\alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i\sum_j \beta_{ij}\ln P_i \ln P_j + \alpha_Y \ln Y + \frac{1}{2}\beta_{YY}(\ln Y)^2 \\ & + \sum_i \beta_{iY}\ln P_i \ln Y + \sum_V \alpha_V \ln V + \frac{1}{2}\sum_V\sum_{V'} \gamma_{VV'}\ln V \ln V' \\ & + \sum_i\sum_V \gamma_{iV}\ln P_i \ln V + \sum_V \gamma_V \ln Y \ln V \qquad (1)\end{aligned}$$

where i and j $\in$ {L, H, K, E, I}, V $\in$ {X, M, T, F}, while the α's, β's, and γ's are parameters. It is assumed that $\beta_{ij} = \beta_{ji}$ and $\gamma_{VV'} = \gamma_{V'V}$. The role of the vector, V, in this specification is an extension of the use of shifting exogenous inputs in the variable translog cost function (McFadden, 1978).

A property of this cost function is that, for given Y and V, it is homogeneous of degree one in input prices. This imposes the following restrictions on equation (1):[39]

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[38] See Berndt (1991: 469-479) and Varian (1992: 209-210).
[39] Although they are not imposed here, other parameter restrictions are possible. To obtain a homothetic translog cost function, it is necessary and sufficient that $\beta_{iY} = 0$ for all i. For one that is homogeneous of degree $1/\alpha_Y$ in output, then in addition to the homotheticity restrictions, it must be true that $\beta_{YY} = 0$. If α_Y is set to equal unity in addition to the homotheticity and homogeneity restrictions, then the dual production function has constant returns to scale. To transform the translog function into a constant returns to scale Cobb-Douglas function, then in addition to all those restrictions, it requires that $\beta_{ij} = 0$ and $\gamma_{iV} = 0$ for all i and j.

$$\sum_i \alpha_i = 1 \quad \text{and} \quad \sum_i \beta_{ij} = \sum_j \beta_{ji} = \sum_i \beta_{iY} = \sum_i \gamma_{iV} = 0 \tag{2}$$

If a translog cost function is differentiated with respect to the logs of the input prices the resulting derivatives are the cost share (S) equations for each input. Thus:

$$\frac{\partial \ln C}{\partial \ln P_i} = \frac{P_i}{C} \cdot \frac{\partial C}{\partial P_i} = \frac{P_i X_i}{C} = S_i \quad \text{and} \quad \sum_i S_i = 1 \tag{3}$$

The cost share equations for the five inputs can be derived from substituting equation (3) into equation (1). The underlying economic theory also requires the share equations to be homogeneous of degree zero in input prices. Imposing this and the restrictions in equation (2) as well as the adding up property of the cost shares in equation (3), four linearly independent cost share equations can be reformulated from the original five equations. If the intermediate material cost share equation is the one eliminated the four linearly independent equations are:

$$\begin{aligned}
S_L &= \alpha_L + \beta_{LL} \ln(P_L/P_I) + \beta_{LH} \ln(P_H/P_I) + \beta_{LK} \ln(P_K/P_I) + \beta_{LE} \ln(P_E/P_I) \\
&\quad + \beta_{LY} \ln Y + \gamma_{LX} \ln X + \gamma_{LM} \ln M + \gamma_{LT} \ln T + \gamma_{LF} \ln F \\
S_H &= \alpha_H + \beta_{LH} \ln(P_L/P_I) + \beta_{HH} \ln(P_H/P_I) + \beta_{HK} \ln(P_K/P_I) + \beta_{HE} \ln(P_E/P_I) \\
&\quad + \beta_{HY} \ln Y + \gamma_{HX} \ln X + \gamma_{HM} \ln M + \gamma_{HT} \ln T + \gamma_{HF} \ln F \\
S_K &= \alpha_K + \beta_{LK} \ln(P_L/P_I) + \beta_{HK} \ln(P_H/P_I) + \beta_{KK} \ln(P_K/P_I) + \beta_{KE} \ln(P_E/P_I) \\
&\quad + \beta_{KY} \ln Y + \gamma_{KX} \ln X + \gamma_{KM} \ln M + \gamma_{KT} \ln T + \gamma_{KF} \ln F \\
S_E &= \alpha_E + \beta_{LE} \ln(P_L/P_I) + \beta_{HE} \ln(P_H/P_I) + \beta_{KE} \ln(P_K/P_I) + \beta_{EE} \ln(P_E/P_I) \\
&\quad + \beta_{EY} \ln Y + \gamma_{EX} \ln X + \gamma_{EM} \ln M + \gamma_{ET} \ln T + \gamma_{EF} \ln F
\end{aligned} \tag{4}$$

Since the equation which is dropped from the original five is chosen arbitrarily, the estimator used should yield results that are invariant to this choice. Two estimators have this property, and the choice between them depends on the exogeneity of the right hand side variables. If all the right hand side variables are exogenous, it is appropriate to use maximum likelihood estimation with the first round variance-covariance matrix obtained from equation-by-equation ordinary least squares without the symmetry restrictions imposed. If some of the right hand side variables are endogenous, the estimation method to use is three-stage least squares (3SLS) with the first round variance-covariance matrix obtained from equation-by-equation two-stage least squares (2SLS) without the symmetry restrictions imposed (Berndt, 1991, pp. 473-474). We choose the first estimator, since later specification tests fail to reject the exogeneity of our right hand side variables.

4.2 Estimations and tests

To estimate the model, the data sets described earlier are used. Both the manufacturing survey data and the industrial trade data are combined to form a panel of 82 four-digit (ISIC) industries, covering the period 1975 through 1993. The cost data for production workers, non-production workers, energy, and non-energy intermediate materials are obtained from the manufacturing survey database. The cost of capital is calculated as the product of an industry's total capital stock and a generic six-month deposit interest rate obtained from the IMF's International Financial Statistics (IFS). The wages of production and non-production workers are calculated directly from the manufacturing survey data base, the price of energy is approximated by the refinery industries' wholesale petroleum price index, published by BPS, and the price of non-energy intermediate materials is approximated by the non-oil wholesale price index, also from the IFS.[40]

The individual industry effects in the panel database used in this study are assumed to be time-invariant. This assumption implies that they can be captured by adding a dummy variable for each industry into the models to be estimated. Adding 82 dummy variables, however, is cumbersome. To get around this problem, the first difference of each variable for each industry over time is used, so that the industry dummy variables cancel out. The openness and technological change indicator variables (X, M, T, and F) contain zero values for some industries over some periods. To retain the logarithmic form, a monotonic transformation of these variables in the form of $V' = 1 + V$ replaces the original definitions of these variables as they are described earlier. Consequently, the logarithm values of these variables are defined as $\ln V' = \ln(1 + V)$, where $V \in \{X, M, T, F\}$.[41]

[40] Unlike the wage rates used, the prices of capital, energy and intermediate materials do not vary by industry.
[41] This transformation reflects a slight change in the definition of variables. For example, the definition of variable X, which is originally defined as export/output, is changed to (output + export)/output. The changes for other variables are analogous.

