ERRATA AND ADDENDA

Page 3, the last line. In the sentence stating "Similarly, other domestic factors....", the words "and increases in unskilled labour productivity" are deleted.

Page 16, the last line. In the sentence stating "This means that the FPE Theorem....", the following words are appended at the end of the sentence: "when countries move from autarky to free trade".

Page 30, fourth paragraph. The second sentence (stating "Moreover, Wood's ...") is amended to read: "This, coupled with Wood's observations that wage gaps in the East Asian 'tiger' economies appear to have fallen after they liberalised their economies, seems to be consistent with the Stolper-Samuelson Theorem". The third sentence (stating "This suggests ...") is deleted.

Page 32, second paragraph. The first sentence is amended to read "Freeman (1995) doubts the relevance of the factor price equalisation theorem in explaining widening wage inequality between skilled and unskilled labour in developed countries. He also questions the assertion that trade acts to link labour markets, even when the traded share of GDP is small."

Page 33, first paragraph. In the last sentence (stating "Therefore, they conclude ..."), the words "that this employment ratio shift suggests" are deleted.

Page 40, third paragraph. The seventh sentence (stating "This policy was finally abandoned ...") is deleted.

Page 47, fourth paragraph. The end of the second sentence is corrected as "... and an increasingly unequal distribution of income (Adelman, 1984)."

Page 70, third paragraph. The end of the first sentence is amended to "... and it retains the assumption of homogeneous products."

Page 78, second paragraph. The existing paragraph is deleted and replaced by:

"To take into account the possibility of the existence of a dual labour market in the developing region, as discussed in Chapter 3, a dual labour market closure is used in each model simulation in addition to the standard integrated labour market closure. This dual labour market closure is implemented by first disabling the CET system whereby households transform labour between skilled and unskilled. The supply of skilled labour is then made exogenous and held constant while the wage of skilled labour remains endogenous. The supply of unskilled labour is made endogenous and its wage is made exogenous. This extreme specification implies that the traditional sector comprises subsistence households able to relinquish labour at a reservation wage without impact on their output.[16]"

Page 80, Table 4.3. The title of this table is changed to read "Changes in Real Unit Factor Rewards in the Developing Region from Removing a 10 per cent Tariff on Skilled Labour Intensive Imports (%)".

Errata and Addenda (continued)

Page 155, third paragraph. In the third sentence (stating "In addition, with critical values ..."), the words " accept the null hypothesis" are replaced by "fail to reject the null hypothesis".

Page 185, second paragraph. The fourth sentence is replaced by "The first is to replicate the effects of globalisation on Indonesian labour markets. It is implemented by simulating observed shocks, and then using the results to apportion significance to each component globalisation shock."

Page 203, first paragraph. The following sentences are added at the end of the paragraph: "Meanwhile, land is a specific factor in the primary sector. Since the output of this sector declines, the real return to land also declines."

Asep Suryahadi
July 1999

The Effects of Openness on Developing Country Labour Markets:

The Case of Indonesia

Asep Yadi Suryahadi

A thesis submitted for the degree of Doctor of Philosopy

of The Australian National University

December 1998

In compliance with the rules of Degree of Doctor of Philosophy of the Australian National University, it is affirmed that, unless otherwise stated, the work that follows is my own.

Asep Yadi Suryahadi

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During the process of writing this thesis, I accumulated debts to many people. The largest one, however, is to Rod Tyers, my thesis supervisor. His mastery on the subject has been instrumental in keeping me focused on the question being analysed. His expertise on International Trade and Applied General Equilibrium has been very helpful in identifying the errors I made in my research. Another large contribution to the process of writing this thesis has been given by Paul Chen, one of my thesis adviser. His outstanding knowledge on Labour Economics as well as on Econometrics has guided me through the cumbersome data analysis. I am also indebted to Chris Manning, my another thesis adviser. His exclusive knowledge on the Indonesian labour market has helped me understand the facts better.

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ABSTRACT

In the past two decades, economic ties between developed and developing countries have increased. In the developed countries, meanwhile, the labour market performance of unskilled workers has deteriorated. In some, their rate of unemployment has risen, while in others their real wage has declined either absolutely or relative to that of skilled workers. Openness and technological change are most commonly seen as the causes of this poor labour market performance. Both openness and technological change have also been important in developing countries over this period, though their labour market impacts have been less widely studied.

This thesis addresses the issue in three parts. First, the contributions of modern trade theory are reviewed. The standard Heckscher-Ohlin-Samuelson (HOS) framework is extended to multiple goods and factors and intra-industry trade is accommodated via differentiation of home from imported products. These extensions alone have been found to dilute the strong labour market effects of trade shocks in the HOS framework. Their examination, however, requires the use of numerical analysis in a stylised computable general equilibrium model. This approach is then extended to examine characteristics common amongst developing countries, including the relative abundance of unskilled labour.

A key result of this exercise concerns the HOS prediction that openness should benefit unskilled workers in developing countries. If unskilled workers are very abundant and their elasticity of supply very large, then this prediction no longer holds. Trade and technology shocks of the type observed in recent decades then all result in increasing wage inequality. Indeed, pure capital accumulation in a modern (manufacturing) sector,

that uses skilled workers more intensively than the economy as a whole, raises the skilled relative to the unskilled wage. This is so even if both types of labour are inelastic in supply to the economy as a whole and even if there is no associated technology change.

Second, a case study of the Indonesian manufacturing sector is carried out. Of particular significance in Indonesia is the transition from inward looking to outward looking trade and regulatory regimes that occurred during the mid 1980s. The case study uses a highly detailed data set covering manufacturing industries. It facilitates an examination of the association between the relative demand for skilled and unskilled workers and such determinants of change as overall economic openness, the trade orientation of domestic firms, foreign ownership, and the rate of capital accumulation at the firm level. The results show that openness and foreign ownership, by themselves, have acted to raise the relative demand for unskilled workers, while the newness of capital is associated with increased relative demand for skilled workers. Overall, the relative demand for unskilled workers has slightly increased, but the relative wage of unskilled workers has declined. This is seen as due to the greater elasticity of supply of unskilled workers previously engaged in other sectors.

Third, a more indicative multi-region computable general equilibrium model is developed to examine Indonesia's trade regime and its labour markets further. Results from the empirical analysis enable the estimation of the labour market impacts of shocks to trade policy, the capital stock, and technology to be examined individually and collectively. Clearly dominant in affecting wage inequality in Indonesia is total factor productivity growth. This strong role of total factor productivity gains is distinctive, considering the prevailing view that East Asia's strong growth was driven primarily by capital accumulation.

Finally, the same model is used to examine possible policy measures to reduce growth-induced wage inequality, including a return to some trade protection and the use of domestic taxes and subsidies. All are found to be costly to the economy as a whole and most to unskilled workers. The last piece of analysis addresses the Asian financial crisis and its effects on Indonesian labour markets. The effects of contractionary shocks prove the opposite of the growth-related shocks of the previous decade. All workers are made worse off, the unskilled less so. Raising the elasticity of skilled labour supply through education, training, and migration is seen as the best approach to addressing the inevitable wage inequality increase that will accompany Indonesia's eventual recovery.

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Chapter 1:

INTRODUCTION

Background

Increasing openness and globalisation have broadened economic links between developed and developing countries in the last three decades. Flows of goods and services between the two country groups have intensified. According to World Bank (1995a), 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. Not only have the magnitudes of the flows risen, but also their patterns have changed. During the 1950s and 1960s, developing countries were mainly exporting primary products to developed countries, while developed countries were exporting manufactures and services to developing countries. Meanwhile, the flow of financial capital during that period was predominantly in the form of development aid from developed to developing countries.

After three decades of change, the pattern of flows has become more complicated. Developed countries' exports to developing countries still mostly consist of manufactures, especially capital goods, and services. Developing countries, however, no longer rely on primary product exports. Their exports are now mostly manufactures too, albeit the simpler ones. Meanwhile, their role on services trade has also increased. Furthermore, the flow of financial capital is now much more diversified. Foreign direct investment, portfolio investment, as well as commercial loans have joined development aid as the common forms of financial flow from developed to developing countries. In the course of five years from 1989 to 1994, net private capital flow to developing countries has increased by more than four times (World Bank, 1995a). In addition, some developing countries have been able to reverse the direction of the capital flow, mainly for investment purposes. Hence there is now a two-way flow of financial capital between the two country groups.

The main causes of these changes in international flows of goods and services appear to be twofold. The first is technological progress, where advances in transportation and communication technologies have facilitated the increasing flows of goods and services across country boundaries. The second is more open commercial policy, the trend toward which has continued amongst developed countries since World War II and more recently amongst developing countries.

The effects of this globalisation on labour markets in developed countries have gained considerable attention recently. This is because two related phenomena have occurred in developed economies simultaneously with the intensifying international economic ties. In countries with regulated labour markets, unemployment has increased among unskilled workers. In others, there has been a widening of wage inequality between skilled and unskilled workers (Davis, 1996). Increasing unemployment among unskilled labour has been typical in continental Europe, while a combination of increased unemployment and wage inequality has been observed in Australia, Canada, the United Kingdom and, most prominently, the United States (World Bank, 1995a).

There is an ongoing debate as to the size of the contribution of openness and globalisation in explaining this poor performance of unskilled workers in developed countries. One side of the debate puts the contribution of increasing trade with developing countries as very substantial (Leamer, 1994; Sachs and Shatz, 1994; Wood, 1994 and 1995). Their argument emphasises standard international trade theory. Developed countries export goods which are intensive in skilled labour and capital to developing countries, while developing countries export goods which are intensive in unskilled labour to developed countries. In developed countries, as this trade expands, industries that are intensive in unskilled labour shrink, while industries which are intensive in relatively abundant skilled labour and capital expand. As a result, demand for unskilled labour decreases relative to skilled labour, pushing the skilled to unskilled wage ratio up. This explains the widening wage inequality between skilled and unskilled workers and, where unskilled labour wages are regulated above market clearing levels, the rise in unemployment.

In addition, Rodrik (1997, pp. 4, 12) argues that globalisation has not only reduced the demand for unskilled labour, but also makes the demand more elastic. The reason is because globalisation makes the services of labour in one country more easily substituted for the services of labour in other countries, either through trade (outsourcing) or through foreign direct investment (FDI).

The other side of the debate argues that spontaneous technological change is the main cause of the demise of unskilled labour, while the role of increasing openness and globalisation is minimal (Baldwin, 1994; Berman *et al*, 1994; Johnson, 1997; Krugman and Lawrence, 1994; Lawrence and Slaughter, 1993). The proponents of this view believe that the reasons for the labour market problems in the developed countries lie mostly in their domestic economies. In their view, manufacturing employment is falling because companies are replacing workers with machines and making more efficient use of those they retain. Meanwhile, wages have stagnated because the rate of productivity growth in the economy as a whole has slowed, and unskilled labour in particular is suffering because a high-technology economy has less and less demand for its services. Similarly, other domestic factors, such as changes in demand for domestic goods and increases in unskilled labour productivity, have been much more important in influencing the changes in total domestic employment than substitution of imports for home products.

If globalisation and technology change have important implications for developed countries, then they clearly have important implications for developing countries too. However, their effects on labour markets in the developing countries have not yet been well researched. In contrast to the substantial volume of analysis in the industrial country context, relatively little careful work has been done on these issues in developing countries (Diwan and Walton, 1997).

The standard international trade theorems, derived from the Heckscher-Ohlin-Samuelson (HOS) model, predict that openness should be beneficial for unskilled labour in developing countries. The decline of barriers to trade has allowed them to realise their comparative advantage in unskilled labour intensive goods. The domestic terms of trade shifts in favour of unskilled labour intensive sectors and so, by the Stolper-Samuelson theorem, the wage of unskilled labour rises relative to product prices and the wage of skilled labour.

Much of the empirical work on this subject (Diwan and Walton, 1997; González and McKinley, 1997; Pissarides, 1997; Robbins, 1996a and 1996b; Tan and Batra, 1997; Wood, 1997a) show mixed results on the labour market outcomes of openness in developing countries, however. Wood (1997a), for example, finds that although trade liberalisation in the East Asian countries during the 1960s and 1970s caused reduced wage equality between skilled and unskilled labour, the experience of the Latin American countries in the 1980s and early 1990s offers contradictory evidence. He argues that the latter is attributed to the entry of large low-income countries such as China and India into world markets for manufacture starting in the late 1970s, which in effect substantially increased the world's supply of unskilled labour.

Thesis Objectives and Main Results

The preliminary work on openness and labour markets in developing countries leaves numerous questions unresolved. New research is required that incorporates more developing countries at various stages of development. The general objective of this thesis is, therefore, to contribute to the understanding of how openness and globalisation affect labour markets in developing countries, both theoretically as well as empirically. The theoretical part of this general objective is pursued by incorporating developing country labour market characteristics into the standard HOS model using a stylised global data base in a computable general equilibrium (CGE) framework. The specific objective is to identify departures from HOS predictions associated with incorporating the developing country labour market complications.

Generalisations to include multiple products and factors and some product differentiation are found not to alter the standard trade theorems' qualitative predictions. The stylised parameters used do, however, yield in the model a muting of the factor market effects of trade shocks relative to HOS predictions. These results are consistent with Falvey *et al* (1995). More substantial divergences from HOS predictions do occur, however, when a dual labour market is imposed by rendering perfectly elastic the supply of unskilled labour. With this type of labour market, most trade and technology shocks lead to increasing wage inequality between skilled and unskilled labour.

The empirical part of the general objective, meanwhile, is achieved by using Indonesia as a case study, concentrating on its manufacturing sector. This sector has been the forefront of increasing openness in the Indonesian economy. If openness has any effect on the labour market, it will be most apparent in this sector. The specific objective of this empirical analysis is to establish the trends in skilled to unskilled labour relative employment and wages in this sector and to account for the effects of openness and technological changes on these trends.

The results show that since Indonesia shifted its development strategy from import substitution to export orientation in the mid 1980s, there is a tendency for the employment of unskilled labour relative to the skilled to increase, but the unskilled wage relative to the skilled wage decreases. Further analysis indicates that greater openness in a developing country increases the relative demand for unskilled labour. Increasing foreign participation also leads to higher relative demand for unskilled labour, because multinational corporations come to developing countries precisely to exploit the abundance of unskilled labour by investing in unskilled labour intensive industries. The only opposing force to this trend is the newness of capital stock. It tends to increase the relative demand for skilled labour.

The increase in the relative employment for unskilled labour is thus driven both by greater openness and increasing foreign participation. Because Indonesia is still in the labour surplus phase, however, skilled labour is relatively inelastic in supply and so the wages of skilled labour still increase faster than those of the unskilled, resulting in the observed widening wage inequality.

In addition, a decomposition of the factors affecting wage inequality is carried out using a CGE framework which is applied to a global data base, in which Indonesia is identified. The results indicate that productivity growth has been dominant in explaining the increase in wage inequality since the mid 1980s. A further analysis of possible policy responses to globalisation and technological change is carried out using the same framework. The results show that the only constructive policy objective to mitigate widening wage inequality is to enhance the labour supply response. A reversal of trade liberalisation or tax and subsidy policies directed at raising demand for unskilled labour are either ineffective or bear negative welfare consequences for the economy.

Thesis Outline

The first part of Chapter 2 reviews the trade theorems derived from the HOS model, which provide a link between trade shocks and changes in factor markets. The second part of the chapter reviews the relatively recent theoretical and empirical work on the subject. Since these studies are mostly conducted with application to developed countries, it is not surprising that their conclusions are not directly applicable to developing countries.

Chapter 3 considers the special case of developing countries. The first part of this chapter addresses the available findings on the effects of trade shocks on developing country labour markets. Quite a variety of different patterns are observed and the discussion concentrates on the development strategies adopted as well as different labour supply behaviour in each country as possible explanations. The second part of this chapter reviews developing country labour market theories.

In Chapter 4, the alternative theories of labour market adjustment to trade and technology shocks in developing countries are explored in a stylised global computable general equilibrium (CGE) framework. The model used has two regions with one representing developing countries as a block and the other for developed countries. Based on the results of simulations using this model, where various openness and technological change shocks are applied, hypotheses about the effects of these shocks are established.

The thesis turns to the case study of Indonesia in Chapter 5. Indonesia is clearly an interesting case to be studied, mainly because of its apparent development strategy shift from inward-looking import-substitution to outward-looking export-orientation in the mid 1980s. It therefore presents an opportunity to observe the effects of this shift on wages and the employment of various types of labour. Using data from the manufacturing sector, trends in skilled-unskilled labour relative employment and wages are established. So are the trends in various openness and technological change indicators.

In Chapter 6, using an econometric analysis, the effects of openness and technological change indicators are accounted for explaining the observed trends in skilled-unskilled labour relative employment and wage as established in Chapter 5. This is done through an interrelated factor demand analysis using input cost shares model, which is derived from a translog cost function. Hence, the analysis does not directly assess the relative employment and wages of skilled and unskilled labour, instead it focuses on their relative demand.

In the first part of Chapter 7, the contribution of trade liberalisation, capital accumulation, and technological change on wage inequality is decomposed. This is carried out in a global CGE framework, where Indonesia is identified as a distinct region in the model. In the second section, the model is used to analyse possible policy responses to globalisation and technological change. In addition, a special section analysing the labour market effects of the Asian economic crisis is supplemented in this chapter.

Finally, Chapter 8 provides the summary and overall conclusions of this thesis as well as their implications.

Chapter 2:

TRADE SHOCKS AND LABOUR MARKET ADJUSTMENTS: THE THEORY AND STYLISED FACTS IN DEVELOPED COUNTRIES

The first section of this chapter reviews the Heckscher-Ohlin-Samuelson (HOS) model and the theorems derived from it. This model is important in understanding the relationships between trade in goods and developments in the labour market because it is the simplest relevant model that links changes in open product markets with changes in factor markets in a general equilibrium framework. In the second section, the stylised facts of current labour market changes in developed countries and the subsequent debates on the explanations of these changes are discussed. Understandably, many of the arguments in these debates are derived from the interpretation of the HOS model and its theorems.

The Heckscher-Ohlin-Samuelson Model

As the review by Burtless (1995) asserts, the most commonly invoked international trade theory to explain the link between trade and the labour market is the two-region two-sector two-factor HOS model of the world economy. This model is a general equilibrium framework which assumes that the two factors of production have fixed supplies and both are perfectly mobile domestically but completely immobile internationally. All agents are price takers in both product and factor markets. The two regions have identical technologies and consumers in both regions have identical homothetic preferences. Four theorems stem from the HOS model: the Heckscher-Ohlin theorem on the pattern of trade, the factor price equalisation theorem, the Stolper-

Samuelson theorem on the relationship between product prices and factor prices, and the Rybczynski theorem on changes in factor supply or endowment. These theorems together can be used to predict the effects of international trade on labour markets both in developed and developing countries.

Pattern of Trade: The Heckscher-Ohlin Theorem

The Heckscher-Ohlin (HO) theorem states that with free trade, a region exports the good making relatively intensive use of the comparatively abundant factor in that region. Wood (1997a) refers to this theorem as often disputed but widely applied. He uses it nonetheless (Wood, 1994), but chooses a less conventional factor dichotomy, namely that of skilled and unskilled labour. If developing countries are relatively abundant in unskilled labour, while developed countries are relatively abundant in skilled labour, the HO theorem is as illustrated in Figure 2.1.

In this figure, which is adapted from Dixit and Norman (1980, pp. 5-8), the horizontal axis represents trade in the unskilled labour intensive good (denoted by subscripts U), while the vertical axis represents trade in the skilled labour intensive good (denoted by subscripts S). The variable X represents exports, M imports, and P prices. Meanwhile, the superscripts I and E index developing and developed countries respectively. This means that, for example, X_U^I is export from developing countries on unskilled labour intensive good. In this case, this is the same as M_U^E, import by developed countries of the same good.

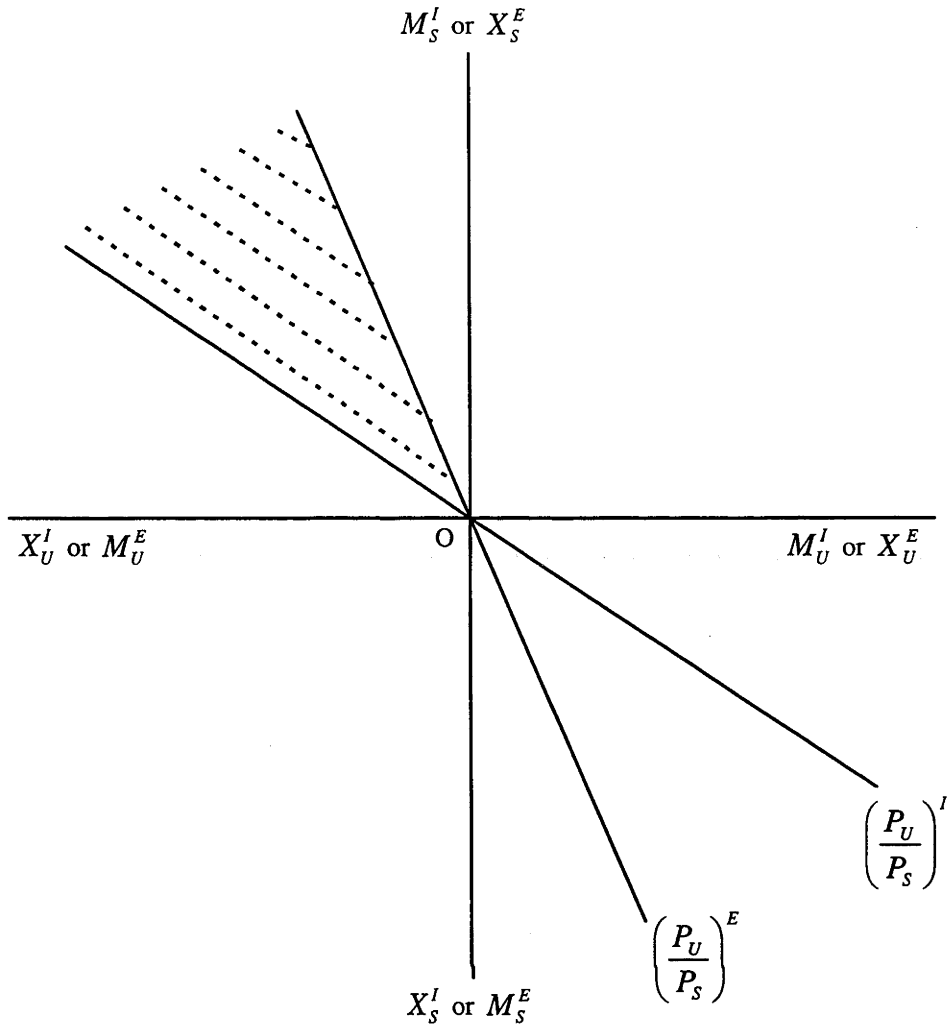

Figure 2.1:
The Pattern of Trade

Source: Dixit and Norman (1980)

The relative price line (P_U/P_S) is the price ratio (terms of trade) between unskilled and skilled labour intensive goods. This line always passes the origin because autarky is always feasible given the production technology and the condition that there be no trade deficit. At the autarky price ratio in developing countries $(P_U/P_S)^I$, all allocations on and to the left of this line are feasible, yet the no-trade case is chosen. This means that autarky must be preferred to all other allocations on and to the left of $(P_U/P_S)^I$. The autarky price ratio in developed countries is $(P_U/P_S)^E$. This line is steeper than $(P_U/P_S)^I$ due to the assumption that developing countries are relatively abundant in unskilled labour and developed countries are relatively abundant in skilled labour. By the same token, autarky is preferred to all allocations on and to the right of $(P_U/P_S)^E$.

This implies that if the developed and developing countries trade with each other, then the equilibrium price ratio will lie between the two autarky price ratios, which means that trade will take place at a point in the area marked with broken lines in Figure 2.1. This implies that, in this framework, the HO theorem predicts that developing countries will export the unskilled labour intensive good (X_U^I) and import the skilled labour intensive good (M_S^I), while the developed countries will export the skilled labour intensive good (X_S^E) and import the unskilled labour intensive good (M_U^E).

The Factor Price Equalisation Theorem

The factor price equalisation (FPE) theorem predicts that free trade will equalise factor returns internationally (Samuelson, 1948 and 1949). Rassekh and Thompson (1993) provide a survey of the theoretical evolution and empirical investigation of this theorem. To establish the FPE theorem formally, let U and S represent the unskilled and skilled labour intensive goods respectively, P_U and P_S as their prices, while I and E index developing and developed countries as before. In addition, let L represent the total quantity of unskilled labour available. Similarly, let H be the total quantity of skilled labour available. Let also w_L and w_H be the wage rates of unskilled and skilled labour respectively.[1] Meanwhile, the input-output coefficients a_{ij} are, respectively, the number of units of factor i (i = L and H) used to produce one unit of output j (j = U and S). If labour markets always clear, then:

$$L_U^I + L_S^I = L^I \tag{2.1a}$$

$$H_U^I + H_S^I = H^I \tag{2.1b}$$

$$L_U^E + L_S^E = L^E \tag{2.1c}$$

$$H_U^E + H_S^E = H^E \tag{2.1d}$$

which, using the input-output coefficients, can be restated as:

$$a_{LU}^I U^I + a_{LS}^I S^I = L^I \tag{2.2a}$$

$$a_{HU}^I U^I + a_{HS}^I S^I = H^I \tag{2.2b}$$

$$a_{LU}^E U^E + a_{LS}^E S^E = L^E \tag{2.2c}$$

$$a_{HU}^E U^E + a_{HS}^E S^E = H^E \tag{2.2d}$$

From the cost minimisation problem, the input-output coefficients a_{ij} are solved as a function of relative factor prices: $a_{ij} = a_{ij}\left(\frac{w_L}{w_H}\right)$. The constant returns to scale assumption implies that these input-output coefficients are independent of the quantity of output produced. This assumption, together with the competitive zero profit condition, implies that:

[1] The formal derivation of this and the subsequent two theorems are based on lecture notes of the "International Trade Theory" course by Rod Falvey in 1995 at the Australian National University.

$$a_{LU}^{I}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_L^I + a_{HU}^{I}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_H^I = P_U^I \tag{2.3a}$$

$$a_{LS}^{I}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_L^I + a_{HS}^{I}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_H^I = P_S^I \tag{2.3b}$$

$$a_{LU}^{E}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_L^E + a_{HU}^{E}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_H^E = P_U^E \tag{2.3c}$$

$$a_{LS}^{E}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_L^E + a_{HS}^{E}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_H^E = P_S^E \tag{2.3d}$$

Because technologies are identical across regions, $a_{ij}^I(\cdot) = a_{ij}^E(\cdot) = a_{ij}(\cdot)$. Furthermore, due to trade liberalisation, $P_j^I = P_j^E = P_j$. Because of these identical technologies and product prices, equations (2.3a) - (2.3d) can be transformed into:

$$a_{LU}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_L^I + a_{HU}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_H^I = P_U \tag{2.4a}$$

$$a_{LS}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_L^I + a_{HS}\left(\frac{w_L^I}{w_H^I}\right)\cdot w_H^I = P_S \tag{2.4b}$$

$$a_{LU}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_L^E + a_{HU}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_H^E = P_U \tag{2.4c}$$

$$a_{LS}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_L^E + a_{HS}\left(\frac{w_L^E}{w_H^E}\right)\cdot w_H^E = P_S \tag{2.4d}$$

However, if there is a unique solution to (2.4a) - (2.4d) given P_U and P_S, then it must be true that $w_L^I = w_L^E = w_L$ and $w_H^I = w_H^E = w_H$, which means that factor prices are equal in both regions. This implies that the equation (2.4a) is identical with (2.4c) and (2.4b) is identical with (2.4d). This solution establishes the FPE theorem. Under the assumptions above, free trade will equalise factor returns internationally.

Figure 2.2 illustrates how factor price equalisation works. The vertical axis represents skilled labour (H), while the horizontal axis represents unskilled labour (L). The isoquants s and u are the unit value isoquants for the skilled labour intensive good (S) and the unskilled labour intensive good (U) respectively. A unit value isoquant combines output levels that correspond in value to one unit of the numeraire. Cost minimisation by producers implies that the input combinations actually employed will be such that the marginal rate of technical substitution between inputs (the slope of the isoquant) will be equal to the relative factor prices (the slope of the isocost line). This means that in equilibrium, if the zero profit conditions are satisfied and hence both goods are being produced, then factor prices must be such that both unit value isoquants are tangent to the unit value isocost line, which is shown by line AB in the figure.

Assuming the initial distortions reduce trade, then this theorem implies that liberalisation of trade between developed and developing countries will result in opposite effects in the labour markets in each region. To see this, imagine that the two regions are making the transition from autarky to free trade. The pattern of trade predicted by the Heckscher-Ohlin theorem has goods intensive in unskilled labour flowing from developing countries to developed countries and goods intensive in skilled labour flowing from developed to developing countries. In the developed countries, this pattern of trade increases demand for skilled labour while it reduces the demand for unskilled labour. Real wages of skilled labour rise relative to those of unskilled labour. In developing countries, on the other hand, demand for unskilled labour increases while demand for skilled labour decreases. Consequently, the real wages of unskilled labour rise relative to those of skilled labour. This means that the FPE theorem predicts that

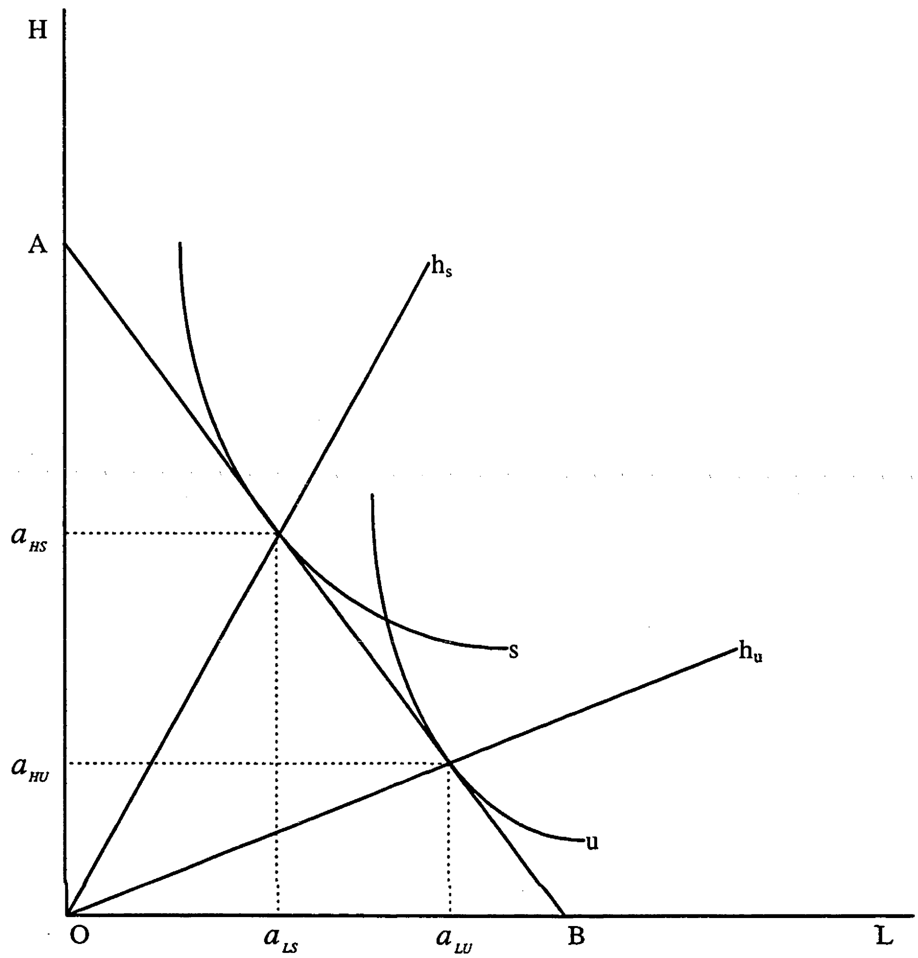

Figure 2.2:
Factor Price Equalisation

Source: Falvey (1994)

wage inequality between skilled and unskilled workers increases in developed countries and decreases in developing countries.

Product and Factor Prices: The Stolper-Samuelson Theorem

The Stolper-Samuelson (SS) theorem, which originated in Stolper and Samuelson (1941), predicts that an increase (decrease) in the relative price of a traded good will increase (decrease) return to the factor which is used intensively in the production of that good and decrease (increase) return to the other factor. To establish this theorem formally, start by totally differentiating the equations (2.4a) and (2.4b) without the superscript I to get:

$$w_L \cdot da_{LU} + a_{LU} \cdot dw_L + w_H \cdot da_{HU} + a_{HU} \cdot dw_H = dP_U \qquad (2.5a)$$

$$w_L \cdot da_{LS} + a_{LS} \cdot dw_L + w_H \cdot da_{HS} + a_{HS} \cdot dw_H = dP_S \qquad (2.5b)$$

At the optimum level of output, the first and the third terms in both equations (2.5a) and (2.5b) cancel each other.[2] Then, converting both equations into proportional changes, the results are:

$$\Theta_{LU} \cdot \hat{w}_L + \Theta_{HU} \cdot \hat{w}_H = \hat{P}_U \qquad (2.6a)$$

$$\Theta_{LS} \cdot \hat{w}_L + \Theta_{HS} \cdot \hat{w}_H = \hat{P}_S \qquad (2.6b)$$

where Θ_{ij} denotes the share of factor i in the unit cost of product j, while the ^ sign denotes a proportional change in the variable.

Using Cramer's rule (Chiang, 1984, p. 107), the solution to the equations (2.6a) and (2.6b) is:

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[2] The slope of unit isoquant for product j is da_{hj}/da_{lj}. At the optimum level of output, the unit isoquant for product j is tangent to the factor price ratio. This means that at the optimum $da_{hj}/da_{lj} = -w_l/w_h$, which implies that $w_l \cdot da_{lj} + w_h \cdot da_{hj} = 0$.

$$\hat{w}_L = \frac{\Theta_{HS} \cdot \hat{P}_U - \Theta_{HU} \cdot \hat{P}_S}{|\Theta|} \tag{2.7a}$$

$$\hat{w}_H = \frac{\Theta_{LU} \cdot \hat{P}_S - \Theta_{LS} \cdot \hat{P}_U}{|\Theta|} \tag{2.7b}$$

where $|\Theta| = \Theta_{LU} \cdot \Theta_{HS} - \Theta_{LS} \cdot \Theta_{HU}$.

Since the cost shares of a product always sum up to one, $|\Theta| = \Theta_{LU} - \Theta_{LS}$ or $|\Theta| = \Theta_{HS} - \Theta_{HU}$. Given the relative factor intensity of the products, $\Theta_{LU} > \Theta_{LS}$ and $\Theta_{HS} > \Theta_{HU}$, so that $|\Theta|$ is positive. Now suppose there is an exogenous increase in the price of the unskilled labour intensive good ($\hat{P}_U > 0$) while the price of the skilled labour intensive good does not change ($\hat{P}_S = 0$), then the wages of unskilled labour will go up ($\hat{w}_L > 0$) and the wages of skilled labour will go down ($\hat{w}_H < 0$). This establishes the Stolper-Samuelson theorem.

This theorem implies that an increase in tariff protection for a good which is relatively intensive in unskilled labour in developed countries increases the real wage received by unskilled labour in this region. A reduction in the protection of this good, therefore, lowers their real wage. Burtless (1995) concludes that for unskilled workers in developed countries, a reduction in protection of goods which use their services intensively will tend to reduce the real wage received by them. For developing countries, on the other hand, a reduction in protection of the unskilled labour intensive good in developed countries increases the price of their export. This raises the real wage of unskilled labour in developing countries and, therefore, reduces wage inequality. In addition, a reduction in developing countries' protection of skilled labour intensive industries reinforces these effects.

Bhongmakapat (1990) suggests, however, that in reality the impact of export expansion on income distribution in developing countries is overestimated by the assumption of perfect intersectoral factor mobility. To see this, Figure 2.3 illustrates the mechanism of the Stolper-Samuelson theorem. The horizontal axis L represents the unskilled labour and the vertical axis H represents the skilled labour, U is the unit value isoquant of the skilled labour intensive good, S is the unit value isoquant of the skilled labour intensive good, p is the wage ratio between unskilled and skilled labour, h_u is the skilled to unskilled labour ratio in the production of the unskilled labour intensive good, and h_s is the skilled to unskilled labour ratio in the production of the skilled labour intensive good.

Now suppose that, due to trade liberalisation in developed countries, the price of the unskilled labour intensive good increases in developing countries. This is represented by an inward shift of the unit value isoquant U to U_1. This means that for developing countries it is now profitable to produce more of the unskilled labour intensive good and less of the skilled labour intensive good. However, at the original wage ratio p, the proportion of skilled labour released per unit of skilled labour intensive good production foregone is higher than that being absorbed per unit of unskilled labour intensive good production added. To maintain full employment, the relative wage of skilled labour has to decline, which is represented by the steeper new wage ratio p_1. Thus, both industries will substitute unskilled labour for skilled labour, with the result that both will then employ a higher proportion of skilled labour per unit of output. This is represented by steeper skilled to unskilled labour ratios, h_{u1} and h_{s1}, in both industries. As Bhongmakapat (1990) asserts, however, without perfect intersectoral factor mobility,

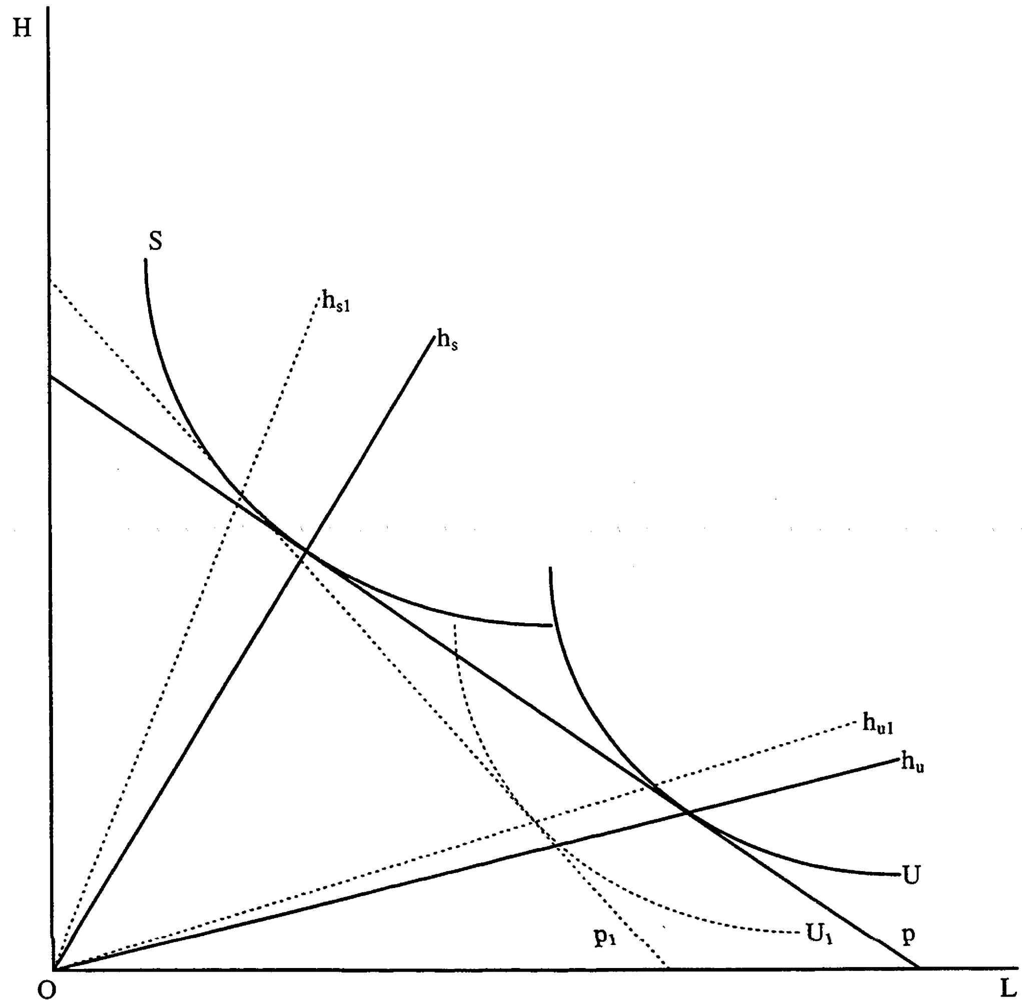

Figure 2.3:
The Stolper-Samuelson Theorem

Source: Lawrence and Slaughter (1993)

this mechanism will not take place. Instead, changes in output prices will be associated with inter-industry wage differentials.

Factor Endowment Change: The Rybczynski Theorem

Finally, the Rybczynski theorem states that, at constant relative prices, an increase (decrease) in the endowment of a certain factor of production will increase (decrease) the production of the good intensive in that factor and decrease (increase) production of the other good (Rybczynski, 1955). To confirm this in the case of domestically mobile factors, let L denote capital which is suitable for the production of simple manufactures of the type produced in developing countries. H then denotes the capital suitable for the production of sophisticated manufactures.[3] Consequently, w_L and w_H now denote the rental rates of both types of capital respectively.

The derivation of this theorem starts by totally differentiating the equations (2.2a) and (2.2b). Dropping the superscript I, the results are:

$$U \cdot da_{LU} + a_{LU} \cdot dU + S \cdot da_{LS} + a_{LS} \cdot dS = dL \tag{2.8a}$$

$$U \cdot da_{HU} + a_{HU} \cdot dU + S \cdot da_{HS} + a_{HS} \cdot dS = dH \tag{2.8b}$$

Since at constant factor prices there will be no changes on the input-output coefficients, the first and the third terms in both equations can be dropped. Converting to proportional changes results in:

$$\lambda_{LU} \cdot \hat{U} + \lambda_{LS} \cdot \hat{S} = \hat{L} \tag{2.9a}$$

$$\lambda_{HU} \cdot \hat{U} + \lambda_{HS} \cdot \hat{S} = \hat{H} \tag{2.9b}$$

where λ_{ij} denotes the share of the total endowment of factor i employed in industry j.

[3] These types of capital are introduced explicitly in extension to the basic model discussed in Chapters 4 and 7. They are then referred to as "simple" and "sophisticated" capital.

Again solve using the Cramer's rule to get:

$$\hat{U} = \frac{\lambda_{HS} \cdot \hat{L} - \lambda_{LS} \cdot \hat{H}}{|\lambda|} \tag{2.10a}$$

$$\hat{S} = \frac{\lambda_{LU} \cdot \hat{H} - \lambda_{HU} \cdot \hat{L}}{|\lambda|} \tag{2.10b}$$

where $|\lambda| = \lambda_{LU} \cdot \lambda_{HS} - \lambda_{LS} \cdot \lambda_{HU}$. Since the endowment shares always sum up to one for each factor, $|\lambda| = \lambda_{LU} - \lambda_{HU}$ or $|\lambda| = \lambda_{HS} - \lambda_{LS}$. Given relative factor intensities of the products, $\lambda_{LU} > \lambda_{HU}$ and $\lambda_{HS} > \lambda_{LS}$, so that $|\lambda|$ is positive. Now suppose in developing countries there is an increase in the endowment of capital which is suitable for simple manufactures ($\hat{L} > 0$) while the endowment of the other type of capital does not change ($\hat{H} = 0$), then the production of simple manufactures will increase ($\hat{U} > 0$) and the production of sophisticated manufactures will decrease ($\hat{S} < 0$). This establishes the Rybczynski theorem.

The mechanism of Rybczynski theorem is illustrated in Figure 2.4. The vertical axis represents the endowment of H, namely capital suitable for the production of sophisticated manufactures. The horizontal axis represents the endowment of L, namely capital suitable for the production of simple manufactures. The levels of production of sophisticated and simple manufactures, meanwhile, are represented by isoquants S and U respectively. The ratio of the two types of capital used in the production of sophisticated manufactures is represented by the line h_s, while for simple manufactures is h_u. These ratios are fixed since standard HOS assumptions prevail and so the FPE theorem holds. If the home country is small, then both product and factor prices are fixed.

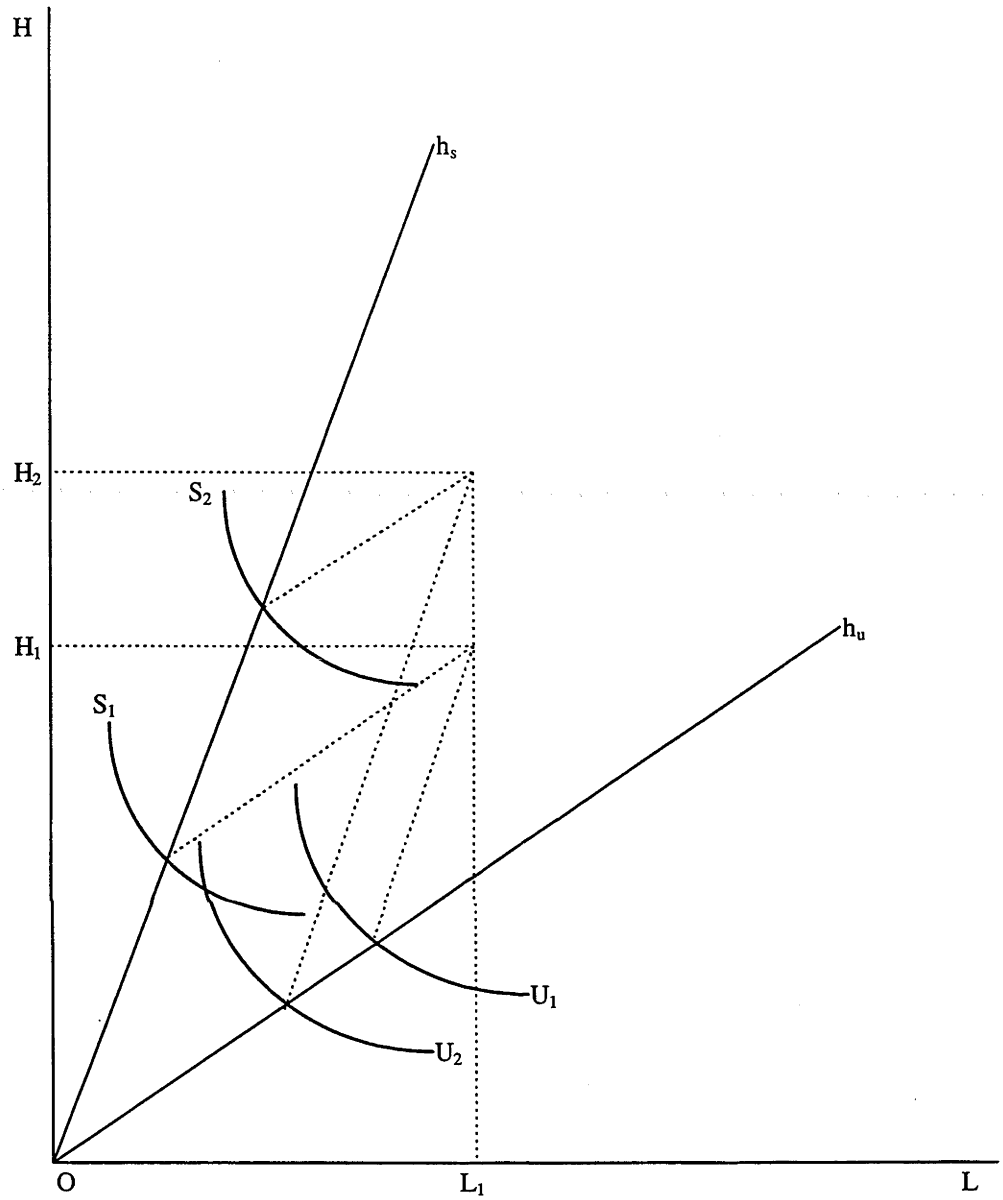

Figure 2.4:
The Rybczynski Theorem

Source: Falvey (1994)

Suppose the original endowments of H and L are H_1 and L_1 respectively. All these endowments are distributed to the production of S and U in accordance to h_s and h_u, so that the quantity of S produced is represented by the isoquant S_1 and that of U by the isoquant U_1. Now suppose the endowment of H increases from H_1 to H_2. The quantities of S and U produced are now S_2 and U_2 respectively. Since S_2 is greater than S_1 and U_2 is less than U_1, this clearly shows that an increase in the endowment of a factor leads to an increase in the production of the good which is intensive in that factor and a reduction in the production of the other good. The production of U decreases because, in order to employ the additional H, some L has to be released from the production of U.