To test for endogeneity of the right hand side variables, in particular input relative prices and output variables, a Hausman test is performed (Hausman, 1978). The null hypothesis is that there is no endogeneity amongst the right hand side variables, which implies that the maximum likelihood estimator is a consistent and efficient estimator. The alternative hypothesis is that input relative prices and output are endogenous variables, which implies that the 3SLS estimator is a consistent and efficient estimator. If input relative prices and output are indeed endogenous, then maximum likelihood estimator becomes an inconsistent estimator. On the other hand, if input relative prices and output are exogenous, then 3SLS estimator is still a consistent estimator but it is inefficient. Using lag-one input relative prices and output variables as the instrumental variables for the alternative hypothesis of the 3SLS estimator, the test results produce a Chi-square value of 23.62, which is not significant at the 5 percent level. The test therefore fails to reject the null hypothesis of exogeneity of the right hand side variables, implying that the maximum likelihood estimator is the appropriate choice.

The results of estimation on the whole database are presented in Table A1 of the appendix. The model explains a good deal of the observed cost share variability. In particular, the R^2 for these regressions ranges between 0.0567 and 0.4169, comparing favorably with the other empirical studies on this subject reviewed earlier. In addition, with critical values of d_L = 1.675 and d_U = 1.863, all the associated Durbin-Watson statistics, which range between 2.5175 and 2.6722, fail to reject the null hypothesis that there is no serial correlation in the data. This is not surprising since the estimations are already conducted in the first differences of the variables. In fact, all subsequent estimation results accept the null hypothesis that there is no serial correlation in the data.

The policy transition in 1986 makes it very likely that there is a structural break in the data in that year.[42] To confirm this, the database is divided into two sub-periods around 1986. Separate estimations are conducted for each sub-period and then a Wald test was applied for difference in the two sets of estimates. The resulting Chi-square value is 274.78, which is significant at the one percent level, permitting us to reject the hypothesis that there is no change in the factor demand parameters.[43]

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[42] Data considerations also motivate concerns about a structural break in 1986 when backcast data was included in the series by the BPS due to under-reporting in the Manufacturing Establishments Survey.

[43] For a more general analysis of structural breaks, see Broemeling and Tsurumi (1987).

A further technical issue is aggregation bias. Our first differencing eliminates any industry-specific constant terms but industry differences could still exist in the estimated parameters. A study in the UK by Lee *et al* (1990) finds that there is a wide diversity in the responsiveness of labor demand across industries, which prompts them to support disaggregation by industry. Since this is basically a question of representativeness of the technology implied by the cost function, the natural way to approach it is to divide industries into technological groups. We do this based on the work of Ray (1995) who divided Indonesian manufacturing into groups based on the average level of R&D expenditure per unit of production, obtained originally from OECD data. He selects four technology groups: high, medium-high, medium-low, and low. Initially, we followed his grouping, allocating the 82 industries identified accordingly. The first three groups ended up with so few industries, however, that we decided to consolidate them. Hence, we adopted two industry groups according to whether they used "high" or "low" technology by Ray's criteria. The composition of these groups is indicated in Table A2 in the appendix. As can be seen from this table, the lower technology group consists mostly of agricultural processing, textiles, wood, paper, and basic metal industries, while the higher technology group includes all remaining manufacturing industries.[44]

To test for industry aggregation, Wald tests comparing the estimated coefficients for higher and lower technology groups are conducted for each period. This test yielded a Chi-square value of 124.55 for the 1975-86 period and 67.09 for the 1986-93 period, both of which are significant at one percent level. Parameters for the two technological groups had therefore to be estimated separately in both periods. For the 1975-86 period, the results of estimation for the higher technology industries are presented in Table A3, while the results for the lower technology industries are in Table A4. For the 1986-93 period, the results for each technology group are presented in Tables A5 and A6 respectively. Not surprisingly, there is a tendency for goodness of fit to improve after disaggregation. Although additional improvements might be yielded with further industry disaggregation, the limited number of

[44] We are grateful to an anonymous reviewer for pointing out that Ray's grouping of industries is based on OECD data and that Indonesian industries may split differently between the high-techonology and the low-technology groups. Unfortunately, because there are no comparable data on R&D by industry in Indonesia, no corresponding classification is available. Some support for the effectiveness of the Indonesian split we adopt is suggested by the difference in technology in the two Indonesian industry groups, as indicated by non-production to production employment ratios. In 1993, these were roughly 0.2 in the lower technology industry group and 0.3 in the higher technology group.

observations available ruled this out. Given the specification tests for structural change over time and our concerns about industry aggregation, the parameter estimates of primary interest are those reported in Tables A3 through A6. Finally, the means and standard deviations of the variables used in the estimations are presented in Table A7 in the appendix.

4.3 The direction of the relative labor demand effect

The main purpose of the analysis here is to assess the effects of openness and technological change indicators on the relative demand for skilled to unskilled labor. For this purpose, the parameter estimates can be interpreted as changes in input cost shares due to proportional changes in the respective indicator, holding input prices and the level of output constant. Since input prices are exogenous, changes in cost shares arise from changes in the relative demand for factors. Therefore, the difference of an indicator's coefficients in the skilled and unskilled labor cost share equations indicates how that particular indicator affects the relative demand for skilled to unskilled labor. If the difference is positive, the indicator has advanced relative demand for skilled labor. If it is negative, the advance is to unskilled labor. These differences are provided in Table 2, for both openness and technological change indicators based on the estimation results in Tables A3 to A6.