One application of this theorem is to analyse the effects of capital mobility. With openness and globalisation, capital can move freely among countries. Since developed countries have relatively more abundant capital than developing countries, then the marginal productivity of capital, and therefore the rate of profit, in developed countries is lower than in developing countries. Consequently, capital moves from the developed to developing countries. Wood (1994, pp. 32, 37) rejects the notion that rate of profit is higher in developing countries, however. He argues that technologies are readily available in the market equally for both developed and developing countries. The only question is whether a country can afford to buy them or not. He implies, therefore, that the rate of profit is the same in developed and developing countries and that this therefore cannot be the driving force of capital movement. Instead, he suggests that the movement of capital in the form of labour intensive manufacturing from the developed to developing countries might have been precipitated by the relative abundance of unskilled labour in the newly open developing countries or by increased scarcity of unskilled labour in the developed countries.

Returning to the Rybczynski theorem, if as before it is assumed that there are two forms of capital, one which is suitable for simple manufactures and the other for sophisticated manufactures, the inflow of the former to developing countries clearly increases the output of that sector. In developed countries, on the other hand, the outflow of this form of capital reduces output of simple manufactures while increasing the output of sophisticated manufactures. This further strengthens the pattern of trade predicted by the Heckscher-Ohlin theorem and its effects on the labour market as predicted by the FPE theorem.[4]

Generalisation of the HOS Model

The HOS model has obvious restrictive assumptions, the most prominent being its low and even dimensionality. Efforts to generalise the model into a many goods, many factors, and many countries framework have been attempted (eg. Ethier, 1974 and 1984). The conclusion from these generalisations is that the basic messages of the theorems still hold to the large extent. The theorems derived from the strictest HOS model turn out to have pointed the way with a good deal of accuracy (Ethier, 1984).

In Chapter 4, the HOS model is generalised in the context of a computable general equilibrium (CGE) framework. The generalisation incorporates product differentiation by country of origin, a non-tradeable services sector, and it adds capital as a factor of production in addition to skilled and unskilled labour. Before generalising the model, however, the remainder of this chapter reviews the debate about labour market

[4] In Chapter 4, the model is extended to include differentiated products and multiple goods and factors. The two types of capital are combined with skilled and unskilled labour. If unskilled labour is a gross complement of simple capital, and skilled labour of sophisticated capital, then a change in the stock of either type of capital has both Rybczynski effects as well as associated changes in the wage ratio.

effects of openness in the developed country context, while the next chapter elaborates on the circumstances of developing countries.

The Stylised Facts and Debate in Developed Countries

During the last three decades, manufacturing exports from developing to developed countries have increased significantly and, at the same time, the demand for unskilled labour in developed countries has fallen substantially, while on the other hand the demand for skilled labour has increased (Wood, 1994). Furthermore, these developments have coincided with increasing unemployment among unskilled workers in some countries, or widening wage inequality between skilled and unskilled labour in some other countries (Wood, 1995).

The phenomenon of widening wage inequality between skilled and unskilled labour became more widespread in developed countries after the 1980s. The degree of this widening, however, varies from country to country. The largest increases in inequality are observed in the United States (US) and the United Kingdom (UK).[5] Substantial increases are also observed in Canada, Australia, and New Zealand, while smaller increases are observed in the Nordic countries, the Netherlands, France, Italy, and Japan. The only developed country which seems to have avoided an increase in wage inequality in recent years is Germany (Gottschalk, 1997; Katz *et al*, 1995).

Evidence that wage inequality increased in so many developed countries, each having its own unique institutional structure, suggests that similar forces have been at work around the globe. The role of internal institutions in each country determines the

[5] Although the trends in wage inequality in the US and the UK are similar, the trends in the real wage of unskilled labour in the two countries are different. While the real wage of unskilled labour in the US fell during the 1980s, it still increased in the UK (Schmitt, 1995). One possible explanation for this is the countries' different approaches to the indexation of prices.

size of any change in wage structure and employment. In the US and the UK, where wage inequality has increased most, the labour market is most decentralised. The other developed countries all have more centralised wage-setting systems and they have experienced smaller increases in wage inequality. Centralised wage-setting tends to compress the wage distribution, particularly at the bottom end. In these countries, people with low skills are much less likely, relative to those with better skills, to find work than are the low skilled workers of the US (Blau and Kahn, 1996; Katz *et al*, 1995).

The German experience, where wage inequality between skilled and unskilled labour has not increased, presents an interesting case. Kraft (1994) actually finds that wage inequality in this country in recent years has decreased. He attributes this tendency to increasing efficiency in the labour market. Nonetheless, he finds that the unemployment rate among unskilled labour has been persistently high and rising in the 1990s. The strongest explanation for this, according to him, lies in Germany's centralised wage policy. An alternative explanation is offered by Nickell and Bell (1996). They argue that the education and training system in the country makes the skill differential between skilled and unskilled labour much narrower than in other developed countries. This, they assert, enables the German economy to respond to demand shifts toward skilled labour in a far more robust fashion. Yet it does not explain Germany's high rate of unemployment.

This poor labour market performance of unskilled workers has attracted a considerable literature directed at its explanation. The changes in wage inequality can be driven by changes in relative supply, relative demand, or institutions governing wages (Kim and Topel, 1995). For most developed countries, however, it is clear that substantial shifts in relative demand favouring skilled labour are necessary to explain the recent changes in wage structures (Katz *et al*, 1995).

Using a basic model of trade, technology, and wages, Richardson (1995) shows that the increasing volume of trade between developed and developing countries will, in two cases, lead to a reduction in demand for unskilled labour in developed countries. Of these two cases, the first is the standard HOS one. It follows the opening of an economy along a given production possibility frontier. The relative wage shifts because opening to trade shifts relative product prices. Increased openness to trade reduces the internal relative price of the good which is intensive in the relatively scarce factor in that economy. For developed countries, this is clearly the unskilled labour intensive good. By Stolper-Samuelson theorem, the fall in the price of the unskilled labour intensive good leads to a fall in the wage of unskilled labour. The second case is when there is an exogenous sectoral technological change that is more rapid in the skilled labour intensive sector than in other sectors. In the open economy, this technological change causes the favoured sector to expand, drawing resources out of the other sectors. The skilled labour intensive sector is able to absorb the large number of unskilled workers released from other sectors only if their relative wage falls.

Along with these two cases, two opposing views have emerged on the role of international trade in reducing developed country demand for unskilled labour. On the one hand, some economists think that the role of trade with developing countries is substantial (Leamer, 1994 and 1996; Revenga, 1992; Sachs and Shatz, 1994; Wood, 1994 and 1995). On the other, some economists put biased technological change as the main cause and dismiss the role of trade as small or unimportant (Baldwin, 1994; Berman *et al*, 1994; Johnson, 1997; Krugman and Lawrence, 1994; Lawrence and Slaughter, 1993). Some other economists have tried to mediate by asserting that the effects of openness and globalisation are not very large but not negligible either (Freeman, 1995; Richardson, 1995).

The Trade Explanation

Leamer (1994) believes that there are three factors which have contributed to widening wage inequality in developed countries, namely technological change, globalisation, and education. He strongly rejects the notion that technological change is the main factor behind the widening wage inequality in developed countries. More than that, his own empirical estimation indicates that technology has led to a larger increase in wages for the unskilled than for the skilled, which means that it actually narrows rather than widens wage inequality.

Wood (1995) asserts that barriers to trade in manufactures have fallen over the past two decades for two reasons. The first is that international transport and telecommunication have become much cheaper, quicker, and of better quality. The second is the change in trade policy regimes, particularly in developing countries. More and more developing countries have switched to export-oriented trade regimes and ceased to offer high protection to capital intensive industries. According to Wood (1994), the evidence suggests that these reductions in trade barriers are the main cause of the growth of manufactured exports from developing countries and they are truly exogenous or independent of other demand and supply shifts in developed country labour markets.

This view is supported by the widening of wage gaps in some developed countries, implying that the imports of unskilled labour intensive manufactured goods are not sucked in by shortages of unskilled labour. Moreover, Wood's observations suggest that wage gaps in the East Asian "tiger" economies appear to have fallen. This suggests that falling trade barriers are a more plausible explanation than rising internal labour surpluses as the cause of their growing exports. Furthermore, he argues that these reductions of trade barriers have shifted developed countries from 'manufacturing autarky', in which they produced all the manufactures they consumed (those intensive in both skilled and unskilled labour), to specialisation in the production of skilled labour intensive manufactures and reliance on imports from developing countries to supply their needs for unskilled labour intensive manufactures. Hence, demand for unskilled labour has declined while demand for skilled labour has increased.

According to Rodrik (1997, pp. 16-27), openness does not only reduce the demand for unskilled labour but also makes it more elastic, meaning that the demand for unskilled labour becomes more responsive to changes in their wages. The reason for this is because openness makes it easier for employers and consumers to substitute foreign workers for domestic workers either by investing abroad or importing foreign products. Furthermore, he argues that the more elastic the demand for their services the harder it is for workers. There is greater uncertainty in labour market outcomes and employment insecurity, because workers' bargaining position *vis a vis* employers is weakened.

To examine the effects of trade on employment and wages in the US manufacturing, Revenga (1992) uses an econometric analysis of the relationships between import prices and the trends in industrial employment and wages. Her main empirical finding is that changes in import prices have had large and significant effects on both employment and wages. However, her findings as to the relative size of the wage and employment effects suggest that the impact of an adverse trade shock on average wages in a particular industry is quite small, with most of the adjustment occurring through employment.

Freeman (1995) doubts the relevance the factor price equalisation theorem and the assertion that trade acts to link labour markets, even where the traded share of GDP is small. He argues that these predictions run counter to a wide body of evidence that domestic developments do affect domestic wages. For instance, the baby boom affected the pay of young workers, the relative number of college graduates altered the premium paid for education, sectoral developments affect pay in certain industries, and wages are more likely to be higher if a firm does well than if it is doing poorly.

In the answer to this argument, Leamer (1996) explains that, because prices are set on the margin, it does not matter whether trade in manufactures is a large or small proportion of GDP or whether employment in apparel is a large or small proportion of the work force. What matters is whether or not the marginal unskilled worker is employed in the apparel sector, sewing the same garments as a Chinese worker whose wages are a twentieth of the US level.

Johnson (1997) opposes the globalisation explanation. He puts forward three reasons. First, the share of total unskilled employment that is in the tradeable goods sector is simply too small to have produced relative demand shifts of the magnitude observed in recent years. Second, relative demand shifts toward skilled labour took place in all industries, tradeable and non-tradeable, which indicates that the source of these shifts was something other than trade. Third, the relative demand has been shifting fairly consistently for at least 40 years. If international factors were the primary cause of the relative demand shifts, such shifts would not be observed before the onset of globalisation in the 1970s.

The Technology Explanation

Lawrence and Slaughter (1993) argue that if it is a trade story then the relative decline in the wage of unskilled labour will be associated with an increase in the employment ratio of unskilled to skilled labour within any firm or industry, because all industries will substitute away from newly expensive skilled labour. This is a prediction derived from the Stolper-Samuelson theorem illustrated in Figure 2.3. They find, instead, that there is a pervasive shift in the US manufacturing toward the increased use of skilled labour despite the rise in its relative wage. Therefore, they conclude that this employment ratio shift suggests that technological change has been the more important pressure on wages of unskilled labour.

A similar conclusion about the cause of declining demand for unskilled labour is given by Berman *et al* (1994). They argue that biased technological change has been the major cause of skill upgrading in American manufacturing. While they admit that increased international trade has undoubtedly caused some increase in the share of skilled labour employment, they assert that this effect is not large enough to explain the bulk of observed skill upgrading in the US manufacturing. They base their argument on their finding that there are strong correlations between within-industry skill upgrading with both research and development investment as well as increases in computer investments.

Bound and Johnson (1992) examine various alternative explanations for the changes in the structure of wages in the US, but do not directly assess trade with developing countries as an alternative explanation. They find, first, that total changes in average industry wages were in the right direction but accounted for a small fraction of relative wage changes. Second, relative supply changes were large but in the wrong direction. Third, the effects of product demand shifts were small and of uneven direction.

Fourth, technological change comprised the principal source of the increase in educational and experience wage differentials. These results lead them to conclude that skill biased technological change is the principal reason for the increases in skill wage differentials.

On the other hand, Mishel and Bernstein (1996) find no support for the technology explanation of increasing wage inequality between skilled and unskilled labour. In their study, they do not find any evidence that technology has become more or less skill biased over time. They argue that, if the effect of technology has been constant over time, then technology cannot be a contributing factor to the increasing wage inequality between skilled and unskilled labour observed in recent years.

Meanwhile, Doms *et al* (1997) find contradictory findings on the effects of technology on wages. On the one hand, the results of their cross-sectional analysis shows that plants that use a large number of new technologies employ more educated workers, managers, professionals, and precision-craft workers. These plants also pay higher wages. On the other hand, their panel data analysis shows that the adoption of new technologies has little effect on skill upgrading. Plants that adopt new factory automation technologies have more skilled workers both before and after the adoption of new technologies. Hence, they conclude that the observed cross-sectional correlation between technology use and worker wages may be due to time-invariant unobserved worker quality differences.

Alternative Globalisation Stories

A problem for the HOS model explanation of increased wage dispersion has been the failure of most empirical studies to observe both the predicted changes in product prices and wages. Contrary to the HOS prediction, Lawrence and Slaughter (1993) find that price growth has been slower in skilled labour intensive industries. Using different data set, Krueger (1995) finds contradictory evidence that prices have grown relatively less in unskilled labour intensive industries. Although this is consistent with the HOS prediction, he admits that his finding could also be consistent with some models of technological change.

Sachs and Shatz (1996) transcend the HOS model theorems, seeking other channels linking international trade with wages. They mention three possible linkages by which increased trade with developing countries reduces the relative wages of unskilled labour in developed countries, even without reducing the relative price of goods which are intensive in unskilled labour in developed countries market. The first possible linkage is that identified earlier by Wood (1994), namely capital flows to developing countries out of unskilled labour intensive sectors in developed countries. This reduces the demand for unskilled labour in developed countries and drive down its wage, while the total supply of unskilled labour intensive goods remains the same.

The second possible linkage depends on oligopoly rents in the unskilled labour intensive sector in developed countries. To take the extreme monopoly or cartel as an example, when subjected to increased import competition, the industry's response would be to lower its production one for one with the increased imports to keep the price from falling. This would also reduce the demand for unskilled labour and drive down its wage. The third possible linkage, meanwhile, is via technology. Technological changes could be occurring in response to the growth of the global market for developed countries' products and greater capital mobility. These could differ in the magnitude of their labour productivity effects, or they could be biased in favour of skilled labour.

The important role played by capital mobility is also argued by Feenstra and Hanson (1996). They find that widening wage inequality is not only happening in developed countries (the US), but also in their developing country trading partners (Mexico). The similarity of these wage movements in both developed and developing countries suggests that they are not caused by trade liberalisation directly, since in that case factor prices would move in opposite directions across the country groups. Therefore, they hypothesise that capital mobility from developed to developing countries is responsible for these wage movements.

Using a model of foreign direct investment, they show that capital movements from developed to developing countries increase activities which are more skill intensive in both regions. This results in rising demand for skilled workers in both regions and, hence, rising skilled labour relative wages in both developed and developing countries.[6] This happens because activities which move along with capital are more skilled-labour intensive than any that formerly occurred in the developing countries, but less skilled-labour intensive than any that now occur in the developed countries. In their conclusion, however, they agree that both trade and investment are important contributing factors to the decline in the relative wages and employment of unskilled labour in the US.

Another channel is hypothesised by Wood (1997b). He argues that globalisation reduces travel and communication costs. This enables skilled workers from developed countries to cooperate on an intermittent basis with workers from developing countries. As a result, it is now economically viable to transfer from developed to developing countries part of the production of high-quality goods, from whose premium prices on world market all developed country workers earn a rent. While this transfer of

[6] This model is discussed more detailed in Chapter 3.

production tends to increase the wages of skilled workers, it depresses the demand and wages of unskilled workers in developed countries. This results in increased wage inequality between skilled and unskilled labour in developed countries.

Markusen and Venables (1996) argue that multinational corporations have important implications for factor returns, in addition to their implications for the volume and composition of trade. They assert that, by being able to segment activities geographically, multinationals lead to more concentration of knowledge and capital intensive production in the developed countries and more concentration of unskilled labour intensive production in developing countries. This, they conclude, raises the wages of skilled labour in the developed countries and, hence, raises skilled-unskilled wage inequality.

While most studies have emphasised the demand side, the role of labour supply on wage inequality, particularly in the US, has been reviewed by Topel (1997). Some supply factors, such as immigration and increasing female labour force participation, have the effect of increasing the relative supply of unskilled labour. Although such factors tend to press down the wages of unskilled labour, they also tend to increase the relative employment of unskilled labour, which is not observed. Education is another supply factor. It tends to increase the relative supply of skilled labour. Since there is no indication that supply factors have been major contributors to rising wage inequality, in the end Topel (1997) agrees that the change in wage structure is demand driven and that this growth in demand has outpaced the increase in supply of skills.

Another factor deemed important in influencing wage dispersion is institutional change. Fortin and Lemieux (1997) argue that institutional changes such as the decline in the real value of the minimum wage, the decline in union membership, and the trend toward economic deregulation all have affected the wage distribution in developed countries. The prevailing view, however, is that institutional factors determine the manner in which the poor performance of unskilled workers is demonstrated. In the US, where the labour market is flexible, such change in relative labour demand leads to an increase in wage inequality between skilled and unskilled labour. In the European Union (EU), where the labour market institutions are more rigid, it takes the form of higher unemployment rates among unskilled workers.

Chapter 3:

THE SPECIAL CASE OF DEVELOPING COUNTRIES:

LABOUR MARKET OUTCOMES OF OPENNESS

The theorems derived from the Heckscher-Ohlin-Samuelson (HOS) model discussed in Chapter 2 predict that openness and globalisation reduce wage inequality between skilled and unskilled labour in developing countries by increasing the demand for unskilled labour relative to the skilled. To examine whether this prediction is observed empirically, the first part of this chapter reviews some early work on the effects of openness on labour markets in developing countries. The studies reviewed yield mixed results as to the fate of unskilled labour in developing countries when these economies experienced greater openness. The second part of this chapter, therefore, reviews some possible explanations for the frequent failure of the HOS model in the developing country context.

Labour Market Outcomes of Openness

Labour market developments across developing countries tend to vary widely. These variations are greater across regions than among countries within a particular region, however. The discussion on labour market developments in this section, therefore, emphasises regional patterns. Three regions are identified explicitly: the Newly Industrialising Countries (NICs),[7] South-East Asia,[8] and Latin America. Each of these country groups has experienced distinct labour market changes. Moreover, the few

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[7] Hong Kong, South Korea, Singapore, and Taiwan.
[8] Thailand, Malaysia, the Philippines, and Indonesia.

published studies on the effects of openness on labour market in developing countries are particularly confined to these regions.[9]

The Newly Industrialising Countries

Hong Kong, South Korea, Singapore, and Taiwan are the four Asian countries that accelerated their development early in the 1950s and 1960s by embracing export oriented development strategies. Since the trend toward the opening, first of merchandise markets then of capital markets, was so prominent in these countries, they are a good starting point for a review of labour market impact of openness.

According to Fields (1984 and 1994), the patterns of labour market development in the NICs clearly follow the labour market transition theory of Lewis (1954 and 1958).[10] In the 1960s and 1970s, which are the first stages of rapid economic growth of these countries, the NICs' economies experienced a decline in the share of agriculture in employment but real wages changed little. This might be thought of as the Lewis "labour surplus" phase. Eventually, a turning point was reached and real wages in Hong Kong, South Korea, and Taiwan rose rapidly, while the share of agriculture in employment declined further. Singapore deviated from the free market approach in its labour market policy, however. The Singapore government actively delayed the rise in real wages in the 1970s through migration and guest worker programs. During this period, real wages rose only by 2 percent while real GDP rose by 9 percent (Fields, 1994). This policy was finally abandoned in 1979 because of the labour shortages it created. Meanwhile, there was a brief recession in South Korea from the late 1970s to the early 1980s. During this

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[9] Horton *et al* (1991), however, mention that white collar to blue collar wage differentials in Egypt narrowed throughout the oil boom in the 1970s and early 1980s and continued to narrow through the recession in the mid 1980s.

[10] This theory is discussed in the later part of this chapter.

period, the unemployment rate increased slightly and real wages fell. Combined with rapid growth of labour productivity, this resulted in the reduction of unit labour costs, which led to a very quick recovery of exports (Horton *et al*, 1991).

During the 1980s, the four NICs continued their rapid economic growth. In this period, however, improvements in labour standards and reductions in poverty began to occur. The data presented in Fields (1994) shows that, from 1980 to 1990, average real earnings improved. The proportion of the population living below the poverty line also declined, with South Korea as the single exception. Trend in income inequality shows reductions in the Gini coefficient in all the NICs, except in Taiwan where it had been comparatively low to begin with.

Kim and Topel (1995) find that overall wage inequality between skilled and unskilled labour in South Korea fell dramatically between 1971 and 1989. Although they find a strong causal link running from productivity growth to exports and employment, they argue that improvements in human capital is the major force that narrowed the wage differences. As high school and university graduates become more plentiful over time, their relative wages fell. Kim and Topel assert that the least skilled benefited from the educational investment of others because their own skills become relatively more scarce.

Wood (1997a), however, asserts that most of the evidence from the NICs supports the view that greater openness increases the demand for unskilled workers relative to skilled workers. He points out that when South Korea, Taiwan, and Singapore undertook a policy switch to outward orientation in the 1960s and 1970s, the gap in wages between skilled and unskilled workers narrowed during the following decade. Hong Kong, on the other hand, experienced a widening gap after the policy switch to export orientation in the 1950s. He argues, however, that it was probably the result of a simultaneously large increase in the relative supply of unskilled labour. Overall, therefore, the experience of the NICs tends to support the HOS prediction that openness is beneficial for unskilled labour in developing countries.

South-East Asia

The South-East Asian countries, particularly Thailand, Malaysia, the Philippines, and Indonesia, share several similar characteristics, including larger population and natural resource endowments compared to the NICs. They also began embracing export-oriented development strategy later than the NICs (in the 1970s and 1980s). A single exception is Thailand, which has always been relatively open since it started to modernise its economy in the 1960s (Krongkaew, 1995). The structure of labour markets in the South-East Asian countries is different from the NICs largely because of their different rates of economic growth and industrial labour absorption in the 1960s and 1970s.

According to Manning and Pang (1990), labour market problems in the South-East Asian countries arise from a rapidly growing labour force and a continued heavy concentration of employment in seasonal agriculture. After embracing export oriented industrialisation, however, these countries also started to follow in the NICs path. Employment growth in the Malaysian manufacturing sector was 24 percent per annum during 1968-73 and 12 percent during 1973-81 period. Similarly in Thailand, manufacturing employment grew at a rate of over 10 percent per annum in this period (Addison and Demery, 1988).

In his study for trade and wages in developing countries, Robbins (1996b) includes two South-East Asian Countries, Malaysia and the Philippines. He finds that openness steadily increased in Malaysia during the 1970s and 1980s and increased sharply from the end of 1980s. During the same period, the relative wage of skilled to unskilled labour in Malaysia has continued to decline. However, he attributes this declining skill premium to the increase in relative supply of skilled labour, which also occurred continuously during this period. As to the effects of openness itself, he finds that trade liberalisation is associated with an increase in the relative demand for skilled labour, and hence its relative wage, mainly due to higher imports of machinery. Similar story also applies to the Philippines. Openness in the Philippines increased in the early 1970s, but then stagnated from the mid 1970s to mid 1980s, and started to increase again in the end of 1980s. The case of Indonesia is studied in detail in Chapters 5 and 6.

Latin America

Compared to the East Asian countries, labour organisations in Latin America have relatively greater power. According to Banuri and Amadeo (1991), the right to strike in Latin American countries was recognised as early as the 1920s, although was restricted by authoritarian governments in the 1970s and 1980s. Almost all Latin American countries legislated minimum wages, mandatory cost of living allowances, and mandatory bonuses. In fact, the World Bank (1995b) states that the most serious labour market distortions in Latin America result from government intervention in setting wages. Other labour market distortions cited are high costs of dismissal, high payroll taxes, and the confrontational nature of labour-management relations.

There are two main reasons that labour is better organised in Latin America. First, in the early part of this century, most Latin American countries had relatively small and concentrated export sectors which were of critical importance in gaining foreign exchange revenues. This facilitated the forging of a national labour movement due to its ability to disrupt the entire economic and political system. Second, Latin American countries have had a very high level of urbanisation. In this situation, organised political action becomes more feasible and effective because it is difficult for the government to localise and contain conflicts.