Consider the first openness indicator, export intensity. The results indicate that the policy transition did significantly affect the association between export intensity and relative demand for unskilled labor in each industry group. During the import substitution period, this association is statistically significant and positive in the lower technology industries but insignificant in the higher technology industries.[45] After the policy transition, however, the association is significant and positive in higher technology industries and insignificant in lower technology industries.

During the inward-focussed period, all manufacturing industries enjoyed protection from import competition. Indonesia's natural comparative advantage was suppressed and so many domestic firms offered skill-intensive products to the domestic market. Export orientation was rare and hence the estimated coefficient for high technology firms in this period is small. Those firms that did employ simpler technologies offered more labor-intensive products and employed more of the relatively abundant unskilled workers. For

[45] Note that the negative coefficient in Table 2, where skilled minus unskilled coefficients are listed, indicates export intensity is positively associated with unskilled employment.

them, export intensity was higher even in the inward-focussed period. This is clearly shown by the negative and significant coefficient of the export intensity ratio for the lower technology industries. After the policy transition, manufacturing protection diminished. The second period coefficient for lower technology industries is very small and insignificant, implying that there is little if any difference in relative labor demand between domestically and export oriented industries. The higher technology industries, meanwhile, are naturally more skill intensive. For these industries, the negative and significant coefficient indicated in Table 2 indicates that the more export oriented among them have the greater relative employment of unskilled labor.

Turning to import competition, for higher technology industries, the coefficient on the import penetration ratio changes from positive but statistically insignificant during the import substitution period to negative and significant in the export orientation period. It is insignificant throughout for lower technology industries. During the import substitution period import competition was controlled by protection to the extent that it had little affect on firms' choice of technique. After the policy transition, however, intensifying competition from imports intensified and firms shifted product lines and adopted techniques with less skill intensity. The contrast between periods is greater for the high technology industries because the others were more likely to have already chosen products and techniques that would be competitive in the event of trade reform.

Now consider the effect of manufacturing capital accumulation and the associated changes of technology. The results show that the faster the rate of accumulation, and hence the larger is the proportion of the capital stock that is "new", the greater is the relative demand for skilled labor. This is true irrespective of period and technology level, though the coefficients are only statistically significant for high technology industries in the first period and for low technology industries in the second. The observed pattern in significance is probably related to the changes in investment. During the import substitution period, the change in capital stock was greatest in the high technology industries, while during the export orientation period, the strongest growth was in the low technology industries.

Turning, finally, to foreign participation, the estimation results for the import substitution period show that the effect of foreign participation on relative demand for skilled labor is positive for higher technology industries and negative for lower technology industries, but that neither is statistically significant. During this period, foreign participation was very restricted and occurred mainly in the domestically focussed higher technology industries. It is not surprising, then, that it would have been skill using in those industries. In the export orientation period, the effects on both industry groups are negative, but insignificant for the high technology industries and significant for the low technology industries. In this period, most foreign investors sought to exploit Indonesia's international comparative advantage in unskilled labor intensive goods. Hence, most foreign investment took place in the lower technology industries with a significant effect on increasing the relative demand for unskilled labor.

4.4 Magnitude of the relative labor demand effect

The analysis of skilled and unskilled labor relative demand in the previous section shows that both greater trade openness, measured either by export intensity or import competition, and increasing foreign participation are associated with increasing relative demand for unskilled labor. This is particularly true for the export orientation period, when the manufacturing capital stock and manufactured exports grew at an unprecedented rate. In spite of this, the newness of the manufacturing capital tended to militate in favor of skilled labor.

To estimate how the developments in openness and technological change after the mid 1980s affected the overall relative demand for labor, it is necessary to compare the magnitude of each indicator's effect on the relative labor cost share. This depends on both the estimated coefficients and the magnitude of in-sample variation in the openness and technology indicators. It can therefore be approximated using the product of the estimated coefficient and the standard deviation of the indicator. Accordingly, the coefficient difference of Table 2 is multiplied by the standard deviation of each indicator for the period 1986-93 (Table A7 in the appendix). The first column of Table 3 reproduces the coefficient difference for the two industry groups in the 1986-93 period while the second gives the standard deviation of each indicator. The third then lists the product of the first and second. At the bottom of the table, the values for all industries in the final column are calculated as averages of the two industry groups weighted by their respective average employment proportion, which is 0.23 for higher technology industries and 0.77 for lower technology industries.

We deduce that, in the higher technology industries, the effects of increasing export intensity, import penetration, and foreign participation, all of which increase the relative demand for unskilled labor, dominate the effect of the increasing proportion of new capital, which raises the relative demand for skilled labor. The total effect for this industry group is negative and statistically significant. For the lower technology industries, on the other hand, the latter slightly dominates the former. The total effect is small and statistically insignificant, but positive. The resulting weighted averages for all industries indicate that the effects of trade openness and foreign participation yield negative signs, indicating that they increase the relative demand for unskilled labor. The effect of new capital, meanwhile, is shown to be positive and statistically significant, suggesting that it raises the relative demand for skilled labor. The overall effect is negative, implying that demand shifts in general favored an increase in expenditure on unskilled relative to skilled labor after the policy transition.

5. Conclusion

Studies that concentrate on the effects of export expansion on labor demand in developed countries find that export expansion increases the relative demand for skilled labor and hence it increases wage inequality.[46] Similarly, those that have concentrated on the effects of import competition on the labor market find that increasing import competition tends to reduce the relative demand for unskilled labor.[47] Our results for relatively labour abundant Indonesia contrast with these findings. Our interrelated factor demand analysis indicates that increased export expansion and import competition have been associated with increased relative demand for unskilled labor.

This contrast is consistent with elemental (HOS) trade theory. As developed and developing countries open their economies to trade with each other, each realises its comparative advantage and so skill-intensive industries experience a terms of trade gain in developed countries and unskilled labor intensive industries experience a terms of trade gain in developing countries. The relative wage of skilled workers therefore rises in developed economies and that of unskilled workers rises in developing countries. The distribution of labor supply across skill levels is not fixed through time, however, and this distribution tends to change more and to be more diverse across regions than is the case in developed countries. Thus, while we conclude that labor demand shifts following Indonesia's transition to openness are consistent with the elemental theory, the corresponding real wage changes are not.