On wage inequality between skilled and unskilled labour, Feenstra and Hanson (1996) find that the relative wages of non-production to production workers in Mexico continued to decline from the early 1960s to the mid 1980s. However, from the mid 1980s onward the wage inequality has risen again. 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 foreign investment policy reform and trade liberalisation during the 1980s. They argue that such capital inflow increases the demand for skilled workers relative to that of unskilled workers and causes the relative wages of skilled workers to rise.

Similarly, Revenga (1995) finds that tariff reductions in Mexican manufacturing during the 1980s are associated with increases in average wages, which suggests that the skill composition is shifting towards more-skilled workers. As a result, the proportion of production workers in total manufacturing employment has slightly decreased. The relative wages of non-production workers, however, have increased more dramatically than the change in workers composition. Furthermore, she finds that this skill wage differential has increased the most among the large reform industries, those with high levels of initial protection but which are now subject to greater competition.

González and McKinley (1997) also find increasing wage inequality in Mexico after the country began a major restructuring of its economy in 1985. They argue, however, that rapid trade liberalisation alone cannot explain the dramatic rise in wage inequality between skilled and unskilled labour. They point to government intervention in the labour market as an additional contributing factor to increasing wage inequality. The government has allowed the wages of skilled workers to increase substantially in order to increase the skill level of the work force, while simultaneously depressed the wages of unskilled workers in order to maintain international competitiveness. This is achieved by progressively weakening the power of labour unions through a series of measures, including privatisation.

For other Latin American countries, Robbins (1996a and 1996b) also finds that trade liberalisation in Chile, Costa Rica, Colombia, and Uruguay has led to an increase in the relative demand for skilled labour. The reason he offers is the same as for the case of South-East Asian countries. It is because trade liberalisation is associated with rising imports of machinery. Since this imported machinery embodies newer skill-biased technology, the relative demand for skilled labour rises.

The Sources of the Differences

It is clear that labour market changes in developing countries, including the trend in wage inequality and the effects of openness on it, vary widely. Finding out the sources of these differences is not an easy task. There are two factors, however, whose effects on the labour market are distinctively identifiable. The first is the development strategy adopted by governments in developing countries, while the second is the characteristics of labour supply in each country. These factors and how they shape labour market changes in developing countries are discussed further in this subsection.

Development Strategy

The views of policy makers in developing countries toward economic linkages with the rest of the world vary very considerably. However, there were obvious broad tendencies toward more "closed" economic policies during the period of 1950s to 1960s and, in most developing countries, a reversal of this trend toward more "open" policies by the 1980s and 1990s. In the 1950s and 1960s, most developing countries had just gained their independence. Their governments felt that to be really independent they had to be free from colonial inheritances, and economic relationships with developed countries were seen as a part of these colonial inheritances.

Furthermore, these new countries wanted to be on equal terms with developed countries as soon as possible. Developing country governments saw industrialisation as the fastest path to achieve that goal. However, they realised that their new established industries would not be able to compete with the already established industries in the developed countries. Worse still, there was widespread export pessimism during that period as primary product inputs per unit of output declined in industrial economies following the development of synthetic materials. Newly established industries were therefore structured to serve their domestic markets, to replace imports (Adelman, 1984).

Despite these general tendencies among developing country governments to look inward in their development process, some that were not endowed with rich natural resources were forced to adopt different development strategies. These countries, notably Hong Kong, Taiwan, South Korea, and Singapore, had to rely on exports as the basis for their development since the 1950s and 1960s. Rapid economic growth, labour absorption, and industrialisation, as experienced by these countries, become the proof of the success of this strategy (Adelman, 1984).

Countries which followed suit in embracing the export led strategy in the 1970s were the other East and South-East Asian countries such as Thailand and Malaysia. In the 1980s more developing countries followed. Indonesia, which financed its import-substitution industrialisation strategy through earnings from oil during the 1970s and early 1980s, was hit hard by the oil price fall in the early 1980s and soon began to open its economy. In the late 1970s, change in Chinese political leadership had made it possible for that country to abandon its isolation policy and become a significant player in the world market.

Export orientation strategies have been seen to result in "modern" sector high employment growth, high rates of wage increase, and (in the NICs) reductions in wage inequality. Yet, for this export orientation strategy to be successful, exports must come from industries which enjoy comparative advantage. Since developing countries are relatively abundant in unskilled labour, their comparative advantage is in unskilled labour intensive industries. By exploiting this comparative advantage through trade openness, the NICs were able to maintain a pace of labour demand increases which are higher than their labour supply growth at their original wage rates.

The import substitution strategy, on the other hand, requires heavy investment in capital intensive industries. As shown by experience, the results of this development strategy are highly dualistic development patterns, slow overall economic growth, balance of payments problems, high capital-output and capital-labour ratios in the "modern" sector, and an increasingly distribution of income (Adelman, 1984). Since the demand for unskilled labour is suppressed, this strategy does not stimulate growth in employment and the wages of unskilled workers. Consequently, the developing countries that persisted longest with this strategy remained longer in the labour surplus phase.

Wood (1997a) argues that the general trend among developing countries to adopt inward looking import substitution strategies during the 1950s to 1960s, and its reversal toward outward looking export orientation strategies in the 1980s and 1990s underlies the labour market outcomes. When the East Asian NICs liberalised their trade during the 1950s through the 1970s, other developing countries were still closed to the world trade. Their opening to trade increased the relative demand for their unskilled labour, reducing wage equality. On the other hand, when the Latin American countries liberalised their trade in the 1980s and 1990s, other low income large developing countries such as China and India have already entered the world market. This meant that the terms of trade facing the slower reformers was less favourable. This may be one reason why the associated gains to their unskilled workers were smaller.[11]

Labour Supply Characteristics

The importance of labour supply responses in determining labour market impacts of greater openness is emphasised by Pissarides (1997) and Robbins (1996a and 1996b). Pissarides (1997) focuses on the "labour surplus" phase, arguing that developing countries commonly have a large potential supply of unskilled labour, which is underemployed or discouraged due to lack of employment opportunities. The response of this potential supply to a positive shock such as greater openness and hence an acceleration in "modern" sector labour demand can be fast, certainly faster than the response of skilled labour supply which is already fully employed or needs to be trained

[11] This argument is rejected by Martin (1993) and is not further addressed in this thesis.

from unskilled labour. Therefore, when greater openness increases the demand for both types of labour, the wages of skilled labour increase faster than those of unskilled labour, resulting in a widening wage inequality. If the supply of skilled labour can catch up with the demand, however, the wage inequality is reduced again.

According to Robbins (1996b), this has been the case for several Asian and Latin American countries. He finds that increasing relative supply of skilled labour has a first-order negative impact on the relative wages of skilled labour. Hence, although these countries faced a pressure from the demand side for skilled labour relative wages to rise due to increasing capital imports, the relative wages of skilled labour in these countries have declined.

Manning and Pang (1990) find that the NICs have experienced slower population growth since the 1960s associated with rapid fertility decline. By 1980, these countries population had growth below 2 percent per year and well below 2 percent for labour force growth rates. In South-East Asian countries, meanwhile, population growth has been more varied. Thailand and Indonesia experienced declining fertility and population growth, but labour force growth has been and will likely remain high for some time. Malaysia, which officially adopts a pro-natalist policy, has had steady population growth of about 2.5 percent since the mid 1960s. The Philippines, which has cultural barriers to fertility control, retains a population growth rate above 3 percent annually.

Education expansion at primary and secondary levels started in the NICs in the 1960s. A shift in production structure toward skill intensive manufacturing and services occurred while the NICs expanded their tertiary education institutions. Rapid expansion in the numbers of educated people, especially at secondary level, is one important feature of labour supply in the South-East Asian countries. Following the experience of the

Philippines in the 1980s, a substantial "push-down" effect on the occupational distribution of educated persons in Indonesia, Thailand, and Malaysia is likely to occur in the 1990s (Manning and Pang, 1990).

Female participation in the work force has been a significant factor in increasing labour supply both in the NICs and the East Asian countries. Change has been most rapid in urban areas, where expansion in education, fertility decline, and increase in demand for young female workers has been strongest (Manning and Pang, 1990).

In Singapore, wage repression in the 1970s was associated with an inflow of foreign labour (Manning and Pang, 1990). In Malaysia, a large influx of unskilled workers from Indonesia in the 1980s and Bangladesh in the 1990s has helped maintain the competitiveness of labour intensive industries by suppressing labour costs (Athukorala and Menon, 1995). South Korea, the Philippines, Thailand, and Indonesia are countries that export manpower, particularly to the Middle East. The Philippines, meanwhile, has experienced a large outflow of skilled workers over three decades, mainly to the United States (Manning and Pang, 1990).

The characteristics of a country's labour supply, particularly its growth rate, shape much of what happens in the labour market. This is more so in developing that in developed countries because changes in population growth, structure, and educational attainment tend to be faster there. Apparently, one of the success of the NICs in their labour market is a combination of reducing labour supply growth and increasing labour demand growth. By following this strategy, the NICs were able to pass the turning point from labour surplus to labour scarcity in a relatively short time. This has positive effects on reducing wage inequality, because developing countries in labour scarce phase will be able to realise the potential effects of trade in reducing wage inequality between skilled and unskilled labour as predicted by the HOS model.

Theoretical Frameworks Alternative to HOS

As the studies discussed in the previous section indicate, there is evidence the HOS prediction, that openness is beneficial for unskilled labour in developing countries, is not always observed. This section explores some alternative theories. First, it is often argued that there is a dual labour market in developing countries and that this is associated with long term rigidity of unskilled wages. Second, the efficiency wage mechanism might work in developing countries' modern sector but not in their traditional sector. Third, neutral capital inflow increases the average capital-labour ratio of the developing economies. If skilled labour and capital are gross complements, and factor price equalisation does not apply because of product differentiation or non-tradeability, then this capital inflow would raise the skilled wage relative to the unskilled. Fourth, a capital inflow with non-neutral embodied technology which favours skilled labour. Finally, the effects of supply side factors in the labour markets of developing countries are more important than in developed countries because change in the population, and its composition, are more rapid there.

The Dual Labour Market Theory

Dual labour market theory was developed by Lewis (1954, 1958, 1972, 1979) and Fei and Ranis (1964). It takes into account the effects of the abundance of unskilled labour on the wage determination process in developing countries. According to Manning (1995a), the essential idea in this theory is that, in the early stages of development, real wages of unskilled labour are held down by an abundant supply of labour in the "traditional" sector. Real wages begin to rise only after this surplus of unskilled labour is absorbed into the "modern" sector. During the surplus labour phase, cheap labour is the main basis for capital accumulation. Consequently, during this phase, the profit share of national income rises and there are increased income disparities between capital owners on the one hand and unskilled labour on the other.

Only after labour becomes scarce in the traditional sector and, at the same time, the modern sector begins to absorb a significant share of the work force, do real wages begin to rise. A "turning point" is then reached, in which market forces dictate a shift toward more capital and skill-intensive industries. The share of profits begins to fall and that of wages to rise. As abstractions, the "labour surplus", "labour scarce", and "turning point" phases are useful for understanding of the relative bargaining power of workers, the pattern of income distribution, and the potential changes in industry structure and technology associated with economic development (Manning, 1995a). They are also important for assessing the effects of openness and globalisation on wage inequality in developing countries.

A mechanism for unskilled wage determination in a dual labour market is illustrated in Figure 3.1. It is adapted from Manning (1995b). In this figure, UU' represents the stock of unskilled labour in the economy and W is the real wage. The supply of unskilled labour in the modern sector is represented by the curve W_RS_M, which has a flat segment along W_RA, representing the reservation wage level W_R. In the traditional sector, meanwhile, the demand for unskilled labour is represented by the curve D_TD_T, which has a flat segment from the left up to point A, representing the subsistence wage level W_S. The level of wages in the modern sector, W_R, is higher than the

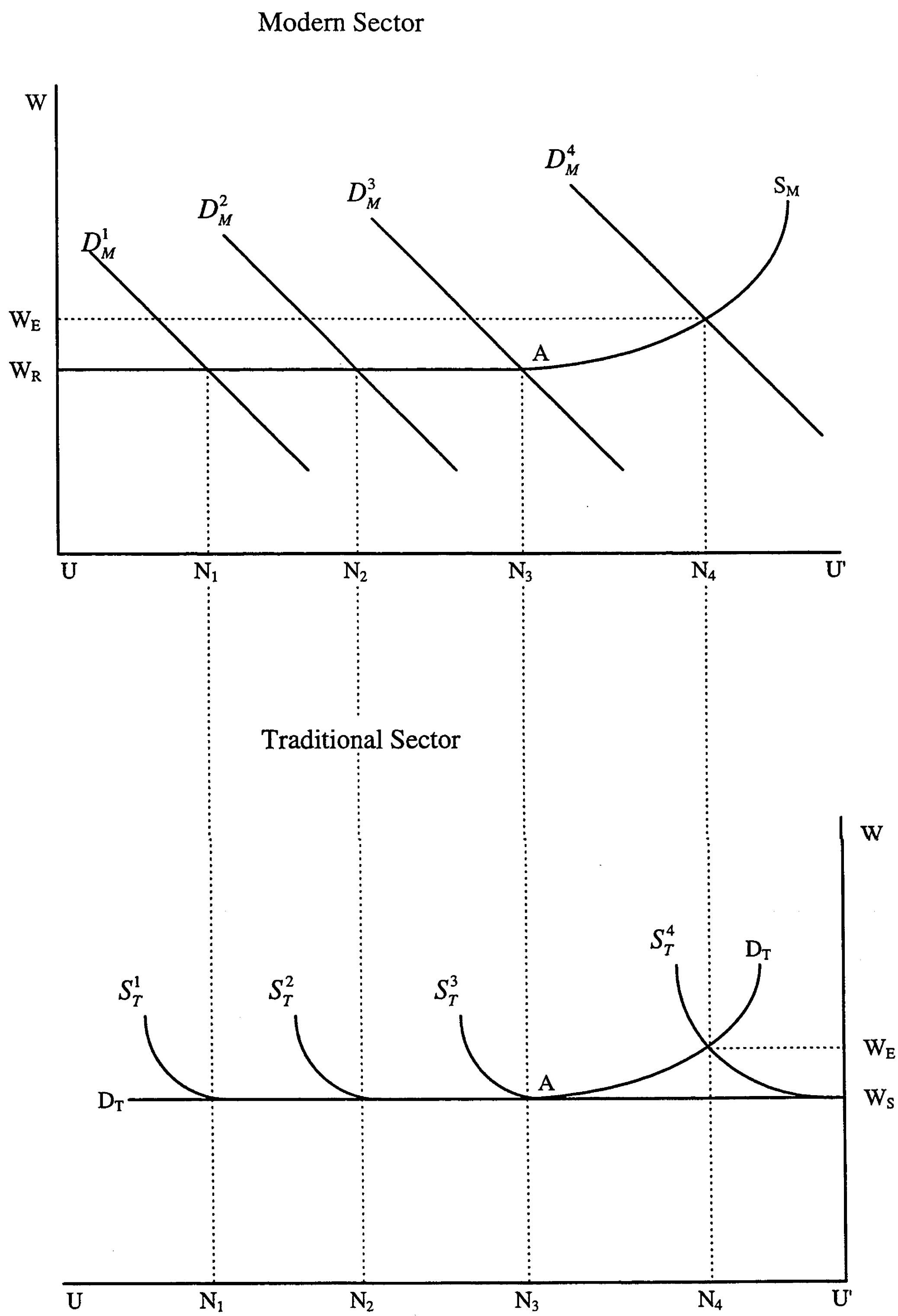

Figure 3.1:
Wage Determination for Unskilled Labour in a Dual Labour Market

Source: Manning (1995b)

subsistence level of wages in the traditional sector, W_S, as a premium to induce workers to migrate from traditional to modern sector.[12]

Originally, the demand for unskilled labour in the modern sector is D_M^1, so that the number of unskilled workers employed in the modern sector is UN_1 and they received wages W_R. The rest of unskilled labour, N_1U' is employed in the traditional sector and receives wages W_S. Suppose now the modern sector expands so that there is an increase in demand for unskilled labour, which is represented by a shift in the demand curve to D_M^2.[13] This induces some workers to move from the traditional sector to the modern sector, so that the supply of unskilled labour in the traditional sector shifts from $S_T^1 W_S$ to $S_T^2 W_S$. As the result, the number of unskilled workers in the modern sector increases to UN_2 while those who work in the traditional sector is reduced to N_2U', but there are no changes in their respective real wages.

Further increases in demand for unskilled labour in the modern sector to D_M^3 induce more workers to move from the traditional to modern sector and cause a temporary rise in the real wage in the latter. In the end, there are no net changes in real wages. However, a further increase in the demand for unskilled labour in the modern sector to D_M^4 changes not only employment but also real wages. A substantial proportion of unskilled labour, UN_4, now works in the modern sector and only N_4U' remains in the traditional sector. Assuming perfect labour mobility, the real wage level in both the modern and the traditional sector is now W_E. Point A is therefore referred to as the turning point.

[12] The wage levels cannot be lower than W_R in the modern sector and W_S in the traditional sector because they are the minimum wage levels for workers to accept employment.

[13] Lewis (1954) assumes that the modern sector expansion is a result of reinvested profits.

Todaro (1989, pp. 68-73) raises three criticisms of this model. First, if the modern sector expansion is based on unskilled labour saving technological change, then wages and employment levels of the masses of unskilled workers will largely remain unchanged. Second, the notion that surplus labour exists in the traditional sector while there is full employment in the modern sector is questionable. He argues that the reverse is more likely true in many developing countries. Third, the notion of a competitive labour market that guarantees the continued existence of constant real wages in the modern sector until the turning point where the supply of traditional sector's surplus labour is exhausted is unrealistic. He suggests that institutional factors tend to negate the competitive forces in developing country labour markets. However, he concludes that this model is valuable as a conceptual portrayal of the development process of sectoral interaction and structural change.

In most empirical studies, it has been assumed that agriculture is the "traditional" sector, while anyone who leaves the rural area is assumed to be employed in the modern sector. Bai (1982) proposes that another category should be added to the traditional sector, namely the urban-traditional sector. He argues that this sector needs to be incorporated because it has characteristics distinctive from that of the modern sector and at some point it has relatively more surplus labour than the agricultural sector. Using this framework, he concludes that the Korean economy passed its turning point around 1975.

This theory implies that the effects of openness and globalisation on the labour market in developing countries depend on whether the countries have passed the turning point or not. For a country that has not passed its turning point, increasing economic ties with the rest of the world at first benefits only workers employed in the modern sector. As the modern sector develops, its capacity to absorb labour released from the traditional sector increases. This results in higher employment but wages for unskilled labour do not change much because of the abundant supply of unskilled labour from the traditional sector. This process continues until the economy reaches its turning point. Beyond this stage, the economy moves to labour scarce phase and the supply of unskilled labour becomes more inelastic. Continuing openness and intensifying economic ties with developed countries increases modern sector employment further. But this time it is accompanied by increases in real wages for unskilled labour and, therefore, reduces wage inequality. At this stage, the economy has developed into low-skill labour-intensive industrial economy. Therefore, only after reaching this stage, a developing economy can fully gain from its trade with developed countries as predicted by HOS model theorems.

Interestingly, Lydall (1975) finds that the lower the degree of development, the greater the number of modern sector jobs in developing countries associated with a given increase in exports. This is probably related to the very elastic labour supply in the early stage of development. In addition, it is important to note that the transition from labour surplus to labour scarcity, accompanied by increasing modern sector employment and real wages works smoothly only if the market is allowed to operate without distortions. For example, Fields and Wan (1989) find that this has been the case for East Asian economies, while the presence of wage setting institutions in Latin American countries has hampered this process.

This theory has also been applied in a computable general equilibrium framework. For example, Chichilnisky (1981) develops a North-South trade model, where the South economy has abundant labour and a dual production structure. The abundance of labour in the South is specified in the form of a very elastic supply of labour. Also, the South economy has different capital-labour ratios across sectors. In this model, higher exports from the South to the North causes a worsening terms of trade in the South and increasing factor price inequality across regions. Chichilnisky argues that, although this result contradicts the conventional wisdom on this matter, it seems closer to the truth. This leads her to conclude that a strong domestic market with the associated high productivity and real wages provides a better basis for a long-term export growth than the cheap and abundant labour supported by widespread poverty.

The Efficiency Wage Theories

Efficiency wage theories offer approaches to explaining why firms are willing to pay workers above the competitive labour market equilibrium wage. These theories offer an explanation of persistent real wage rigidities in the presence of involuntary unemployment where no effective minimum wage or other rigidity exists. In a departure from standard microeconomic models, the theories employ a production function that has labour used in efficiency units, where these not only depend on the number of workers but also their level of effort. Furthermore, this level of effort, hence productivity, is positively related to the real wage. Therefore, the effect of labour on output is determined by both the number of workers hired as well as the wage rate. Because of the positive relationship between wages and productivity, the wage rate becomes endogenous to the firm which chooses an optimal wage rate to maximise profit. Firms therefore choose wage rates that minimise their average cost per unit of efficiency labour. Once the efficiency wage rate is determined, the firm hires as many workers and other inputs as required to produce the maximising level of output. If, at the efficiency wage level, the supply of labour exceeds demand, then involuntary unemployment will occur.

An important implication of the efficiency wage mechanism is that firms react to macroeconomic shocks by altering employment, not wages (Riveros and Bouton, 1994). Suppose firms in developing countries employ efficiency wage mechanism. This means that workers are paid above the prevailing competitive wage level. Now suppose that due to greater openness, demand for unskilled labour intensive goods increase. Firms react by increasing employment of the unskilled labour, but not necessarily their wages. As a result, there may be no reduction in wage inequality between skilled and unskilled labour despite greater relative demand for unskilled labour.

Technology-Neutral Capital Inflow

During the past three decades, developing countries have experienced a massive increase in foreign direct investment. This capital inflow can have some effects on wage inequality in developing countries. Depending on the model one has in mind, the effects could be to increase or reduce wage inequality between skilled and unskilled labour. In Chapter 2, a model by Feenstra and Hanson (1996) is briefly described and shows how capital inflow to developing countries could widen wage inequality in both developed and developing countries. This model is elaborated further in this section.

Feenstra and Hanson (1996) assume that there is one good produced both in developed and developing countries, using a continuum of intermediate goods that are produced using unskilled labour, skilled labour, and capital. It is assumed that developing countries are relatively abundant in unskilled labour, so that the skilled to unskilled wage ratio is higher in this region. In addition, it is assumed that developing countries have less capital stock, so that the return to capital is higher in this region. This implies that the range of intermediate goods that are relatively intensive in unskilled labour are produced in developing countries, while the range of intermediate goods that are relatively intensive skilled labour are produced in developed countries.

Suppose there is a relaxation of assumption allowing capital movement, so that capital flows from developed to developing countries. At the new equilibrium, a range of intermediate goods which formerly were produced in developed countries now are produced in developing countries. This range of intermediate goods are more skilled labour intensive than the range of intermediate goods which were originally produced in developing countries, but they are still less skilled labour intensive than the range of intermediate goods now produced in developed countries. As the result, the relative demand for skilled labour in both developed and developing countries increases and, consequently, the skilled to unskilled wage ratio in both regions increases. Furthermore, assuming the supply of labour responds to the relative wage, the ratio of skilled to unskilled labour employed in production in both region increases.

Embodied Skill-Intensity in Imported Capital

The issue of skill-intensity embodied in capital flowing to developing countries is also important in assessing the effects of openness on their labour markets. If the capital flowing to developing countries requires a high level of skills to utilise it in the production process, then the relative abundance of unskilled labour available in developing countries serves to depress the unskilled labour wages. On the other hand, if the capital does not require too much skill to utilise it in the production process, then unskilled labour is drawn into the modern sector at a greater rate with a positive effect on their wages.

Studies in developed countries usually do not question the ability or the compatibility of labour to be mixed with capital in the production process. It is commonly assumed that developed countries' labour forces can match whatever skill level is required by capital. Gordon (1995), for example, in assessing the trade-off between unemployment and productivity growth between the United States (US) and the European Union (EU) finds that much of the productivity growth advantage of the EU over the US is explained by convergence and more rapid capital accumulation.

Such an assumption is not automatically applicable in developing countries. For example, a case study on foreign direct investment (FDI) in Malaysia by Athukorala and Menon (1995) shows that the type of capital which comes to this developing country gradually changes from time to time. At first, FDI in Malaysia was limited only to the primary sector, mainly in tin mines and rubber plantations. This form of capital inflow did not require a high level of skills and was easily mixed with unskilled labour in the production process. Later, the FDI came in the form of light manufacturing, which required labour with basic skill. Now that the education level in Malaysia has much improved, FDI in sectors which require much higher skills are beginning to materialise.