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[46] See, for example, Bernard and Jensen (1995, 1997).
[47] See Grossman (1987), Lee (1995) and Revenga (1992).

The effects on labour demand of technical changes associated with rapid capital accumulation are not addressed directly by the elemental trade theory. Studies in developed countries have shown that technological change has been unskilled labor saving and, therefore, that it has tended to reduce the relative demand for unskilled labor.[48] The positive association between new capital and skilled labor relative demand found in this study suggests that the effect of technological change in developing countries is similar to that in the developed countries. This means that, even where unskilled labor is relatively abundant, the technology embodied in new capital tends to be biased against it.

Foreign participation, in and of itself, has been found by Wood (1994) to foster investments in developing countries that bring unskilled labor using technology and that therefore raise unskilled labor demand. Our results for Indonesia confirm this. Much foreign participation in Indonesian manufacturing has transferred labor intensive industrial technology from the NICs where recent wage rises had rendered parent firms uncompetitive. Our results do, however, contrast with the findings of Aitken *et al* (1996) and Feenstra and Hansen (1996) that foreign investment in some Latin American developing countries raised skilled relative to the unskilled labor demand. We suggest, for the case of Indonesia at least, that it is the newness of capital, and not its foreignness, which increases the relative demand for skilled labor.

The small net increase in relative demand for unskilled labor derived from our interrelated factor demand model is consistent with the observed increase in relative employment of unskilled labor after the mid 1980s. However, demand side changes by themselves cannot explain the increasing relative wage of skilled labor during this period. For this, more attention to the supply side is required, in particular to the rural sector in Indonesia, which remains a vast employer of unskilled workers. A small transfer from its work force to that of manufacturing may change the unskilled wage little, while causing a comparatively large proportional increase in the manufacturing work force. This implies that unskilled labor is comparatively elastic in supply to manufacturing. Hence, while the surge in manufacturing capital accumulation over the decade between the policy transition and the Asian Crisis raised relative demand for unskilled labor, relative wage growth favored less elastically supplied skilled workers.

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[48] See Berman *et al* (1994) and Lawrence and Slaughter (1993).

Since the Asian crisis, however, further very substantial changes have occurred in Indonesian labour markets. The currency collapse, combined with widespread exposure by firms to foreign debt caused widespread insolvencies in both the services and manufacturing sectors and, at least temporary, the idling of a substantial part of the manufacturing capital stock. Recent evidence suggests that both skilled and unskilled workers have taken very substantial real wage losses. Provided financial reforms are successful and the policy regime in Indonesia retains the trend toward openness, the recovery phase there might be expected to follow the post transition pattern examined here. If this is borne out, as old capital comes back on line and new capital is invested, the demand for both skilled and unskilled labor will grow again, as will the real wages of both.

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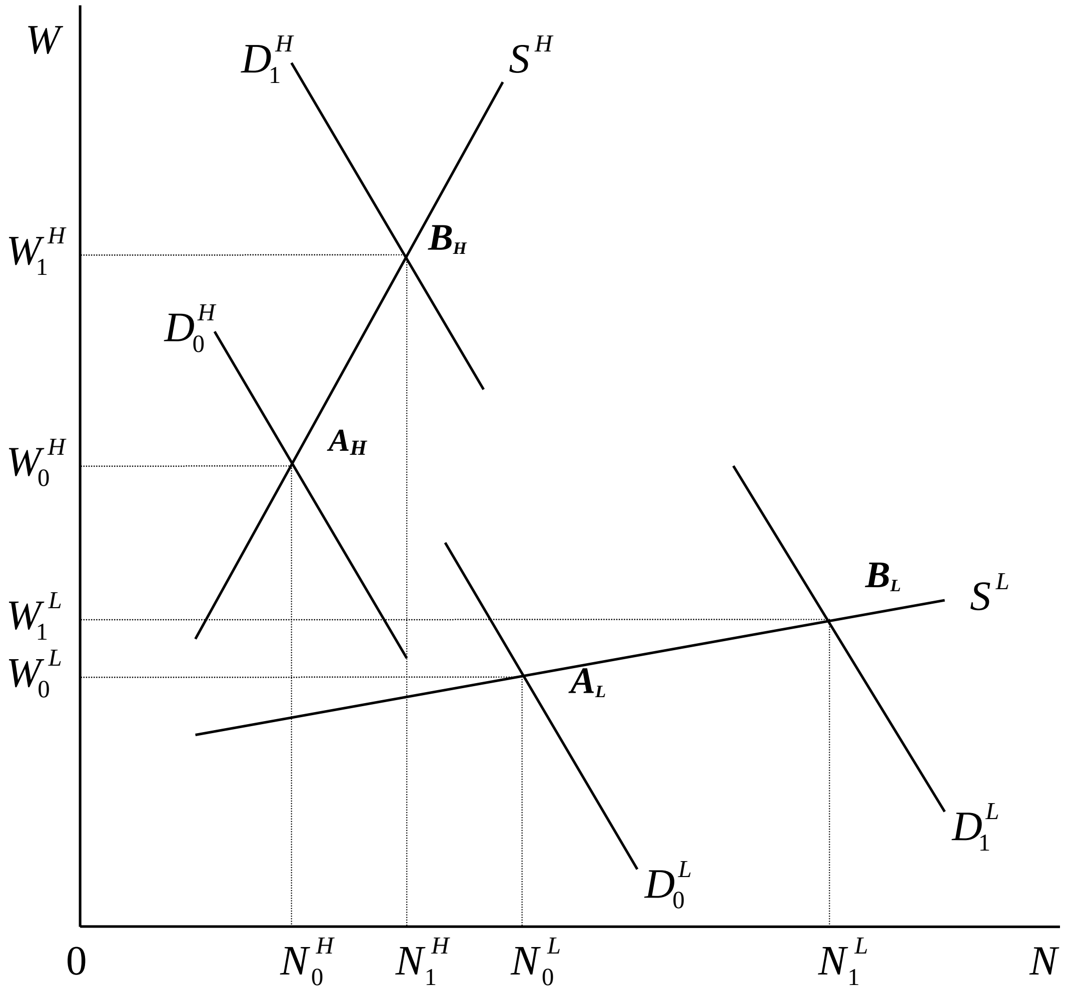

Figure 1:
Demand Increases and Changes in Employment and Wages of Skilled and Unskilled Labour

Figure 2:
Wage Ratio (left axis) and Employment Ratio (right axis) of Non-Production to Production Workers in Indonesian Manufacturing, 1975-93

Figure 3:
Coefficients of Variation of All, Production, and Non-Production Workers' Real Wages in Indonesian Manufacturing, 1975-93

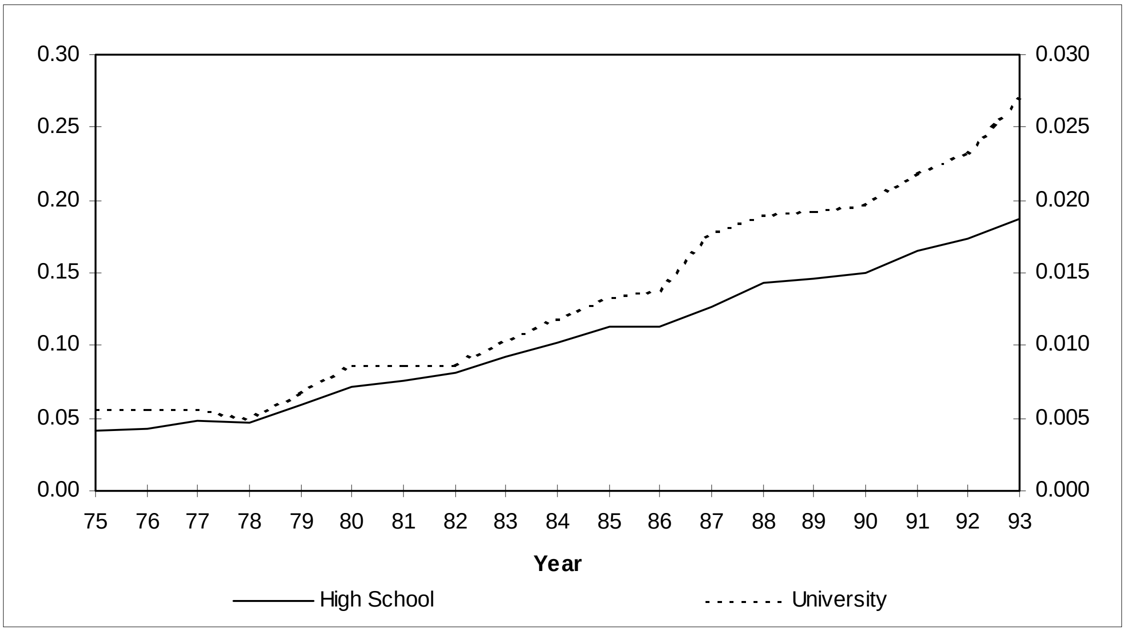

Figure 4:
Ratio of High School and Above to Below High School Graduates (left axis) and Ratio of University to Below University Graduates (right axis) in the Indonesian Labor Force, 1975-93 (Source: BPS, Statistik Indonesia)

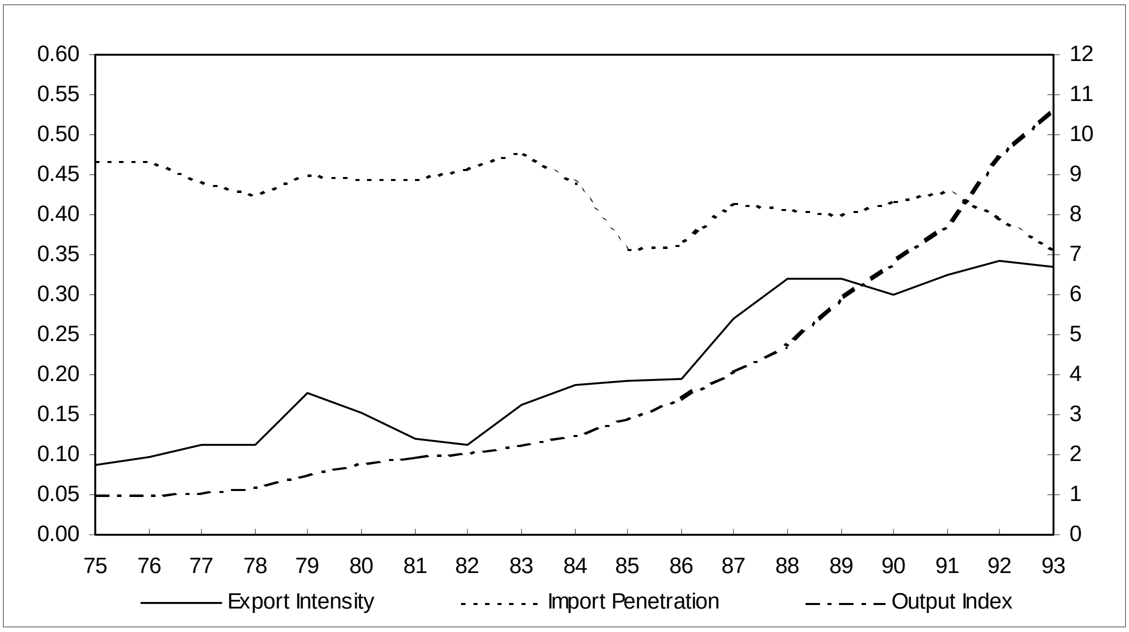

Figure 5:
Export Intensity and Import Penetration Ratios (left axis) and Index of Real Output (right axis) in Indonesian Manufacturing, 1975-93