According to Harrison (1994), FDI could facilitate technology transfer through three avenues. First, new technology may not be commercially available and innovating firms may refuse to sell their technology. Therefore, allowing these firms to invest in developing countries may be the best means to facilitate technology transfer. Second, foreign investments may provide the competition necessary to stimulate technology diffusion, particularly if local firms are protected from foreign competition. And third, foreign firms may provide a form of worker training that cannot be replicated in domestic firms or purchased from abroad, such as managerial skills. In addition, Aitken *et al*

(1996) explain that technology diffusion from multinational corporations to domestic firms may take place by way of training of suppliers, imitation by domestic firms, or labour mobility from foreign to domestic firms

A study of Mexico and Venezuela, also by Aitken *et al* (1996), finds that foreign investments are associated with higher wages for workers in the foreign owned firms. These wage differentials persist even after taking into account several control variables, such as firm size, geographic location, skill mix, and capital intensity. This means that it seems plausible to assume that foreign firms have technologies with higher skill requirements and, therefore, that they hire workers with higher skills than the average domestic firms. Their estimation results also indicate that the effect of foreign investment on raising wages is greater for skilled labour than for unskilled labour. These wage differentials imply that the skill-intensity embodied in imported capital is likely to increase wage inequality in developing countries.

A similar conclusion is reached by Markusen and Venables (1996) using a model of multinationals. They find that, when the barrier to FDI is removed, multinationals shift a part of their production activities from developed to developing countries. This results in geographically segmented activities, where there is more concentration of knowledge and capital intensive production in developed countries and more concentration of unskilled labour intensive production in developing countries. However, they find that if the difference in relative skill endowment between developed and developing countries is moderate to large, the relative wage of skilled workers still increases.

Technology Transfer Through Trade

Pissarides (1997) argues that trade can become an avenue for technology transfer from developed to developing countries. He explains that technology transfer does not always require a flow of capital goods from developed to developing countries, but can also take place in the form of the production in developing countries of capital goods that were previously only produced in developed countries. His key assumption, however, is that such technology transfers require the services of skilled labour and not of unskilled labour.

His model indicates that even if the technology transferred is neutral, it will still result in widening wage inequality between skilled and unskilled workers in developing countries because the process requires the services of skilled labour only. This is then reflected in higher relative wages for skilled labour for the duration of transition. This advantage for the skilled labour, however, is temporary. Once this transition ends, the relative wage is back to its original position. If the technology transferred is biased in favour of skilled labour, however, the widening wage inequality resulted will be permanent.

Skill-Biased Technological Change

Tan and Batra (1997) argue that technology plays a vital role in shaping the inter-firm structure of wages in developing countries. Although they agree that exporting can become an avenue for technological progress in developing countries, they argue that the more important sources for technological progress are research and development and worker training. Using firm level data from Colombia, Mexico, and Taiwan, they find that technology investments lead to large wage premiums for skilled workers but not for unskilled workers. This technology-skill complementarity implies that investment in technology generating activities in developing countries could contribute to increasing wage inequality between skilled and unskilled labour.

Supply Side Factors

As the labour market transition theory suggests, the speed with which a country's turning point is reached depends on the relative pace of labour demand and labour supply growth. If labour demand grows faster than labour supply, such as suggested by the NICs experience, then the turning point is achieved in a relatively short time. On the other hand, if labour supply growth matches or exceeds the growth of labour demand, as in some South-East Asian countries, then the labour surplus phase will be longer.

The growth of labour demand is largely determined by the growth in economic activity, particularly that which is labour intensive. Greater openness forces the realisation of a developing country's comparative advantage and hence positively affects labour demand. The effects of openness on the labour market, however, also depend on the corresponding behaviour of labour supply. Although labour demand and labour supply are not independent, some factors have been known to more strongly affect labour supply.

The first is the rate of population growth. Higher fertility means larger labour supply at a later period. Economic growth first reduces death rates and then reduces fertility later following the "demographic transition". As a result, population growth first rises and later falls again. In the pre-development period, countries have low population growth because high birth rates are matched by equally high death rates. At the first stage of development, improvements in basic public health lower the death rates. Since the birth rates stay high, this period is characterised by high population growth. Further development raises the costs of children while reducing the services they provide for the family. Lower birth rates finally return population growth to low rates again.

The second factor affecting labour supply is education expansion. On the one hand, education expansion holds up the growth of labour supply by retaining people who would otherwise enter the job market at early ages in schools. On the other hand, education expansion has been recognised as positively affecting female participation in the work force. Besides its effects on the quantity of labour supply, education expansion also affects the quality of labour supply through its skill upgrading effects. Kim and Topel (1995), for example, argue that the increase in relative supply of skilled labour is more important than the increase in relative demand for unskilled labour in explaining the reduction in wage inequality between skilled and unskilled labour in South Korea during the 1970s and 1980s.

Third, as has been mentioned above, female labour force participation increases. In most traditional societies, most women do not market their labour. At an early stage of development, such women are induced to enter the labour market by both push and pull factors. The most important push factor is increasing family need for cash due to monetisation in the rural areas which is brought about by development process. Another important push factor is, as already mentioned above, better education opportunities for women, which further encourages women to enter the labour market. On the other hand, development of labour intensive industries in the urban areas becomes an important pull factor for women to work. In terms of the relative supply of skill, increasing labour force participation by women is thought of as increasing relative supply of unskilled labour, for which there is clear evidence even in the developed country case (Topel, 1997).

The fourth factor is international migration. The importance of this factor is not widespread across all developing countries, however. In most cases, developing countries are the source for out migration of unskilled workers either to developed countries, such as from Mexico to the US, or to another developing countries, such as from Indonesia and Bangladesh to Malaysia or the Middle East. In the latter case, the receiving countries usually have passed the turning point and are in the labour scarce phase. Some developing countries, however, have experienced brain-drain in the form of out migration of skilled workers, as in the case of the Philippines in the late 1970s and early 1980s.

Labour supply in developing countries has a more important impact on labour markets compared with developed countries. At early stages of development, many of these supply side factors serve to offset the reduction in wage inequality induced by greater openness as predicted by the HOS model. As a result, it is possible that developing countries will experience increasing wage inequality despite trade liberalisation.

The importance of the labour supply response in determining the skilled-unskilled labour relative wage outcome from trade liberalisation is also emphasised by Pissarides (1997). As in the Lewis model, he argues that developing countries have a large potential supply of unskilled labour, which is waiting for an opportunity to enter modern sector employment. The response of this supply to a positive shock is fast. The response of skilled labour supply is slower because such workers are already employed in the modern sector and additional skilled workers require training. Therefore, when trade liberalisation increases the demand for both skilled and unskilled labour, the wage of skilled workers increases faster than the wage of unskilled workers because of their different supply responses. He argues, however, that in the long run, the supply of skilled labour will catch up and reduce wage inequality.

Chapter 4:

QUANTITATIVE EXTENSIONS TO THE THEORY: A STYLISED GENERAL EQUILIBRIUM APPROACH

As discussed in Chapter 2, the theorems derived from the Heckscher-Ohlin-Samuelson (HOS) model predict that openness and globalisation reduce wage inequality between skilled and unskilled labour in developing countries. As discussed in Chapter 3, however, this prediction may not be observed in reality in spite of greater openness in developing countries during the last three decades. Possible opposing influences include duality in the labour market, the efficiency wage mechanism, capital movements, technological change, and the supply side factors in developing country labour markets. Each of these is associated with one or more violations of HOS assumptions.

Falvey *et al* (1995) show that, when the HOS assumptions are relaxed by introducing multiple goods and factors and differentiation of imports from home produced goods, the HOS results on factor rewards are weakened. In particular, they invalidate the factor price equalisation theorem. This means that, although Rybczynski effects might be observed following factor endowment changes, factor reward changes will now also occur. Hence, while capital accumulation in developing countries might cause the non-capital-intensive sectors to shrink, it might also reduce the real return to capital relative to both the skilled and the unskilled wage. This in turn might change the relative wage of skilled to unskilled labour. The relative wage will rise, for example, if the skill-intensive sector is also the most capital-intensive. A dual labour market breaks the fixed factor supply assumption, an efficiency wage mechanism breaks the homogeneity of factors by introducing effort, and technological change breaks the common technology assumption.

The objective of this chapter is to generalise from the HOS model predictions as to the trends in wage inequality in developing countries when there is greater openness and technological change. Following Falvey *et al* (1995), a two-region model is developed with the standard HOS specification. Then, this specification is relaxed by incorporating non-tradeable services as an additional economic sector and three factors of production (skilled labour, unskilled labour, and capital). Then, to relax further the HOS specification, product differentiation is introduced into the model by making imports imperfect substitutes for domestically produced goods. In addition, a dual labour market closure is employed to examine whether or not labour market duality in developing countries affects the predicted changes in wage inequality.

The intent is to extend the pure theory into areas beyond those for which analytical solutions are possible. This is done by developing model specifications that combine realism with analytical intractability and then solving the system numerically. The global (two-region) computable general equilibrium (CGE) model developed here clearly defines intersectoral as well as intercountry economic links, thus providing a useful tool for measuring the transmitted effects of shocks between the internationally traded product markets and domestically confined labour markets.

Richardson (1995) observes that there is increasing agreement on the necessity to give a prominent role to the general equilibrium perspective in the analysis on the connections between trade, technology, and wage inequality. This view is supported by Tyers *et al* (1997), who argue for economy wide analysis, so that arbitrariness in selecting endogenous and exogenous variables can be avoided. Moreover, not only does the analysis flow naturally from the HOS framework, but also the proposed explanations can thereby be examined in a consistent setting.

Previous Quantitative General Equilibrium Studies of Labour Market Effects

Openness and technological change and their impacts on labour markets have been the focus of several general equilibrium analysis. These include Falvey *et al* (1995), Lejour *et al* (1997), McDougall and Tyers (1994 and 1997), Minford *et al* (1997), and Tyers and Yang (1997). They focus on the developed countries and, except for Minford *et al* (1997), all conclude that openness is not the main cause of wage inequality increases. Biased technological change is found to be the dominant factor in the declining demand for unskilled labour. Minford *et al* (1997), meanwhile, conclude that the roles of trade and technology are roughly equal.

McDougall and Tyers (1994 and 1997) use an adaptation of the Global Trade Analysis Project (GTAP) model and data base (Hertel, 1997; Hertel and Tsigas, 1993). They find that the surge of labour intensive exports from the rapidly developing economies reduces the wage-rental ratio in the older industrial countries (Australia, North America, European Union). The results imply a shift in the composition of labour demand in the industrial economies against low-skill workers, but the effect is quite modest. Hence, they conclude that the main force behind the declines in the relative unskilled wage in developed countries is technological change.

Similarly, Tyers and Yang (1997), who use a further modified version of the GTAP model and data base, find that although trade with the rapidly developing economies in Asia may have contributed a small amount of increased urban wage dispersion in the older industrial countries, skill upgrading appears to have been the dominant cause. The reason is that skill upgrading affects primary factor demand more directly than does trade competition. Moreover, non-tradeable services sectors, in which skill upgrading has also occurred contribute more than half of these developed countries' gross domestic product (GDP). Hence, the effect of skill upgrading is more widespread than trade competition.

Lejour *et al* (1997) use the WorldScan (World Scenario Analysis) model, which is also calibrated to the GTAP data base. They find that although trade liberalisation impairs the position of unskilled workers in developed countries, it is not the main reason for increasing wage inequality. In any case, they find that increasing wage inequality is mitigated by the shift from non-tradeables to tradeables. Hence, they argue that domestic factors, such as asymmetric technological change and education, are more important in explaining increasing wage inequality than international factors.

The model used by Minford *et al* (1997), meanwhile, is based on the HOS model and it retains homogeneous products. Nonetheless, four modifications are made. First, some factors of production are sector specific depending on the degree of international market integration. Second, a non-traded goods sector is incorporated into the model. Third, it is assumed that technology is superior in the developed countries and that it is transferred to the developing countries in a catching up process, which responds both to the physical ease of transfer and to the legal and physical environment in the developing countries. Fourth, the supply of factors is assumed elastic.

The world is divided into two regions (North and South), where each region has three traded industries (agriculture, manufactures, and services) and one non-traded goods sector. There are three immobile factors (labour, human capital, and land) and two mobile factors (capital and raw materials). The technology is Cobb-Douglas. The North is calibrated to represent the OECD countries, while the South is all non-OECD countries except the former Soviet bloc. The simulation results show that a combination of globalisation and technological change shocks can account for around 90 percent of the variation in the world economy's trend behaviour during the 1970-90 period. Of the effects on labour markets in the North, 60 percent is due to technological change and 40 percent to trade. Hence, they conclude that both factors are important in explaining developed country labour market experience.

Falvey *et al* (1995) use a stylised two-region model to generalise the HOS results. Their objective is to understand why the HOS effects take the (often small) magnitudes that are suggested by most general equilibrium studies. In general, their findings confirm that the changes in factor returns attributable to the effects of increasing openness are compressed substantially by departures from the HOS model, including most prominently multiple goods and factors, differentiated products, and non-traded goods sectors. In the remainder of this chapter, an approach similar to this is employed to explore further generalisations, this time as they affect developing countries.

A Stylised Global Database

The point of departure is the stylised two-region data base of Falvey *et al* (1995). The first step in the formation of this data base is to represent an identical two-region global economy, where one region is called "developed countries" and the other is called "developing countries". Both regions produce and consume three commodities: an unskilled labour intensive good, a skilled labour intensive good, and non-traded services. There is a one to one relationship between producing industry (sector) and commodity. There are three factors of production: unskilled labour, skilled labour, and capital. In addition, each production process requires intermediate inputs of all three types, acquired from both domestic firms and imports. The distribution of value added across industries and factors in this data base is shown in Table 4.1.

Table 4.1:
Distribution of Value Added in Each Region in the Identical Two-Region Data Base (%)

Factor of Production	Industry: Unskilled labour intensive good	Industry: Skilled labour intensive good	Industry: Non-traded services	Total
Unskilled labour	8.0	8.0	24.0	40.0
Skilled labour	4.0	4.0	12.0	20.0
Capital	8.0	8.0	24.0	40.0
Total	20.0	20.0	60.0	100.0

Source: Stylised preliminary data base discussed in the text.

GDP is divided between consumption, investment, and government expenditure in the proportions of 45:40:15. Household final demand for goods is split between the unskilled labour intensive good, the skilled labour intensive good, and non-traded services in the proportions of 20:20:60. Imports to meet final demand are 20 percent of total consumption in the two tradeable goods sectors. Overall factor costs are divided between unskilled labour, skilled labour, and capital in the proportions of 40:20:40. Government expenditure is financed by a 25 percent income tax levied on skilled and unskilled labour.

To create a stylised global data base suitable for this study, the identical two-region data base is shocked twice to differentiate technology across sectors and factor endowments across regions. First, the unskilled to skilled labour demand ratio in the unskilled labour intensive industries is doubled, as is the skilled to unskilled labour demand ratio in the skilled labour intensive industries. The model solves for a new data base where relative factor intensities are now consistent with the industry labels assigned. Second, this new data base is then shocked again by making the skilled to unskilled labour supply ratio in the developed region five times higher and, simultaneously, the unskilled to skilled labour supply ratio in the developing region five times higher. These factor abundance shocks make the developed region relatively abundant in skilled labour, while the developing region becomes relatively abundant in unskilled labour. The new asymmetric database thus created, is hereafter called the stylised global data base. The distribution of value added in this stylised global data base is shown in Table 4.2.

Table 4.2:
Distribution of Value Added in the Stylised Global Data Base (%)

Factor of Production	Industry			Total
	Unskilled labour intensive good	Skilled labour intensive good	Non-traded services	
Developed countries:				
Unskilled labour	8.4	6.7	24.2	39.2
Skilled labour	2.1	6.7	12.1	20.8
Capital	7.0	8.9	24.2	40.0
Total	17.4	22.2	60.4	100.0
Developing countries:				
Unskilled labour	10.7	5.3	24.0	40.0
Skilled labour	2.7	5.3	12.0	20.0
Capital	9.0	7.1	24.0	40.0
Total	22.4	17.6	60.0	100.0

Source: Synthesis discussed in the text.

Model Specification

The model used has the main features of that adopted by Falvey *et al* (1995). In models which run on the Gempack computer software, such as the one used in this study, the linearised equations which define the model specification are specified in a so called "Tablo" input file (Harrison and Pearson, 1993). The key equations which specify the model used in this study (which is called the "basic model" for simplicity) are defined in the first part of this chapter's appendix, while the specification of Tablo input file which is used to run the model is provided in the first section of Thesis Appendix. The main features of this model are described briefly below.[14]

The specification of demand side of the model is illustrated in Figure 4.1. Each region consists of a single household with a Cobb-Douglas utility function of three composites: private household expenditure, government expenditure, and saving. Because the utility function is Cobb-Douglas, each of its components retains a constant share of regional income. The private household and government components of expenditure are specified as a Cobb-Douglas function of a composite of commodities.[15] Saving is committed to the global composite commodity "capital goods", which is produced in turn from the identified goods and services. After the demand for each commodity is determined, the decomposition of traded goods into home goods and imports is implemented using the Armington approach (Armington, 1969). Imports are thereby differentiated from home produced goods via an elasticity of substitution that is different for each good.

[14] The formulation is a much simplified version of the GTAP model, which is discussed in depth by Hertel (1997).

[15] The private household expenditure is actually specified as a constant difference elasticity (CDE) function (Hanoch, 1975), but the parameters used for this study (presented in the second part of this chapter's appendix) collapse this to a Cobb-Douglas function. The CDE specification is used in the version of the model adapted in Chapter 7.

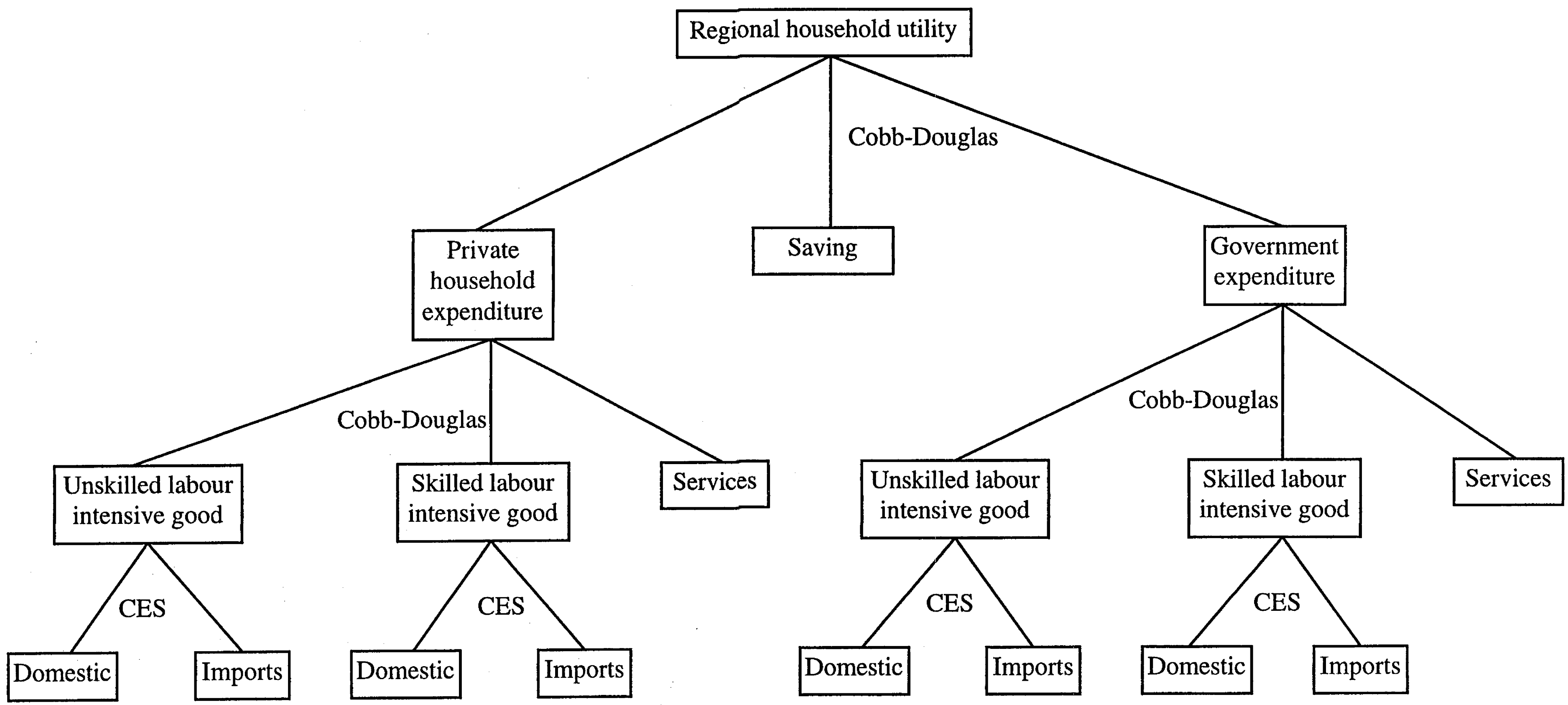

Figure 4.1:
Demand Structure

The specification of supply side of the model is illustrated in Figure 4.2. Firms are perfectly competitive with constant returns to scale. They use a Leontief production function to combine a composite of intermediates and a composite of primary factors. The composite of intermediates is derived from a constant elasticity of substitution (CES) production function (Arrow *et al*, 1961), as is the composite of primary factors. In each industry and in each region a single elasticity of substitution determines the subdivision of value added among primary factors. For the analysis of this chapter, all factor substitution elasticities are set to unity, collapsing the CES to Cobb-Douglas functions. Intermediate demand for each traded commodity is also decomposed into home goods and imports using the Armington approach in line with the treatment of final demand.

The quantity of global investment is equal to global savings, which is the sum of all regional savings. The regional distribution of investment expenditure, however, need not be equal to the pattern of savings. The allocation of regional investment is governed by a closure which requires the convergence of the expected rate of return on investment across regions. Expected rates of return diminish exponentially with the volume of investment. This means that returns on current fixed capital differ from those on investment whenever it is allocated unequally between the regions. Capital is therefore mobile internationally, but income from fixed capital accrues only within region.

Skilled and unskilled labour are region-specific factors that are imperfectly transformable. The overall labour supply is determined exogenously and the allocation of supply between types is determined according to a constant elasticity of transformation (CET) function. For the analysis discussed in this chapter, however, by specifying a negligible elasticity of transformation, such transformation is practically prohibited,

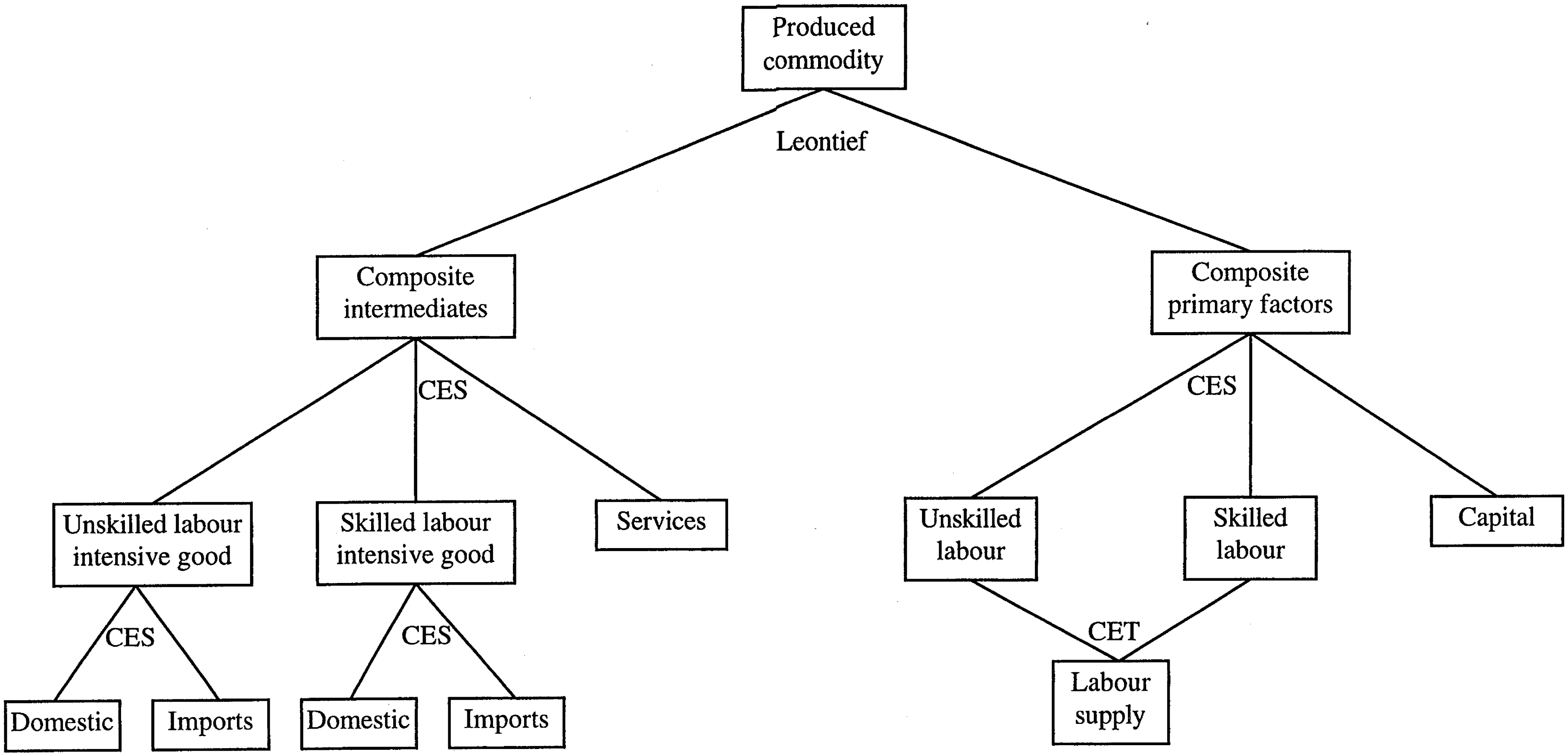

Figure 4.2:
Supply Structure

implying exogenous supply of each type of labour. Parameter values used in this study are based on Falvey *et al* (1995) and presented in Table A4.1 in the second part of this chapter's appendix.