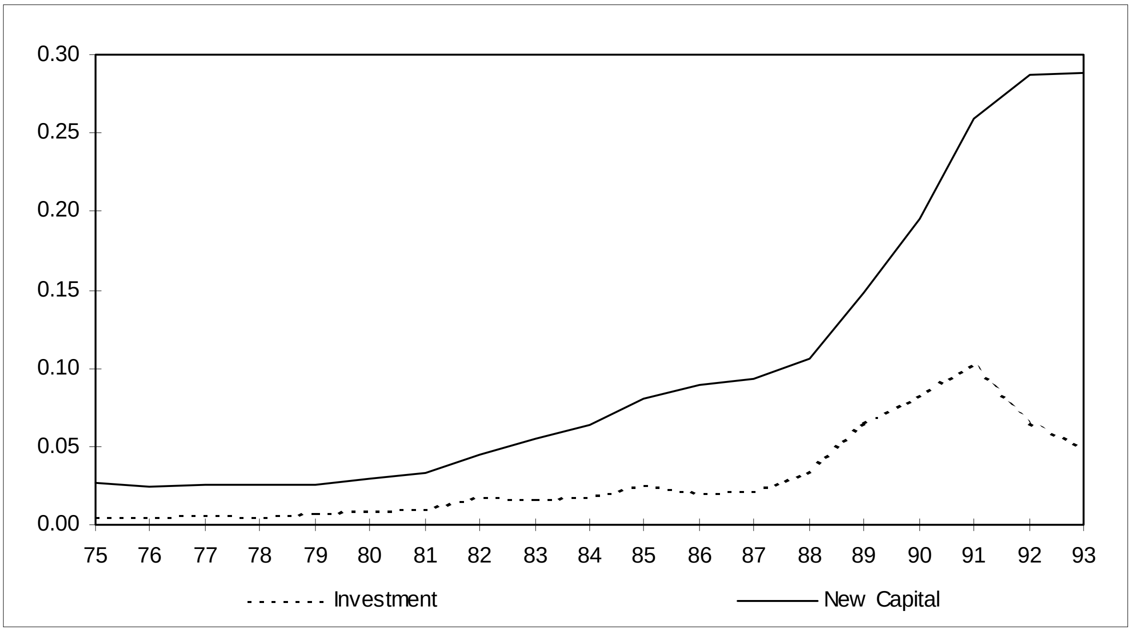

Figure 6:
Proportions of Investment and New Capital in the Total Capital Stock in Indonesian Manufacturing, 1975-93

Figure 7:
Proportions of the Number of Firms (left axis) and Output (right axis) of firms with foreign participation in the Indonesian Manufacturing Sector, 1975-93

Table 1:
Nominal and Effective Rates of Protection in Indonesian Manufacturing, 1987 and 1995 (%)

	1987	1995
Nominal rate of protection[a]	21	6
Effective rate of protection[b]	86	24

Source: [a] Fane and Condon (1996)
[b] Fane (1996)

Table 2:
Openness and Technological Change Indicators' Coefficient Differences in Skilled and Unskilled Labor Cost Share Equations[a,b]

Indicators	1975-86		1986-93	
	Coefficient Difference	Standard Error	Coefficient Difference	Standard Error
Higher Technology Industries:				
ln X'	-0.0000	0.0049	-0.0091*	0.0041
ln M'	0.0084	0.0155	-0.0322**	0.0058
ln T'	0.0172**	0.0055	0.0070	0.0095
ln F'	0.0258	0.0197	-0.0245	0.0219
Lower Technology Industries:				
ln X'	-0.0320**	0.0089	0.0002	0.0083
ln M'	0.0067	0.0061	-0.0008	0.0080
ln T'	0.0157	0.0115	0.0243**	0.0086
ln F'	-0.0147	0.0264	-0.0560*	0.0330

a ** is significant at 1 percent level, * is significant at 5 percent level.
b The reported standard errors and levels of significance account for the variance and covariance terms attached to the estimated coefficient pairs, γ^H and γ^L used in calculating the coefficient differences γ^H-γ^L.
Source: Econometric analysis described in the text.

Table 3:
Magnitude of Openness and Technological Change Indicators' Effects on Relative Labor Demand, 1986-93[a,b]

Indicator	Coefficient Difference	Standard Deviation	Effect Magnitude
Higher Technology Industries:			
ln X'	-0.0091*	0.4615	-0.0042*
ln M'	-0.0322**	0.3516	-0.0113**
ln T'	0.0070	0.2272	0.0016
ln F'	-0.0245	0.0709	-0.0017
Total			-0.0157**
Lower Technology Industries:			
ln X'	0.0002	0.3360	0.0001
ln M'	-0.0008	0.2004	-0.0002
ln T'	0.0243**	0.2881	0.0070**
ln F'	-0.0560*	0.0709	-0.0040*
Total			0.0030
All Industries:			
ln X'			-0.0009
ln M'			-0.0027*
ln T'			0.0058**
ln F'			-0.0035*
Total			-0.0013

a ** is significant at 1 percent level, * is significant at 5 percent level.
b The reported levels of statistical significance for the total effect magnitude account for the variance and covariance terms of the estimated coefficients, γ^H and γ^L from which the total effect is calculated.
Source: Econometric analysis described in the text.

Appendix

Table A1:

Estimation Results for All Industries, 1975-93

Independent Variables	Dependent Variables			
	S_L	S_H	S_K	S_E
Constant	-0.0003	-0.0002	0.0097**	-0.0001
	(0.0007)	(0.0004)	(0.0024)	(0.0006)
$\ln(P_L/P_I)$	0.0295**	-0.0029**	-0.0078**	0.0005
	(0.0022)	(0.0011)	(0.0021)	(0.0019)
$\ln(P_H/P_I)$	-0.0029**	0.0128**	-0.0029**	-0.0043**
	(0.0011)	(0.0009)	(0.0012)	(0.0014)
$\ln(P_K/P_I)$	-0.0078**	-0.0029**	0.1536**	-0.0024
	(0.0021)	(0.0012)	(0.0075)	(0.0019)
$\ln(P_E/P_I)$	0.0005	-0.0043**	-0.0024	0.0196**
	(0.0019)	(0.0014)	(0.0019)	(0.0046)
ln Y	-0.0016	0.0011*	-0.0865**	0.0056**
	(0.0011)	(0.0007)	(0.0038)	(0.0010)
ln X'	0.0047	-0.0056**	0.0264*	0.0011
	(0.0037)	(0.0022)	(0.0128)	(0.0033)
ln M'	-0.0058	-0.0057*	-0.0012	-0.0071*
	(0.0043)	(0.0025)	(0.0147)	(0.0038)
ln T'	-0.0359**	-0.0175**	-0.0661**	-0.0191**
	(0.0052)	(0.0030)	(0.0179)	(0.0046)
ln F'	0.0077	0.0049	-0.1177*	0.0135
	(0.0151)	(0.0088)	(0.0520)	(0.0133)
R^2	0.1094	0.1314	0.4169	0.0567
Durbin-Watson	2.5674	2.6722	2.5396	2.5175
n = 82 x 18 = 1,476				