To take into account the possibility of the existence of a dual labour market in the developing region as discussed in Chapter 3, a dual labour market closure is used in each model simulation in addition to the standard integrated labour market closure. In the dual labour market closure, the real wage of unskilled labour is set exogenously, making the supply of unskilled labour perfectly elastic. This extreme specification implies that the traditional sector (outside the model) comprises subsistence households able to relinquish labour at a reservation wage without impact on their output.[16]

Openness and Technological Change Shocks

As described earlier, the objective of this chapter is to generalise the HOS model predictions about wage inequality in developing countries following trade liberalisation and technological change. In this exercise, the trade liberalisation reduces tariff equivalents in skilled labour intensive imports. Technological change shocks are of two types: neutral and biased. Neutral technological change is represented by an increase in total factor productivity in the unskilled labour intensive industry. Biased technological change, meanwhile, is represented by a reduction in the demand for unskilled labour in the unskilled labour intensive industry. Finally, an increase in the developing region's capital endowment is also simulated to examine its effects on wage inequality.

[16] A more plausible approach would incorporate a large unskilled labour intensive traditional sector that is technically efficient but from which labour might be drawn to a smaller modern sector with only modest effect on the real wage. This approach is adopted in the model used in Chapter 7.

Trade Liberalisation

Trade protection is usually given to industries which are intensive in the region's relatively scarce factors. The autarky prices of these factors are always higher than the corresponding free trade prices. Such industries, it is commonly argued, contribute some positive externality, either private or public, so that they need to be protected from import competition. Because developing countries are relatively scarce in skilled labour and capital, trade protection has commonly been given to industries intensive in these factors. In Indonesia in 1987, for example, the effective rate of protection in manufacturing sector (excluding oil and gas) was 86 percent, while in the agriculture sector it was only 24 percent (Fane and Condon, 1996). Hence, the most highly protected industries are those in which Indonesia's comparative advantage is least. Trade liberalisation in developing countries therefore reduces the protection given to industries that are relatively intensive in skilled labour or capital.

To simulate this type of trade liberalisation in developing countries, the stylised data base is shocked by completely removing a 10 percent *ad valorem* tariff on the skilled labour intensive good imports in developing countries. Because there is no tariff in the stylised global data base, the experiment is actually done by applying a 10 percent *ad valorem* tariff on skilled labour intensive good import in the developing region. The effects of removing this tariff are obtained by reversing the signs of the simulation results. The experiment is implemented twice, first using the integrated labour market closure (fixed supplies of each labour type, endogenous real wages) and then using the dual labour market closure (fixed supply of skilled labour, endogenous skilled real wage, fixed unskilled real wage, endogenous unskilled labour supply). The effects on real factor returns are presented in Table 4.3, while those on other selected variables are presented in Table A4.4 in the chapter appendix.

Table 4.3:
Changes in Real Factor Returns in Developing Region from Removing a 10 Percent Tariff on Skilled Labour Intensive Imports (%)

	Labour Market Closure	
Factor of Production	Integrated	Dual
Unskilled labour	0.88	0.00
Skilled labour	-0.32	0.23
Capital	0.48	1.02

Source: Model simulations discussed in the text.

With the integrated labour market closure, the prediction given by the Stolper-Samuelson theorem that trade liberalisation in developing countries will benefit unskilled labour still holds. The simulation results in the first column of Table 4.3 show that the removal of an *ad valorem* tariff on skilled labour intensive imports in developing countries leads to an increase in the real wage of unskilled labour and, on the other hand, a decrease in the real wage of skilled labour. This implies that trade liberalisation, by itself, in the developing region reduces wage inequality between skilled and unskilled labour.

The removal of a tariff on skilled labour intensive imports reduces the import price of this good by slightly less than the tariff removed, as shown in Table A4.4. This cheaper price of import competition leads to substitution in final and derived demand and a surge in the importation of this good. At the same time, it reduces its domestic production and sales. The output reduction reduces demand for both skilled and unskilled labour. The factors of production released from this industry are then absorbed mostly by the newly expanding export-oriented unskilled labour intensive industry. Increasing demand for both skilled and unskilled labour in this industry is associated with the expansion of this industry's output and exports. Meanwhile, a small downward adjustment in the production of non-tradeable services also takes place.

Similar adjustments in the developed region result in the contraction of unskilled labour intensive good production, hence pushing up the import price of this commodity in the developing region. Meanwhile, in the developing region, the increase in skilled labour intensive imports is proportionally much larger than the reduction in its domestic production. Hence, skilled labour intensive exports from this region also increase albeit from a small base, practically resulting in greater intra industry trade.

The fall in the import price of the skilled labour intensive good is transmitted into developing region's domestic market price. Substitution then pressures the domestic price of other goods to decrease, resulting in a lower consumer price index. Since there are no other taxes, and transportation costs are assumed zero, the lower domestic traded good prices are fully transferred to their respective export prices. Hence, the index of prices received for tradeables in the developing region decreases, while on the other hand the index of prices paid for the same commodities increases. This results in an unfavourable change in the terms of trade. This is because the regions are of roughly equal size and so both are "large" economies and "optimal tariff" effects are substantial. Therefore, removing the tariff shifts the terms of trade adversely and causes the loss of aggregate income and welfare. The loss of aggregate income is what reduces demand for non-traded services.[17]

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[17] This result parallels the export pessimism stories of the 1950s and 1960s and it motivated the work on the fallacy of composition issue by Martin (1993). It is not the focus of the analysis presented here.

In the dual labour market closure the real wage of unskilled labour is held fixed by its perfectly elastic supply. The simulation results in the second column of Table 4.3 show that this causes trade liberalisation to actually increase the real wage of skilled labour, which means that now the wage ratio of skilled to unskilled labour increases. In other words, the presence of a dual labour market makes the removal of a tariff on skilled labour intensive imports in developing countries actually increases wage inequality. But the real winners now are capital owners because elastic unskilled labour supply makes capital the scarce factor.

Although the presence of a dual labour market does change the direction of the effects of trade liberalisation on wage inequality, it does not change the directions of the effects on other variables, as shown in Table A4.4. There is now a larger increase in the demand for unskilled labour by the unskilled labour intensive industry and a smaller decrease in the demand by skilled labour intensive industry. Consequently, now there is also a larger increase in demand for skilled labour by the unskilled labour intensive industry and a smaller decrease in demand in the skilled labour intensive industry. The changes in industries' demands for factors of production are reflected in the changes in output. Now there is a larger increase in the production of the unskilled labour intensive good, a smaller decrease in the production of the skilled labour intensive good, and a slight increase in the production of non-traded services.

Neutral Technological Change

Developing countries are relatively abundant in unskilled labour and, therefore, have a comparative advantage on unskilled labour intensive goods. This means that, after they open to trade, new capital inflow and technology is likely to be directed to those industries. Because of this, neutral technological change in developing countries is likely to occur, initially at least, in the form of higher total factor productivity in the unskilled labour intensive sector.

To simulate the effects of this type of technological change, the stylised global data base is subjected to a 10 percent total factor productivity increase in the unskilled labour intensive industry in the developing region. This shock means that the same level of usage of factors of production employed in the unskilled labour intensive industry now can produce 10 percent more output. As before, the experiment is also conducted twice, first using the integrated and then the dual labour market closure. The effects on real factor returns are presented in Table 4.4, while those on other selected variables are presented in Table A4.5 in the chapter appendix.

Table 4.4:
Changes in Real Factor Returns in Developing Region from a 10 Percent Neutral Technological Progress in Unskilled Labour Intensive Industry (%)

	Labour Market Closure	
Factor of Production	Integrated	Dual
Unskilled labour	4.52	0.00
Skilled labour	3.17	6.02
Capital	4.07	6.88

Source: Model simulation discussed in the text.

With the integrated labour market closure, neutral technological progress leads to higher real returns to all factors. The simulation results in the first column of Table 4.4 show that the real wage of unskilled labour increases by more than that of skilled labour. This implies that neutral technological change in the unskilled labour intensive sector reduces wage inequality between skilled and unskilled labour. The reason is that even though now the unskilled labour intensive industry needs fewer factors to produce the same level of output, overall demand for unskilled labour rises, as shown in Table A4.5. This is caused by two effects. First, as the price of unskilled labour intensive good falls, exports and consumption rise, so that unskilled labour demand in the unskilled labour intensive industry falls by less than the productivity change. Second, lower price of this good means cheaper inputs in other sectors. This reduces costs, stimulating output and labour demand in the other sectors.

The increase in output of the unskilled labour intensive industry and its lower product price not only increases this good's domestic sales and exports, but also reduces competing imports. The decrease in output of the skilled labour intensive good, on the other hand, reduces this good's domestic sales and exports, hence its imports increase. The price changes result in almost the same decline in the indices of prices received and paid for tradeables, hence the terms of trade changes only slightly. Higher factor productivity in the developing region increases the real returns to these factors, which in turn increase regional real income. More income means more expenditures and utility in the region is increased. Higher income, however, also bids up the price of non-tradeable services, which in the end pushes up the overall consumer price index.

When there is a dual labour market, even higher productivity does not increase the real wage of unskilled labour. As shown by the simulation results in the second column of Table 4.4, now skilled labour enjoys a much larger increase in its real wage compared to when the labour market is integrated, which leads to an increase in the wage ratio between skilled and unskilled labour. This means that, if there is a dual labour market, even neutral technological progress in the unskilled labour intensive industry can lead to a higher wage inequality between skilled and unskilled labour. In addition, capital owners now also enjoy a larger return.

When the rise in unskilled labour demand caused by the increase in unskilled labour productivity can no longer cause its real wage to increase, the unskilled labour intensive industry's demand for this factor now increases, as shown in Table A4.5. As a result, the rate of increase in this industry's output is now much higher than the rate of increase in overall productivity. A similar factor demand pattern is also observed in the non-traded services sector, which also experiences a large increase in its output. Meanwhile, in the skilled labour intensive sector there is now a much smaller reduction in demand for unskilled labour, resulting in a much smaller decline in its output.

The greater increase in output of the unskilled labour intensive good leads to a larger increase in its domestic and export sales as well as a larger decline in competing imports. On the other hand, the smaller decline in the output of the skilled labour intensive good leads to smaller reductions in its domestic and export sales. Yet imports of this good increase more because of a larger increase in its production in the developed region. The price changes embody an unfavourable change in the developing region's terms of trade. In spite of the larger returns to skilled labour and capital, the constant return to unskilled labour ensures that there is a smaller increase in regional real income and welfare.

Biased Technological Change

Unskilled labour saving technologies have been widely identified as one important factor contributing to reduced demand for unskilled labour and the subsequent widening of wage inequality between skilled and unskilled labour in the developed countries. With openness and globalisation, new technologies permeate across countries more easily. Therefore, it is important to assess what would happen to wage inequality were such unskilled labour saving technologies to be adopted in developing countries.

To simulate this biased technological change, the unskilled labour intensive industry in the developing region is subjected to a 10 percent rise in unskilled labour productivity. The implication of this new technology is that, at the same product and factor prices, the same level of output in this industry can now be produced using 10 percent less unskilled labour and the same levels of usage of other inputs. The effects on real factor returns are presented in Table 4.5, while those on other selected variables are presented in Table A4.6 in the chapter appendix.

Table 4.5:
Changes in Real Factor Returns in Developing Region from a 10 Percent Less Demand for Unskilled Labour in the Unskilled Labour Intensive Industry (%)

	Labour Market Closure	
Factor of Production	Integrated	Dual
Unskilled labour	0.81	0.00
Skilled labour	1.80	2.31
Capital	1.14	1.64

Source: Model simulations discussed in the text.

The simulation results in the first column of Table 4.5 show that, with the integrated labour market, the introduction of unskilled labour biased technology in the unskilled labour intensive industry in developing countries leads to an increase in the real wage of unskilled labour which is smaller than the increase in the real wage of skilled labour. This means that the wage ratio between skilled and unskilled labour increases and, therefore, implies that a diffusion of unskilled labour saving technologies to developing countries would cause increased wage inequality between skilled and unskilled labour.

The technological change in the unskilled labour intensive industry leads to an expansion of this sector and a contraction of the skilled labour intensive sector, as shown in Table A4.6. In the unskilled labour intensive industry, although the demand for unskilled labour decreases per unit of output, the output expansion causes the demand for this factor to actually increase. Because the technological change is biased against unskilled labour, however, the skilled labour demand in this industry increases by a large proportion. The skilled labour intensive industry contracts because it has to give up both skilled and unskilled labour to the expanding unskilled labour intensive industry. Smaller adjustments, meanwhile, take place in the services sector, where its output and unskilled labour demand increase but its skilled labour demand decreases.

The changes in product prices and outputs then lead to predicted changes in domestic as well as international sales. The domestic sales and exports of unskilled labour intensive good increase, while its imports decrease. On the other hand, the domestic sales and exports of the skilled labour intensive good decrease, while its imports increase. Reflecting the lower cost of production due to the technological change in the unskilled labour intensive industry, the market price of this industry's output falls while other good prices increase, resulting in a slight increase in the consumer price index. The market prices of tradeable goods are fully transferred to their export prices while import prices fall, resulting in a slight increase in the terms of trade. Regional real income and utility both increase.

When there is a dual labour market, the real wage of unskilled labour cannot go up. They simply increase their overall supply. This is shown by the simulation results in the second columns of Tables 4.5 and A4.6. This means that unskilled labour is cheaper in the dual story. There is therefore more expansion of the unskilled labour intensive industry and less contraction of the skilled labour intensive industry. The net effect of this on the real wage of skilled labour is that its increase is larger. Hence, the presence of a dual labour market enhances the effects of biased technological change on increasing wage inequality between skilled and unskilled labour. In addition, capital owners now gain more since there is, overall, more labour with which to combine the capital.

The fact that real wage of unskilled labour is sticky upward, effectively making it less expensive than in the integrated case, increases the demand for this factor by the whole economy. This means that there is an addition of some unskilled labour to the modern sector from the traditional sector. As before, the unskilled labour intensive industry demands more skilled labour, bidding up its real wage and inducing the other industries to release some of the skilled labour they employed. The effects on other variables are also qualitatively the same as in the integrated labour market case.

Increase in Capital Endowment

The past decade witnessed an accelerating inflow of capital to developing countries. This, combined with high domestic savings, resulted in an extraordinary rate of capital accumulation.[18] To examine the effects of this capital accumulation on wage inequality between skilled and unskilled labour, an exogenous increase in the capital stock by 10 percent is introduced into the stylised data base. As before, the simulations

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[18] Indeed, Krugman (1994) have suggested this is the dominant source of growth in East Asia.

are conducted twice, first using the integrated and then the dual labour market closure. The effects on real factor returns are presented in Table 4.6, while those on other selected variables are presented in Table A4.7 in the chapter appendix.

Table 4.6:
Changes in Real Factor Returns in Developing Region from a 10 Percent Increase in Capital Stock (%)

Factor of Production	Labour Market Closure	
	Integrated	Dual
Unskilled labour	3.73	0.00
Skilled labour	3.83	5.86
Capital	-5.67	-3.89

Source: Model simulation discussed in the text.

As shown by the simulation results in the first column of Table 4.6, when the labour market is integrated, an increase in the capital stock has a practically neutral effect on wage inequality between skilled and unskilled labour. Real wages of both types of labour increases by almost the same percentage, although that of skilled labour tend to increase slightly more. This is not surprising since, as indicated by value added distribution in Table 4.2, all sectors have equal capital intensity. The effect on real return to capital is, as expected, negative.

More capital makes it possible for all industries to expand their outputs, as shown in Table A4.7. The increase in output of all industries is transmitted into increases in domestic and export sales. Imports, however, also has to increase to meet increasing demand for intermediate goods by industries. Increasing supplies then depress the domestic and export prices of all commodities, but increasing demand for imports bids up their import prices. Hence, while the index of prices received for tradeables declines, the index of prices that have to be paid for the same commodities increases, resulting in an unfavourable change in terms of trade. However, the increase in outputs is more than enough to compensate this, so that real income and utility still both increase.

When there is a dual labour market, the potential gain for unskilled labour is completely offset by its perfectly elastic supply, resulting in an increase in the employment of unskilled labour by all industries. As the simulation results in the second columns of Tables 4.6 and A4.7 show, the potential gain for unskilled labour is then distributed to skilled labour and capital owners. Hence, when there is a duality in the labour market, an increase in capital stock in the developing economy increases wage inequality between skilled and unskilled labour in this region.

Since now both capital and unskilled labour stocks increase, all industries experience an even higher increase in production. This is achieved, among other things, by a greater reallocation of skilled labour by the services sector to the other two sectors. The effects on domestic and international trade is basically the same as in the first case, except that the magnitudes of trade increase become much higher. Another exception is that imports of unskilled labour intensive good now decline due to a much higher increase in domestic production of this commodity. The effects on prices, terms of trade, real income, and utility is also similar as when the integrated labour market closure is used. The failure of real wage of unskilled labour to increase, however, slightly reduces the increase in real income and utility.

An Alternative Model

The data base used in the previous section is structured so that both tradeable goods are equally capital intensive. The two wage rates therefore give a neutral effect of an increase in capital endowment in developing countries on wage inequality between skilled and unskilled labour. This result supports neither the proposition that foreign direct investment (FDI) to developing countries will reduce wage inequality because capital which flows into developing countries is suitable for unskilled labour (Wood, 1994), nor the contrary proposition that FDI will increase wage inequality because it embodies unskilled labour saving technologies (Feenstra and Hanson, 1996).

What these studies suggest is that there are different types of capital, some of which are "friends" of, or gross complement to, unskilled labour and some others are its "enemies" or its gross substitutes. To examine the effects of such different types of capital, an alternative model is used in this section. This alternative model maintains the same demand structure as the previous one, as illustrated in Figure 4.1. The supply structure, as illustrated in Figure 4.2, retains the composite intermediates branch on the left side of the tree. But the composite primary factors branch is modified to incorporate two different types of capital. For want of better terms, they will be entitled "simple capital" and "sophisticated capital".

The modification of this primary factors composite is illustrated in Figure 4.3. In this alternative supply structure, firms firstly determine a mix of unskilled labour and simple capital to create an unskilled composite and, simultaneously, determine a mix of skilled labour and sophisticated capital to create a skilled composite. Then firms determine the mix of the two composites to create a composite of all the primary factors used. Finally, as in the previous model, firms determine the mix of this primary factor

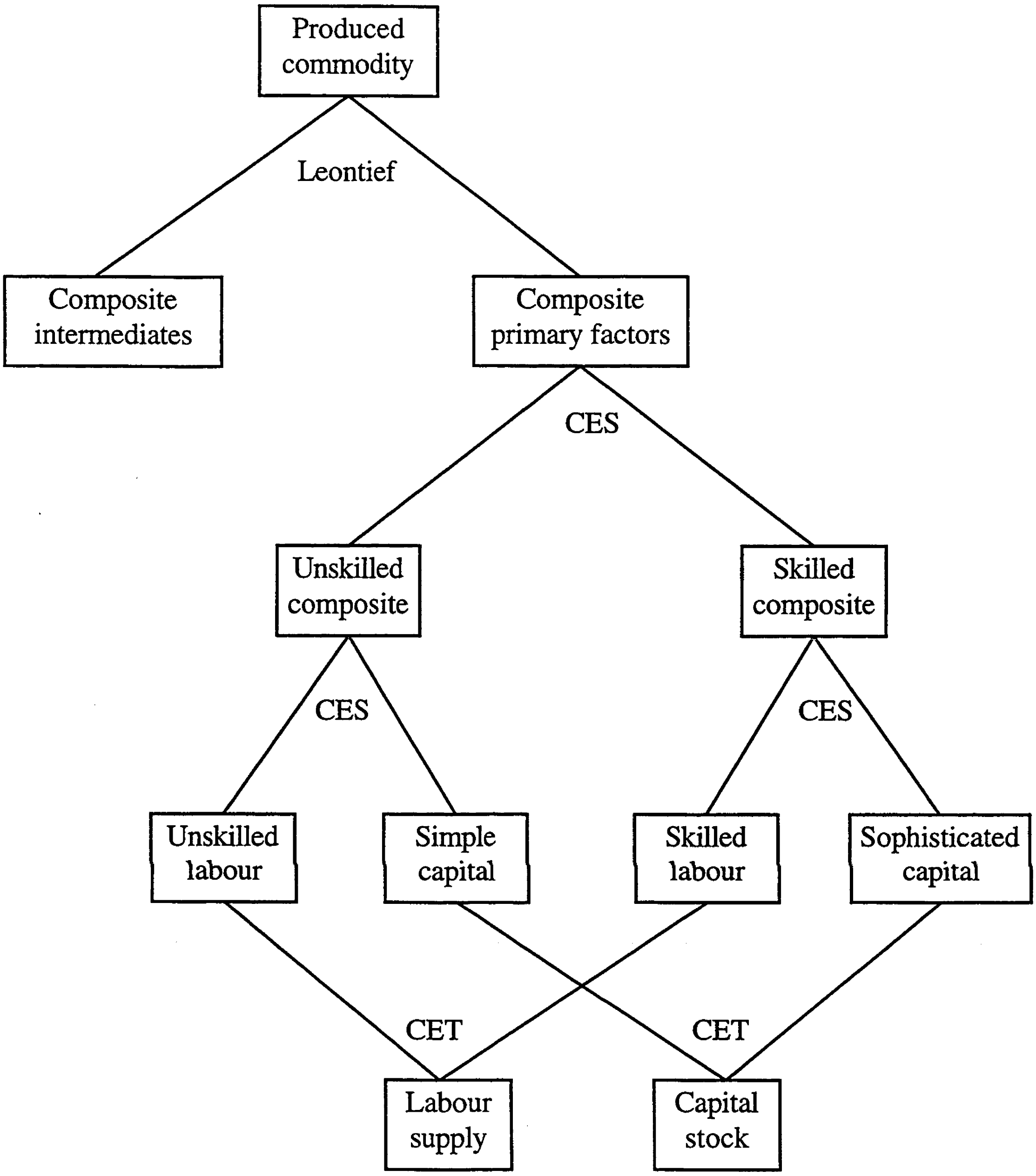

Figure 4.3:
Supply Structure in the Alternative Model

composite with the unaltered composite of intermediate goods. The treatment of the total capital supply is analogous to the that of total labour supply used in the previous model. The two types of capital are imperfectly transformable, via a CET function.

The data base for this alternative model is modified from the stylised global data base used previously, where capital value added is divided into the two types of capital in the same proportions as labour value added is divided between skilled and unskilled. The distribution of value added in the new data base is shown in Table A4.2 in the chapter appendix. The parameter values used for this are also the same as the ones used for the previous model.