Note: numbers in parentheses are standard error,

** is significant at 1 percent level, * is significant at 5 percent level.

Table A2:

Technology Grouping of Industries

Original Technology Group[a]	Industries	New Technology Group[b]
High	3522, 3832, 3845 n = 3	Higher
Medium-High	3511, 3512, 3513, 3514, 3521, 3523, 3529, 3831, 3833, 3839, 3843, 3850 n = 12	
Medium-Low	3551, 3559, 3560, 3610, 3620, 3631, 3632, 3633, 3640, 3690, 3820, 3841, 3844, 3901, 3902, 3903, 3904, 3906, 3909 n = 19	
Low	3111, 3112, 3113, 3114, 3115, 3116, 3117, 3118, 3119, 3121, 3122, 3123, 3124, 3125, 3126, 3127, 3128, 3131, 3132, 3133, 3134, 3140, 3211, 3212, 3213, 3214, 3215, 3216, 3219, 3220, 3231, 3233, 3240, 3311, 3312, 3313, 3314, 3319, 3320, 3411, 3412, 3419, 3420, 3710, 3811, 3812, 3813, 3819 n = 48	Lower

Source: [a]Ray (1995)
[b]Discussed in text

Table A3:

Estimation Results for Higher Technology Industries, 1975-86

Independent Variables	Dependent Variables S_L	S_H	S_K	S_E
Constant	-0.0018	-0.0009	0.0045	0.0004
	(0.0014)	(0.0011)	(0.0048)	(0.0015)
$\ln(P_L/P_I)$	0.0186**	-0.0025	-0.0070*	0.0018
	(0.0041)	(0.0026)	(0.0038)	(0.0041)
$\ln(P_H/P_I)$	-0.0025	0.0094**	-0.0022	-0.0006
	(0.0026)	(0.0024)	(0.0030)	(0.0031)
$\ln(P_K/P_I)$	-0.0070*	-0.0022	0.1573**	-0.0019
	(0.0038)	(0.0030)	(0.0132)	(0.0041)
$\ln(P_E/P_I)$	0.0018	-0.0006	-0.0019	0.0374**
	(0.0041)	(0.0031)	(0.0041)	(0.0096)
ln Y	0.0024	0.0036**	-0.0658**	0.0028
	(0.0017)	(0.0013)	(0.0054)	(0.0018)
ln X'	-0.0024	-0.0024	-0.0133	0.0021
	(0.0076)	(0.0060)	(0.0254)	(0.0079)
ln M'	-0.0116	-0.0032	0.2401**	-0.0183
	(0.0236)	(0.0188)	(0.0785)	(0.0247)
ln T'	-0.0382**	-0.0209**	-0.0922**	-0.0315**
	(0.0083)	(0.0066)	(0.0279)	(0.0087)
ln F'	-0.0251	0.0007	-0.3769**	-0.0094
	(0.0303)	(0.0239)	(0.0960)	(0.0315)
R^2	0.1081	0.1267	0.5137	0.0789
Durbin-Watson	2.4344	2.6374	2.5272	2.5148
n = 34 x 11 = 374				

Note: numbers in parentheses are standard error,

** is significant at 1 percent level, * is significant at 5 percent level.

Table A4:

Estimation Results for Lower Technology Industries, 1975-86

Independent Variables	Dependent Variables			
	S_L	S_H	S_K	S_E
Constant	0.0003	0.0008	0.0118*	0.0012
	(0.0015)	(0.0007)	(0.0052)	(0.0009)
$\ln(P_L/P_I)$	0.0417**	-0.0101**	-0.0091**	-0.0038
	(0.0046)	(0.0020)	(0.0039)	(0.0028)
$\ln(P_H/P_I)$	-0.0101**	0.0143**	-0.0026	-0.0094**
	(0.0020)	(0.0017)	(0.0019)	(0.0020)
$\ln(P_K/P_I)$	-0.0091**	-0.0026	0.1691**	-0.0003
	(0.0039)	(0.0019)	(0.0135)	(0.0023)
$\ln(P_E/P_I)$	-0.0038	-0.0094**	-0.0003	0.0163**
	(0.0028)	(0.0020)	(0.0023)	(0.0053)
ln Y	-0.0019	0.0001	-0.1039**	0.0089**
	(0.0026)	(0.0013)	(0.0087)	(0.0015)
ln X'	0.0075	-0.0245**	0.0351	-0.0033
	(0.0099)	(0.0048)	(0.0336)	(0.0058)
ln M'	-0.0145*	-0.0078**	-0.0092	-0.0091*
	(0.0068)	(0.0033)	(0.0230)	(0.0040)
ln T'	-0.0451**	-0.0294**	-0.1308**	-0.0125**
	(0.0129)	(0.0062)	(0.0434)	(0.0075)
ln F'	0.0324	0.0177	0.0132	0.0483**
	(0.0295)	(0.0143)	(0.0997)	(0.0172)
R^2	0.1101	0.1916	0.3905	0.1502
Durbin-Watson	2.6489	2.5587	2.5889	2.5024
n = 48 x 11 = 528				

Note: numbers in parentheses are standard error,

** is significant at 1 percent level, * is significant at 5 percent level.

Table A5:

Estimation Results for Higher Technology Industries, 1986-93

Independent Variables	Dependent Variables			
	S_L	S_H	S_K	S_E
Constant	-0.0008	0.0003	0.0067*	0.0009
	(0.0011)	(0.0006)	(0.0035)	(0.0018)
$\ln(P_L/P_I)$	0.0227**	0.0042**	-0.0131**	0.0001
	(0.0039)	(0.0017)	(0.0046)	(0.0049)
$\ln(P_H/P_I)$	0.0042**	0.0203**	-0.0054*	-0.0027
	(0.0017)	(0.0014)	(0.0025)	(0.0032)
$\ln(P_K/P_I)$	-0.0131**	-0.0054*	0.0936**	-0.0088
	(0.0046)	(0.0025)	(0.0160)	(0.0064)
$\ln(P_E/P_I)$	0.0001	-0.0027	-0.0088	-0.0430*
	(0.0049)	(0.0032)	(0.0064)	(0.0190)
ln Y	-0.0068**	-0.0110**	-0.0940**	-0.0025
	(0.0028)	(0.0015)	(0.0088)	(0.0035)
ln X'	0.0097*	0.0006	-0.0034	0.0033
	(0.0043)	(0.0023)	(0.0137)	(0.0055)
ln M'	0.0229**	-0.0094**	-0.0082	0.0117
	(0.0062)	(0.0033)	(0.0197)	(0.0079)
ln T'	-0.0046	0.0025	0.0503	-0.0126
	(0.0101)	(0.0053)	(0.0323)	(0.0129)
ln F'	0.0287	0.0042	-0.0234	0.0708**
	(0.0233)	(0.0123)	(0.0741)	(0.0296)
R^2	0.2746	0.5090	0.4245	0.0811
Durbin-Watson	2.0874	2.4496	2.0042	2.2709
n = 34 x 7 = 238				

Note: numbers in parentheses are standard error,

** is significant at 1 percent level, * is significant at 5 percent level.

Table A6:

Estimation Results for Lower Technology Industries, 1986-93

Independent Variables	Dependent Variables S_L	S_H	S_K	S_E
Constant	0.0000	0.0009*	0.0154**	-0.0009
	(0.0012)	(0.0005)	(0.0031)	(0.0015)
$\ln(P_L/P_I)$	0.0293**	0.0028*	-0.0033	0.0106**
	(0.0041)	(0.0016)	(0.0050)	(0.0041)
$\ln(P_H/P_I)$	0.0028*	0.0170**	-0.0000	-0.0111**
	(0.0016)	(0.0015)	(0.0023)	(0.0033)
$\ln(P_K/P_I)$	-0.0033	-0.0000	0.1129**	-0.0067
	(0.0050)	(0.0023)	(0.0143)	(0.0059)
$\ln(P_E/P_I)$	0.0106**	-0.0111**	-0.0067	-0.0441**
	(0.0041)	(0.0033)	(0.0059)	(0.0164)
ln Y	-0.0097**	-0.0070**	-0.1213**	0.0149**
	(0.0029)	(0.0012)	(0.0070)	(0.0029)
ln X'	-0.0010	-0.0008	-0.0240	0.0075
	(0.0086)	(0.0036)	(0.0216)	(0.0088)
ln M'	-0.0041	-0.0050	0.0017	-0.0060
	(0.0082)	(0.0034)	(0.0206)	(0.0085)
ln T'	-0.0248**	-0.0005	0.0393*	-0.0041
	(0.0089)	(0.0037)	(0.0224)	(0.0091)
ln F'	0.0499	-0.0061	-0.0282	-0.0810*
	(0.0340)	(0.0143)	(0.0851)	(0.0349)
R^2	0.1793	0.3168	0.5300	0.1698
Durbin-Watson	2.5609	2.6408	2.0638	2.4922
n = 48 x 7 = 336				

Note: numbers in parentheses are standard error,

** is significant at 1 percent level, * is significant at 5 percent level.

Table A7:

Means and Standard Deviation of Variables in Estimation

Variables	Higher Technology Industries 1975-93	1975-86	1986-93
S_L	0.0516	0.0532	0.0490
	(0.0401)	(0.0424)	(0.0357)
S_H	0.0275	0.0278	0.0273
	(0.0185)	(0.0199)	(0.0162)
S_K	0.2757	0.3297	0.1899
	(0.2750)	(0.3093)	(0.1753)
S_E	0.0527	0.0519	0.0553
	(0.0850)	(0.0900)	(0.0777)
$\ln(P_L/P_I)$	0.1047	0.0306	0.2284
	(0.3684)	(0.3667)	(0.3358)
$\ln(P_H/P_I)$	0.1928	0.0965	0.3448
	(0.4766)	(0.4772)	(0.4327)
$\ln(P_K/P_I)$	-1.2141	-1.1019	-1.3812
	(0.4934)	(0.5758)	(0.1858)
$\ln(P_E/P_I)$	0.3881	0.2123	0.6596
	(0.3079)	(0.2539)	(0.0936)
ln Y	1.5763	0.9130	2.6382
	(1.7686)	(1.5096)	(1.5807)
ln X'	0.1823	0.1250	0.2672
	(0.3804)	(0.3112)	(0.4615)
ln M'	0.3347	0.3318	0.3366
	(0.2997)	(0.2575)	(0.3516)
ln T'	0.3026	0.2610	0.3640
	(0.3493)	(0.3976)	(0.2272)
ln F'	0.0892	0.0920	0.0837
	(0.0863)	(0.0945)	(0.0709)

Note: numbers in parentheses are standard deviations

Table A7:

Continued

Variables	Lower Technology Industries 1975-93	1975-86	1986-93
S_L	0.0546	0.0553	0.0537
	(0.0464)	(0.0477)	(0.0456)
S_H	0.0266	0.0274	0.0252
	(0.0217)	(0.0243)	(0.0165)
S_K	0.2760	0.3356	0.1790
	(0.2778)	(0.3062)	(0.1872)
S_E	0.0379	0.0351	0.0436
	(0.0581)	(0.0555)	(0.0623)
$\ln(P_L/P_I)$	0.2501	0.1578	0.4015
	(0.4350)	(0.3953)	(0.4521)
$\ln(P_H/P_I)$	0.2571	0.1462	0.4360
	(0.6133)	(0.5717)	(0.6307)
$\ln(P_K/P_I)$	-1.2141	-1.1019	-1.3812
	(0.4933)	(0.5756)	(0.1857)
$\ln(P_E/P_I)$	0.3881	0.2123	0.6596
	(0.3078)	(0.2538)	(0.0935)
ln Y	1.5901	0.8606	2.7615
	(1.8607)	(1.4842)	(1.7682)
ln X'	0.1641	0.1228	0.2256
	(0.2951)	(0.2564)	(0.3360)
ln M'	0.2054	0.2172	0.1793
	(0.2438)	(0.2640)	(0.2004)
ln T'	0.2649	0.1867	0.3843
	(0.3047)	(0.2839)	(0.2881)
ln F'	0.0535	0.0566	0.0476
	(0.0807)	(0.0861)	(0.0709)

Note: numbers in parentheses are standard deviations