In addition, Table A4.3 in the chapter appendix gives the chosen substitution elasticities between unskilled factors, skilled factors, and between the unskilled composite with the skilled composite. The choice of 0.5 for the elasticity of substitution between unskilled labour and simple capital makes the two factors complementary to each other. The same complementarity applies to skilled labour and sophisticated capital. The production structure described by Figure 4.3 and the low substitution elasticity used make simple capital a gross complement of unskilled labour and sophisticated capital a gross complement of skilled labour. Meanwhile, the substitution elasticities between the skilled and unskilled composites are set at 1.5, which in effect makes the skilled and unskilled composites gross substitutes. The choice of these magnitudes for factor substitution elasticities based on the survey by Dixon *et al* (1992, p. 220). As in the case of labour transformation, for the purpose of this analysis the elasticity of transformation between the two types of capital is set so low as to practically prohibit any transformation between them.

All the shocks introduced in the previous section are here reapplied to the alternative model. The shock of increasing the capital endowment, however, now becomes two different shocks, the first increasing simple capital endowment and the second increasing sophisticated capital endowment. The effects of all these simulations on real factor returns are shown in Table 4.7. Each shock is also implemented twice, first using the integrated and then the dual labour market closure.

The simulation results in Table 4.7 for trade liberalisation, neutral technological change, and biased technological change show no important change over the results reported in Tables 4.3 to 4.5.[19] This means that, for the integrated labour market case, trade liberalisation and neutral technological change reduce wage inequality between skilled and unskilled labour, while biased technological change increases it. For the dual labour market case, again all shocks result in increasing wage inequality.

The complementarity between unskilled labour and simple capital and between skilled labour and sophisticated capital force the changes in real returns for each pair to be same across factors. Except that when there is a biased technological change, capital endowment is increased, or the dual labour market closure is used, one or both pairs do not have the same changes in real returns. Interestingly, the results for biased technological change in the integrated case are the same as in the dual labour market case. This suggests that the effects of technological change and output expansion on unskilled labour demand exactly offset each other.

[19] The results for variables other than the real factor returns are not presented. They, however, show no important change either.

Table 4.7:
Changes in Real Factor Returns in Developing Region from Various Shocks Using the Alternative Model (%)

	Labour Market Closure	
	Integrated	Dual
Trade Liberalisation:		
Unskilled labour	0.75	0.00
Skilled labour	-0.06	0.17
Simple capital	0.75	1.61
Sophisticated capital	-0.06	0.17
Neutral Technological Change:		
Unskilled labour	4.37	0.00
Skilled labour	3.46	4.76
Simple capital	4.37	9.49
Sophisticated capital	3.46	4.76
Biased Technological Change:		
Unskilled labour	0.00	0.00
Skilled labour	1.06	1.06
Simple capital	2.58	2.57
Sophisticated capital	1.06	1.06
Increase in Simple Capital Endowment:		
Unskilled labour	5.02	0.00
Skilled labour	1.23	2.52
Simple capital	-8.94	-3.94
Sophisticated capital	1.23	2.52
Increase in Sophisticated Capital Endowment:		
Unskilled labour	0.51	0.00
Skilled labour	3.56	3.71
Simple capital	0.51	1.08
Sophisticated capital	-7.61	-7.48

Source: Model simulation discussed in the text.

Meanwhile, the neutral effect of an increase in the capital endowment observed using the previous model (as presented in the first column of Table 4.6), wherein capital intensities were identical, does not hold when there are different types of capital. The simulation results show that when the simple capital endowment increases, wage inequality tends to decrease because the increase in the real wage of unskilled labour is much greater than that of skilled labour. On the other hand, when the sophisticated capital endowment which increases, wage inequality tends to increase because the increase in real wage of unskilled labour is much smaller than that of skilled labour. This means that the effects of an increase in the capital stock are determined by whether the additional capital stock is a "friend" of skilled or unskilled labour.

Hypotheses on Wage Inequality in Developing Countries

Based on the effects of the openness and technological change shocks on wage inequality quantified in the two previous sections, some hypotheses concerning wage inequality in developing countries can be synthesised. First, if the labour market is integrated, then trade liberalisation, neutral technological change, and an increase in the "simple" capital endowment all reduce wage inequality. Technological change that is biased against unskilled labour and an increase in the "sophisticated" capital endowment, on the other hand, both increase wage inequality. Second, if there is a duality in the labour market, then all economic shocks increase wage inequality.

Chapter Appendix

Key Equations of the Model

Regional household utility:

$$U_r = A_r E_r^{\alpha_r} G_r^{\beta_r} S_r^{(1-\alpha_r-\beta_r)}$$

U_r = household utility in region r

A_r = region specific shift term

E_r = private household expenditure in region r

G_r = government expenditure in region r

S_r = saving in region r

α_r, β_r = Cobb-Douglas parameters (shares of regional income)

r = index: developed countries, developing countries

Private household expenditure:

$$\sum_i B_{ir} U_{pr}^{\gamma_{ir}\chi_{ir}} \left[\frac{P_{ir}}{E(P_r, U_{pr})} \right]^{\gamma_{ir}} \equiv 1$$

B_{ir} = commodity and region specific shift term

U_{pr} = prespecified level of private household utility in region r

P_{ir} = private household price of commodity i in region r

P_r = vector of private household prices in region r

$E(\bullet)$ = minimum expenditure required to attain U_{pr} given P_r

γ_{ir} = CDE substitution parameter

χ_{ir} = CDE expansion parameter

i = index: skilled labour intensive good, unskilled labour intensive good, services

Government expenditure:

$$G_r = D_r \prod_i G_{ir}^{\lambda_{ir}}$$

$$\sum_i \lambda_{ir} = 1$$

D_r = region specific shift term

G_{ir} = government expenditure on commodity i in region r

λ_{ir} = Cobb-Douglas parameter (expenditure share)

First stage production function:

$$X_{ir} = \min(\Omega_r N_r, \Psi_r F_r)$$

X_{ir} = output of commodity i produced in region r

N_r = composite of intermediate inputs in region r

F_r = composite of primary factors in region r

Ω_r, Ψ_r = Leontief technology parameters

Composite of intermediate inputs:

$$N_r = H_r \left[\sum_i \delta_{ir} N_{ir}^{\rho_r} \right]^{1/\rho_r}$$

$$\sum_i \delta_{ir} = 1$$

H_r = region specific shift term

N_{ir} = commodity i used as intermediate input in region r

δ_{ir}, ρ_r = CES technology parameters

Composite of primary factors:

$$F_r = M_r \left[\sum_k \theta_{kr} F_{kr}^{\eta_r} \right]^{1/\eta_r}$$

$$\sum_k \theta_{kr} = 1$$

M_r = region specific shift term

F_{kr} = primary factor j used in region r

θ_{kr}, η_r = CES technology parameters

k = index: skilled labour, unskilled labour, capital

Demand decomposition into domestic good and import:

a. Composite price index:

$$P_{cir} = P_{dir}^{\Theta_{ir}} P_{mir}^{1-\Theta_{ir}}$$

P_{cir} = composite price index of commodity i in region r

P_{dir} = domestic price of commodity i in region r

P_{mir} = import price of commodity i in region r

Θ_{ir} = weight index parameter

b. Demand for domestic good:

$$Q_{dir} = Q_{cir} \left[\frac{P_{cir}}{P_{dir}} \right]^{\sigma_i}$$

Q_{dir} = demand for domestic commodity i in region r

Q_{cir} = demand for composite commodity i in region r

c. Demand for imported good:

$$Q_{mir} = Q_{cir}\left[\frac{P_{cir}}{P_{mir}}\right]^{\sigma_i}$$

Q_{mir} = demand for imported commodity i in region r

Data Base and Parameter Values

Table A4.1:
Parameter Values in the Basic Model

Parameter	Value
Substitution parameter of the CDE expenditure function	0.5
Expansion parameter of the CDE expenditure function	1.0
Import-domestic substitution elasticity	5.0

Note: These parameter values apply to all goods in both regions

Table A4.2:
Distribution of Value Added in the Data Base for the Alternative Model (%)

Factor of Production	Sector: Unskilled labour intensive good	Skilled labour intensive good	Non-traded services	Total
Developed countries:				
Unskilled labour	8.4	6.7	24.2	39.2
Skilled labour	2.1	6.7	12.1	20.8
Simple capital	5.6	4.4	16.1	26.1
Sophisticated capital	1.4	4.4	8.1	13.9
Total	17.4	22.2	60.4	100.0
Developing countries:				
Unskilled labour	10.7	5.3	24.0	40.0
Skilled labour	2.7	5.3	12.0	20.0
Simple capital	7.2	3.5	16.0	26.7
Sophisticated capital	1.8	3.5	8.0	13.3
Total	22.4	17.6	60.0	100.0

Table A4.3:
Substitution Elasticites in the Alternative Model

Produced Commodity	Unskilled Commodities Substitution Elasticity	Skilled Commodities Substitution Elasticity	Skilled-Unskilled Composite Substitution Elasticity
Unskilled labour intensive good	0.5	0.5	1.5
Skilled labour intensive good	0.5	0.5	1.5
Service	0.5	0.5	1.5
Capital goods	0.0	0.0	0.0

Simulation Results

Table A4.4:
Changes in Developing Region from Removing a 10 Percent Tariff on Skilled Labour Intensive Imports (%)

	Labour Market Closure	
	Integrated	Dual
Output:		
Unskilled labour intensive good	4.17	4.87
Skilled labour intensive good	-4.61	-4.06
Services	-0.20	0.32
Industry Demand for Unskilled Labour:		
Unskilled labour intensive industry	3.88	5.29
Skilled labour intensive industry	-5.16	-3.56
Services	-0.60	0.77
Total employment	0.00	1.43
Industry Demand for Skilled Labour:		
Unskilled labour intensive industry	5.02	5.07
Skilled labour intensive industry	-3.91	-3.80
Services	0.60	0.54
Total employment	0.00	0.00
Domestic Sales:		
Unskilled labour intensive good	2.83	3.54
Skilled labour intensive good	-8.72	-8.10
Services	-0.20	0.32
Imports:		
Unskilled labour intensive good	-10.95	-11.24
Skilled labour intensive good	19.18	19.42
Exports:		
Unskilled labour intensive good	8.50	9.17
Skilled labour intensive good	15.65	15.90
Market Prices:		
Unskilled labour intensive good	-1.06	-1.21
Skilled labour intensive good	-1.82	-1.80
Services	-1.24	-1.33
Consumer price index	-1.56	-1.64
Price of Imports:		
Unskilled labour intensive good	1.59	1.64
Skilled labour intensive good	-8.04	-7.97

Table A4.4:
Continued

	Labour Market Closure	
	Integrated	Dual
Price of Exports:		
Unskilled labour intensive good	-1.06	-1.21
Skilled labour intensive good	-1.82	-1.80
Terms of Trade:		
Index of prices received for tradeables	-1.46	-1.54
Index of prices paid for tradeables	0.75	0.78
Terms of trade	-2.21	-2.32
Income and Utility:		
Regional real income	-0.47	-0.49
Per capita utility	-0.86	-0.90

Source: Model simulations discussed in the text.

Table A4.5:
Changes in Developing Region from a 10 Percent Neutral Technological Progress in Unskilled Labour Intensive Industry (%)

	Labour Market Closure	
	Integrated	Dual
Output:		
Unskilled labour intensive good	10.21	14.24
Skilled labour intensive good	-9.42	-6.57
Services	2.70	5.29
Industry Demand for Unskilled Labour:		
Unskilled labour intensive industry	-0.14	7.41
Skilled labour intensive industry	-9.93	-2.35
Services	2.25	9.40
Total employment	0.00	6.81
Industry Demand for Skilled Labour:		
Unskilled labour intensive industry	1.17	1.31
Skilled labour intensive industry	-8.75	-7.89
Services	3.59	3.19
Total employment	0.00	0.00
Domestic Sales:		
Unskilled labour intensive good	7.83	11.60
Skilled labour intensive good	-7.40	-4.37
Services	2.70	5.29
Imports:		
Unskilled labour intensive good	-17.48	-19.58
Skilled labour intensive good	21.61	22.74
Exports:		
Unskilled labour intensive good	17.90	22.79
Skilled labour intensive good	-19.38	-17.41
Market Prices:		
Unskilled labour intensive good	-7.55	-8.33
Skilled labour intensive good	4.10	4.13
Services	4.65	4.11
Consumer price index	1.86	1.44
Price of Imports:		
Unskilled labour intensive good	-2.47	-2.12
Skilled labour intensive good	-1.42	-0.94

Table A4.5:
Continued

	Labour Market Closure	
	Integrated	Dual
Price of Exports:		
Unskilled labour intensive good	-7.55	-8.33
Skilled labour intensive good	4.10	4.13
Terms of Trade:		
Index of prices received for tradeables	-0.74	-1.16
Index of prices paid for tradeables	-0.79	-0.57
Terms of trade	0.05	-0.59
Income and Utility:		
Regional real income	5.07	4.95
Per capita utility	5.57	5.34

Source: Model simulation discussed in the text.

Table A4.6:
Changes in Developing Region from a 10 Percent Less Demand for Unskilled Labour in the Unskilled Labour Intensive Industry (%)

	Labour Market Closure	
	Integrated	Dual
Output:		
Unskilled labour intensive good	2.11	2.79
Skilled labour intensive good	-4.18	-3.68
Services	0.44	0.91
Industry Demand for Unskilled Labour:		
Unskilled labour intensive industry	0.14	1.50
Skilled labour intensive industry	-3.78	-2.39
Services	0.77	2.04
Total employment	0.00	1.29
Industry Demand for Skilled Labour:		
Unskilled labour intensive industry	10.19	10.23
Skilled labour intensive industry	-4.71	-4.59
Services	-0.21	-0.27
Total employment	0.00	0.00
Domestic Sales:		
Unskilled labour intensive good	2.08	2.75
Skilled labour intensive good	-3.36	-2.82
Services	0.44	0.91
Imports:		
Unskilled labour intensive good	-2.07	-2.39
Skilled labour intensive good	7.26	7.51
Exports:		
Unskilled labour intensive good	2.19	2.91
Skilled labour intensive good	-8.26	-7.95
Market Prices:		
Unskilled labour intensive good	-1.73	-1.87
Skilled labour intensive good	1.44	1.45
Services	1.54	1.45
Consumer price index	0.77	0.70
Price of Imports:		
Unskilled labour intensive good	-0.91	-0.86
Skilled labour intensive good	-0.66	-0.58

Table A4.6:
Continued

	Labour Market Closure	
	Integrated	Dual
Price of Exports:		
Unskilled labour intensive good	-1.73	-1.87
Skilled labour intensive good	1.44	1.45
Terms of Trade:		
Index of prices received for tradeables	0.11	0.04
Index of prices paid for tradeables	-0.34	-0.31
Terms of trade	0.45	0.35
Income and Utility:		
Regional real income	1.42	1.39
Per capita utility	1.62	1.57

Source: Model simulations discussed in the text.

Table A4.7:
Changes in Developing Region from a 10 Percent Increase in Capital Stock (%)

	Labour Market Closure	
	Integrated	Dual
Output:		
Unskilled labour intensive good	3.85	8.60
Skilled labour intensive good	4.63	9.12
Services	3.68	4.44
Industry Demand for Unskilled Labour:		
Unskilled labour intensive industry	0.00	7.63
Skilled labour intensive industry	0.76	9.25
Services	-0.16	3.97
Total employment	0.00	5.35
Industry Demand for Skilled Labour:		
Unskilled labour intensive industry	-0.10	1.67
Skilled labour intensive industry	0.65	3.20
Services	-0.27	-1.79
Total employment	0.00	0.00
Domestic Sales:		
Unskilled labour intensive good	4.21	7.64
Skilled labour intensive good	4.89	8.62
Services	3.68	4.44
Imports:		
Unskilled labour intensive good	0.50	-7.06
Skilled labour intensive good	1.16	3.46
Exports:		
Unskilled labour intensive good	2.70	11.74
Skilled labour intensive good	3.34	11.59
Market Prices:		
Unskilled labour intensive good	-0.38	-1.70
Skilled labour intensive good	-0.34	-0.97
Services	-0.41	-1.55
Consumer price index	-0.33	-1.26
Price of Imports:		
Unskilled labour intensive good	0.34	1.23
Skilled labour intensive good	0.38	1.39

Table A4.7:
Continued

	Labour Market Closure	
	Integrated	Dual
Price of Exports:		
Unskilled labour intensive good	-0.38	-1.70
Skilled-labour intensive good	-0.34	-0.97
Terms of Trade:		
Index of prices received for tradeables	-0.35	-1.34
Index of prices paid for tradeables	0.17	0.58
Terms of trade	-0.52	-1.92
Income and Utility:		
Regional real income	2.20	1.80
Per capita utility	2.11	1.48

Source: Model simulation discussed in the text.

Chapter 5:

THE CASE OF INDONESIA'S MANUFACTURING SECTOR: TRADE AND INVESTMENT LIBERALISATION AND THE EVOLUTION OF THE LABOUR MARKET

The simulation results in Chapter 4 show that if a developing country has the economic structure assumed and an integrated labour market, then trade liberalisation, neutral technological change, and an increase in capital endowment of the type which is gross complement to unskilled labour tend to reduce wage inequality between skilled and unskilled labour. Meanwhile, technological change which is biased against unskilled labour and an increase in capital endowment of the type which is gross complement to skilled labour tend to will increase it. On the other hand, if there is Lewis type duality in the developing country's labour market, all openness and technological change shocks result in increased wage inequality. General patterns such as these are investigated empirically in this and the next chapter using data from Indonesia's manufacturing sector.

The manufacturing sector has been the driving force behind the surge of Indonesia's non-oil exports since the mid 1980s. These non-oil exports made up 77 percent of all Indonesian exports in 1995, while the manufacturing sector provided 24 percent of gross domestic product (GDP) in the same year. This sector, therefore, has been at the forefront in increasing trade and investment openness in Indonesian economy during the past decade. Moreover, it is a sector diverse in product variety, technology, and capital intensity, providing low-skill labour intensive products such as textile, as well as sophisticated machinery such as motor vehicles. Thus, if openness and globalisation have affected wage inequality between skilled and unskilled workers in Indonesia, it should be reflected in this sector. To facilitate understanding of the data presented, a background on the overall Indonesian economy and its labour market developments precedes the analysis.

Background: The Evolution of the Economy

Indonesia entered a rapid economic growth phase following the launching of its first five-year development plan in 1969. Since then the country's economy has undergone significant changes. With an average real GDP growth of around seven percent annually during the 1967-95 period, Indonesia holds its place with the other rapidly growing East Asian economies. Since it started from a very low position, however, its per capita income remains still far below its neighbours in absolute terms. In 1967, Indonesia's per capita income was around US$ 50 and it was one of the poorest countries in the world (Agrawal, 1996). According to Indonesia's Central Agency of Statistics (*Badan Pusat Statistik* or BPS), per capita income in 1995 reached US$ 1,023. Hill (1996, p. 5) estimates that between 1965 and 1991 the real GDP *per capita* increased from 190 to 610, measured in 1991 US$, which constitutes growth of 4.6 percent annually.[20]

Growth Phases

Since the late 1960s, economic development in Indonesia can be divided into three phases. The first is from the late 1960s to mid 1970s, where Indonesia's "New Order" regime embraced trade and investment policies which were remarkably open for the period. In 1967, a foreign investment law that guaranteed foreign investors the right

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[20] Starting in mid 1997, Indonesia is hit by a financial crisis that caused substantial contraction and continues to impair its performance in 1998. For preliminary discussions on the Indonesian crisis, see Johnson (1998), McLeod (1998), and Soesastro and Basri (1998).

to repatriate capital and profits was passed. In 1970, there were reforms that reduced the existing barriers to goods trade and foreign borrowing by unifying the multiple exchange rate system and abolishing most of the exchange controls on capital and current account transactions. According to Aswicahyono *et al* (1996), the government's adherence to reasonably open trade and investment policies during this period was a legacy of the abrupt change in economic policy beginning in the mid 1960s.

The second phase is from the mid 1970s to the mid 1980s, where Indonesia adopted an inward-looking import-substitution strategy. Awash with revenue from oil exports, the government was eager to build capital intensive industries to replace imports. In addition, it spent a large sum of money in building infrastructure, in particular to support agricultural development. Not surprisingly, the role of the public sector in the economy's growth was dominant during this period. Aswicahyono *et al* (1996) argue that this change of policy resulted from tremendous internal pressure on the government to embark on a more interventionist path, especially in the area of industrial policy.

They note that such intervention was manifested in at least four areas. First, the banking system was dominated by state owned banks. The government maintained a regime of subsidised credit, which was rationed through selective allocation to favoured clients. Second, the government itself became a major player in the economy through large investments in state owned enterprises. Third, barriers to imports were raised continuously. And fourth, a complex set of regulations designed to promote government's industrial policy objective was instituted. As Hill (1991) details, Indonesia's manufacturing sector became almost wholly inward oriented.

The third phase started in mid 1980s when the Indonesian economy started to open again. This was an indirect result of the large drop in oil prices that began in the early 1980s (Hill, 1996, p. 11). Because the oil revenue shrank quickly, the government faced a sudden external imbalance. The import substitution strategy had left the Indonesian industries inefficient and unable to compete in the world market at the maintained exchange rate. A combination of this and general decline in primary commodity prices raised the premium on foreign exchange. In 1986, the import substitution strategy was therefore discarded and replaced with export orientation, followed by a devaluation of the exchange rate and combined with deregulation in the domestic economy.

The economic deregulation began with a liberalisation of export-import procedures.[21] Since then, various deregulation measures were introduced in order to make the economy more efficient. Despite some backward steps, the government was successful in its efforts to increase the efficiency of its industries and improve their international competitiveness (Fane, 1996). As a result, by the late 1980s, Indonesia appeared at last to be following the East Asian pattern of rapid growth in labour intensive manufactured exports (Hill, 1991).

Structure of the Economy

During the three decades of economic development to the mid 1990s, the Indonesian economy underwent substantial structural change. Table 5.1 illustrates how the changes are reflected in output, while Table 5.2 illustrates how they are reflected in employment. The share of the agriculture sector in GDP has declined throughout the period. Reflecting the oil boom, the share of the industrial sector more than doubled

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[21] Earlier, in 1983, the government had started deregulating the banking sector by allowing banks to set their own interest rates. In this year, the government also devalued the exchange rate.

during the 1970s.[22] A combination of falling oil prices and emerging non-oil industries saw a moderate decline of the industrial sector share in 1990. By 1995, the growth of non-oil industries has almost offset the decline in the oil sector, so that the share of industrial sector bounced back to near its 1980 level. The role of non-oil industries is best illustrated by the continuous increase in the contribution to GDP of manufacturing which increased threefold during the period. Meanwhile, after the share of services sector fell slightly during the 1970s, it rose again during the 1980s and 1990s.

Table 5.1:

Shares of Agriculture, Industry, and Services Sectors in Indonesian GDP, 1971-95 (%)

Sector	1971	1980	1990	1995
Agriculture	45	25	22	17
Industry	20	43	39	42
- Manufacturing	8	12	20	24
Services	35	32	39	41

Source: BPS, Statistik Indonesia (various issues)

The share of agriculture in employment has also continued to decline during the whole period, but at a much slower rate than the decline in its GDP share. On the other hand, the share of industrial sector in employment has continued to expand, doubling throughout the period. Much of this industrial work force is in the manufacturing sector, whose share has also increased continuously and almost doubled throughout the period. The share of services sector, meanwhile, has also steadily increased during the period.

[22] The industrial sector here is broadly defined and includes mining, manufacturing, utilities, and construction (Hill, 1996, p. 19).

Table 5.2:
Shares of Agriculture, Industry, and Services Sectors in Employment in Indonesia, 1971-95 (%)

Sector	1971	1980	1990	1995
Agriculture	67	55	50	44
Industry	9	13	17	18
- Manufacturing	7	9	12	13
Services	24	32	33	38

Source: BPS, Statistik Indonesia (various issues)

During the last three decades, the Indonesian economy has also become more interrelated with the international economy. Table 5.3 measures the proportion of exports and imports of goods and services in GDP. During the oil boom, the proportion of exports in GDP more than doubled. The decline in the oil price is then reflected in the declining proportion of exports thereafter. The proportion of non-oil exports in GDP, meanwhile, was steady during the 1970s then rapidly increased thereafter. According to Hill (1996, p. 14), between 1982 and 1992, the contribution of non-oil exports to GDP rose remarkably, far outpacing the rise in oil GDP at any period, and underlining the significance of the Indonesian economy's growing internationalisation. Similarly, the proportion of imports increased continuously throughout the period.

Table 5.3:
Proportion of Exports and Imports to GDP in Indonesia, 1971-95 (%)

	1971	1980	1990	1995
Exports	14	30	27	26
- Non-Oil Exports	8	9	14	18
Imports	17	22	26	28

Source: BPS, Statistik Indonesia (various issues)

Labour Market Development

The development of Indonesia's labour market, however, is quite different from that of its goods and financial markets. Until the early 1990s, the Indonesian labour market was relatively free from distortions. The government did not intervene in wage determination, nor did it enforce regulations on laying off workers. Along with that, the government tightly controlled the union movement by allowing only one government sanctioned labour union. Therefore, as noted by Manning (1994), there has been little effective direct government or union involvement in wage setting. In fact, this free labour market is considered one of the contributing factors to Indonesia's high economic growth.

The early 1990s, however, witnessed significant changes in the Indonesian labour market. Among them, three are most important. First, the government revoked the regulation which banned strikes. Second, the government started to enforce the implementation of regional minimum wage regulations, which are updated annually. Third, some independent labour unions were established despite the government's efforts to disband and declare them illegal. These changes were in response to both internal and external pressure. The internal pressure came from the rising number of people who are concerned with the fate of labourers in the increasingly industrialised Indonesian economy. This includes growing concern among senior policy makers that somehow labour has not shared in the high growth that has taken place in the economy (Agrawal, 1996; Manning, 1994).

The external pressures, meanwhile, came from increasing exports from Indonesia to North America and the European Union (EU), where concern has risen about labour market conditions in exporting developing countries. The focus has been on workers in export sectors, who, it is claimed, have poor working conditions, low wages, and the denial of their fundamental right to form labour union. This belief has led to calls for a 'social clause' in developed-developing countries' trade arrangements stipulating that favoured access to developed country markets would not be granted to countries where labour standards are unsatisfactory (Addison and Demery, 1988).

Review of Data

The study in this and the following chapters utilises the data from the Manufacturing Establishments Survey, which is conducted annually by BPS. The survey covers all manufacturing establishments which employ at least 20 workers. It attempts to enumerate all establishments, except for those in the state-run oil and gas processing industry (Aswicahyono *et al*, 1996). The data available 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 of All Economic Activities) code based on its main product. This study utilises the survey data from its inception in 1975 through 1993.

An analysis of the quality of the data base is offered in Hill (1990a and 1990b). In particular, he points out 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 data base is used in this study wherever appropriate.

In addition, this study also uses industrial trade data compiled and made available by the International Economic Data Bank (IEDB) at the Australian National University. This data base records manufacturing export and import data at four digit of the ISIC code. The original source of data for this data base is the United Nations data on exports and imports, which are based on the SITC (Standard International Trade Classification) code. Using specific knowledge of the structure of production and trade in each country and the allocation of quantities within any single ISIC category among SITC categories and vice versa, IEDB has made an approximate concordance to rearrange trade values according to the ISIC category.

Trends in the Indonesian Labour Market

Several indicators of the trend in wage inequality or relative employment among workers over time have been used in empirical studies on this topic. Often these measures are imperfect and controversial. They are of two types. The first type measures wage inequality or relative employment by comparing different groups of workers. Examples include wage and employment ratios between non-production (professional) and production workers, or between workers with different educational attainment, or workers in different occupations. It is always assumed in these measures that each group of workers is representative of a certain skill level. Non-production workers, for instance, are assumed on average more skilled than production workers (Doms *et al*, 1997). It is the validity of this assumption that often becomes the debating point in studies which use these measures.

The second type of indicator, meanwhile, measures wage variability within a group of workers. Absolute variability measures, such as variance and standard deviation, as well as relative variability measures, such as the coefficient of variation, are used to measure wage dispersion. Higher overall variability of wages is then interpreted as a higher wage inequality among workers.

Since there is no agreement as to which method is best in measuring labour market outcomes of openness, and since each method has its own strengths and weaknesses, a combination of both indicators is used in this study. First, the non-production to production workers' wage and employment ratios and, second, the coefficient of variation of wages.

Wages and Employment of Non-Production and Production Workers

The use of non-production and production workers as an approximation of skilled and unskilled labour is widely employed in empirical studies of wage inequality in developed countries. Some of the studies that use this approximation, among others, are Berman *et al* (1994), Doms *et al* (1997), Feenstra and Hanson (1996), and Lawrence and Slaughter (1993). On the other hand, Leamer (1994) argues that this is not an appropriate measure to use because the categories of production and non-production workers are diverse and not clearly linked with skills. Berman *et al* (1994), however, shows that both conceptually and empirically the production and non-production worker distinction closely mirrors the distinction between blue- and white-collar occupations, which in turn closely reflects the educational level of workers.

The trends in average real wages of production and non-production workers in the Indonesian manufacturing sector from 1975 to 1993 are shown in Figure 5.1. The figure shows that both production and non-production workers experienced steady real wage growth, except for some minor fluctuations, during the whole period from 1975 to 1993. The wage growth of non-production workers, however, seems to fluctuate more than that of production workers. During the whole period from 1975 to 1993, the average real wage of production workers grew at 4.1 percent per year, while that of non-production workers grew at 4.2 percent per year.[23] This continuous wage growth corresponds to labour productivity growth. Szirmai (1994) finds that there was rapid labour productivity growth in Indonesian manufacturing between 1975 and 1990, except for the brief stagnation during 1982-84 period.

The employment side of the story is illustrated in Figure 5.2. During the whole period, employment growth for production workers is 9.4 percent per year while for the non-production workers is 9.6 percent per year. However, the figure also indicates that the employment growth rate for production workers has accelerated since 1986. While the employment growth rate for production workers from 1975 to 1986 is 8.3 percent per year, from 1986 to 1993 it has accelerated to 11.1 percent per year. Manning (1994) also finds that there is more rapid growth of manufacturing employment of unskilled labour after the mid 1980s, which he attributes to the rapid growth of the manufacturing export sector. The employment growth rate for non-production workers, on the other

[23] Calculated using exponential growth rate formula, $W_{93} = W_{75} \cdot e^{rt}$, where W_{93} and W_{75} are the 1993 and 1975 real wage levels respectively, e is the base of natural logarithm, r is the yearly growth rate, and t is the time period (18 years).

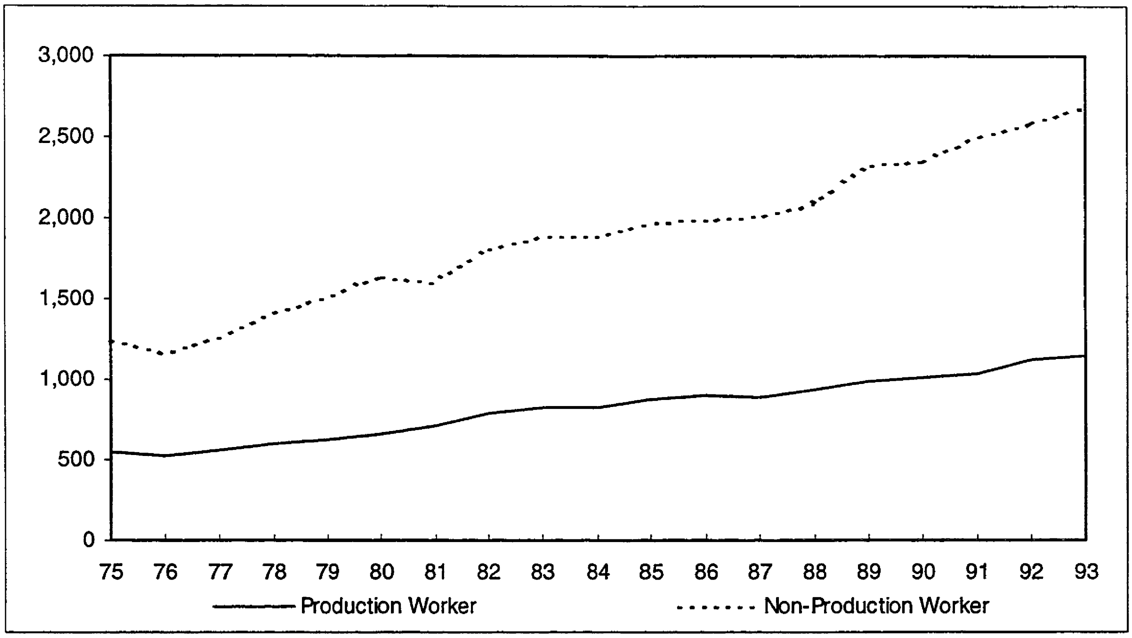

Figure 5.1:
Average Real Wage of Production and Non-Production Workers in Indonesian Manufacturing, 1975-93 (Rp. 1,000 per year, 1990 prices)

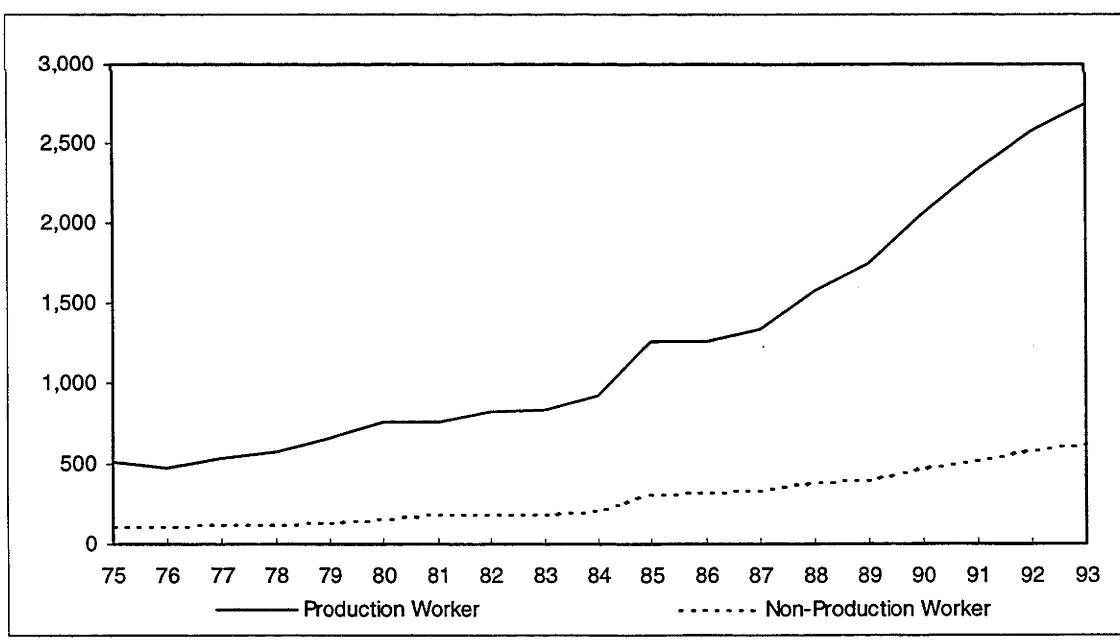

Figure 5.2:
Employment of Production and Non-Production Workers in Indonesian Manufacturing Sector, 1975-93 (1,000 workers)

hand, slowed down slightly in the later period, from 9.7 percent per year in 1975-86 period to 9.5 percent per year in the 1986-93 period.

Figure 5.3 tracks the trends in the wage and employment ratios between skilled and unskilled labour based on Figures 5.1 and 5.2. It clearly shows that the trend in the employment ratio is the mirror image of the trend in the wage ratio, suggesting a negative relationship between wage and employment ratios and therefore that supply shocks have broadly identified labour demand behaviour. The magnitudes of the wage ratio in the figure concord with the ratio of private sector wage payments in manufacturing summarised in Manning (1994). He reports differentials between skilled and unskilled labour of 2-3:1 for skilled blue collar workers in the early 1970s.

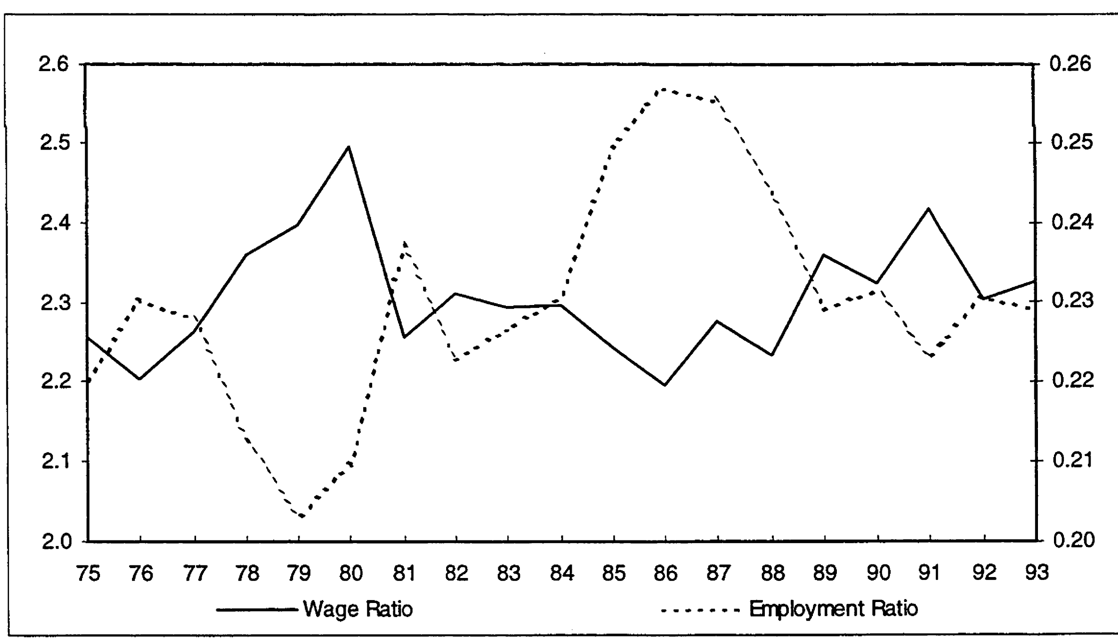

Figure 5.3:
Wage Ratio (left axis) and Employment Ratio (right axis) of Non-Production to Production Workers in Indonesian Manufacturing, 1975-93

Figure 5.3 indicates some changes in the trends. From the mid to late 1970s, the trend of the wage ratio is increasing, while the employment ratio is decreasing. This indicates that, in this early period, growth in the relative supply of skill was inadequate to meet demand at the old relative wage. From the late 1970s to the mid 1980s, the wage ratio is decreasing, while the employment ratio is increasing. This suggests a slowing in relative demand and a lagged response in relative supply. Using educational level as the proxy for skill, Manning (1994) also finds that there were narrowing wage differentials between more and less educated workers from 1977 to 1982. Finally, from the mid 1980s to early 1990s, the trend in the wage ratio is increasing again, while the employment ratio is decreasing. This coincides with the resurgence of GDP growth in this period and the rise of a newly competitive manufacturing sector intensive in unskilled labour.

Since the economic deregulation policy in Indonesia began in the mid 1980s, the figure suggests that the (immediate) effects of openness have been to increase wage inequality but to reduce the relative employment of skilled to unskilled labour. From 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).[24]

On the other hand, 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 percent. In the US, meanwhile, from 1979 to 1989 the employment ratio rose from 0.35 to 0.44

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[24] 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.

(Lawrence and Slaughter, 1993), an increase of 25 percent. A key difference is in the direction of the trend in unskilled labour demand. In Indonesia, there has been an expansion in manufacturing industries employing low skill labour, while in the US, a contraction has occurred. This makes the rise in the wage ratio in Indonesia the more surprising.

Wage Variability

The coefficients of variation of real wages for all manufacturing workers as well as for production and non-production workers are shown in Figure 5.4. From the mid 1970s to the mid 1980s, relative wage variability has tended to decline over time. However, starting from 1986, there was a clear tendency for wage dispersion to increase, at least until 1992, most profoundly for non-production workers. There is a decline in relative wage variability in 1993 over 1992, which is probably the result of the new minimum wage policy. This finding is consistent with that from the previous approach, that there has been a tendency for wage inequality between skilled and unskilled workers to rise since the mid 1980s.

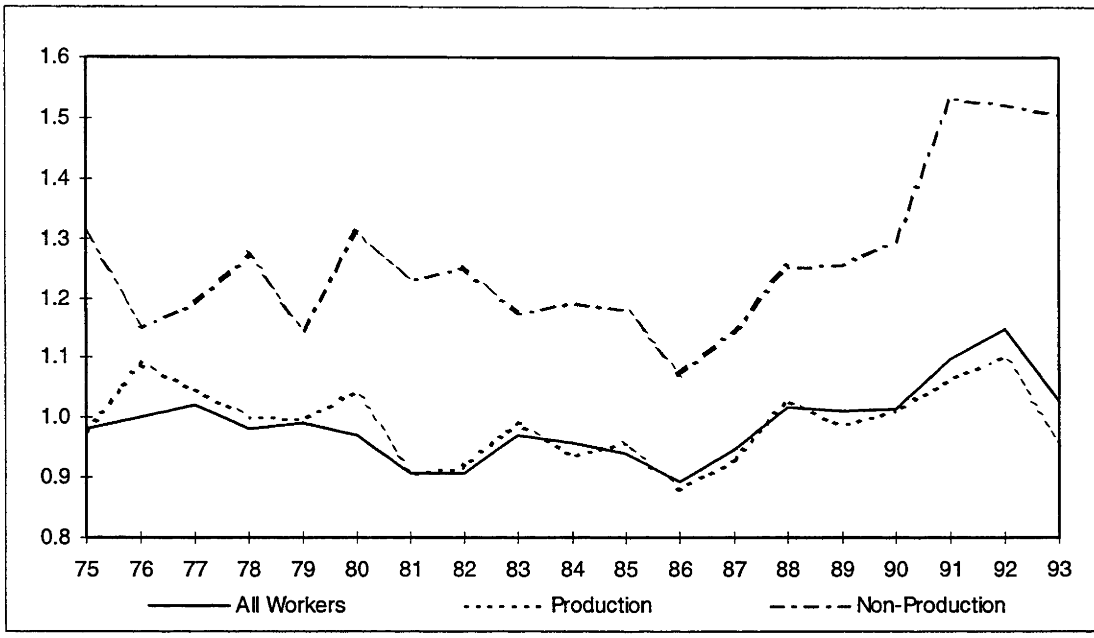

Figure 5.4:
Coefficient of Variations of All, Production, and Non-Production Worker Real Wages in Indonesian Manufacturing, 1975-93

Trends in Relative Supply and Demand

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 mid 1980s. The relative employment of skilled labour, on the other hand, has declined. This section reviews the trends in the relative supply of and relative demand for skilled to unskilled labour in the Indonesian economy in general and in the manufacturing sector in particular.

Trend in Relative Supply

The relative supply of skilled to unskilled labour is measured using the education level of the labour force. Figure 5.5 shows the ratio of high school and above to below high school graduates as well as the ratio of university to below university graduates in the Indonesian labour force between 1975 and 1993. In developed countries, the latter measure is commonly used as the indicator of relative supply of skilled labour. In the context of developing countries, however, where the average educational attainment of the population is lower, the former may give a better picture.

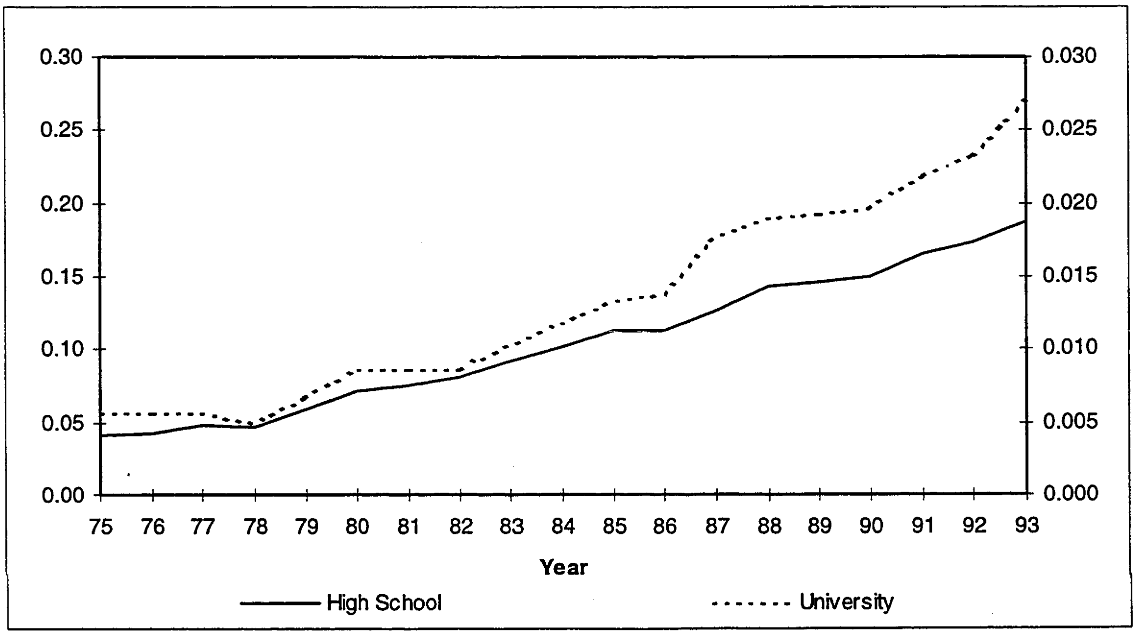

Figure 5.5:
Ratio of High School and Above to Below High School Graduates (left axis) and Ratio of University to Below University Graduates (right axis) in the Indonesian Labour Force, 1975-93

Source: BPS, Statistik Indonesia (various issues)

In any case, both indicators show consistently that there has been a steady increase in the relative supply of more educated workers in Indonesia since the late 1970s. Furthermore, the graphics indicate that the ratio of university to below university graduates increased faster than the ratio of high school and above to below high school graduates, indicating that the expansion of tertiary has been faster than secondary education. Nevertheless, the educational attainment of the Indonesian labour force is still very low, even compared with other South-East Asian countries. Considering that Indonesia's labour force numbered more than 90 million in 1993, it is clear that Indonesia retains a large pool of unskilled labour.

Trend in Relative Demand

In general, changes in the demand for skilled relative to unskilled labour may arise for three reasons. First, differences in growth across industries will shift relative demand. If, for example, industries that are relatively unskilled labour intensive grow faster than those that are relatively skilled labour intensive, then the relative demand for unskilled labour will increase. Differences in industry growth could be caused by changes in consumption shares or by the opening up of an economy to trade. Second, relative demand will change if there are technological changes that are biased against one type of labour so that relative demand within industries also change. Third, even if technological change is factor neutral but is concentrated in one sector, then relative demand may shift. In the remains of this section, therefore, trends in indicators of openness and technological change in the Indonesian manufacturing sector are discussed to assess their possible effects on the relative demand for skilled and unskilled labour.

Openness

Andriamananjara and Nash (1997) assert that, because of the many dimensions of trade restrictiveness, there is no consensus on what constitutes the best, or even a reasonable, measure of openness. The difficulty in finding objective measures of openness is also emphasised by Helleiner (1992). The measures of openness most adopted are of two types, based on incidence or outcome. Those based on incidence are constructed from data on the actual barriers, such as average tariff rates and non-tariff barriers. Those based on outcome infer information on the policy-induced trade barriers from data on the variables they presumably affect, such as prices or trade flows.

The simplest outcome-based measure of openness is the "trade intensity ratio", which is defined as the ratio of exports plus imports to output.[25] According to Campa and Goldberg (1997), this measure is the most widely used. They argue, however, that a more appropriate measure of openness would focus on the particular role played by patterns of trade for the international transmission of shocks. Hence, in this study 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. For practical reasons, consumption is approximated by output plus imports minus exports. Hill (1991) argues that exports are a better indicator of the two because they are less distorted by countries' trade policy interventions, but the inclusion of imports complements the picture and provides a better overall measure of openness.

Incidence-based measures, such as the nominal rate of protection and the effective rate of protection are calculated by comparing domestic and border prices of similar products (Vousden, 1990, pp. 53-58). While these measures are easier to interpret economically, they require data that are often not readily available in many developing countries. For the case of Indonesia, Fane and Condon (1996) and Fane and Phillips (1991) have calculated the nominal and effective rates of protection for certain sectors and years. Table 5.4 shows the nominal and effective rates of protection in the

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[25] Leamer (1988) argues that a better measure of openness is the deviation of actual from predicted trade intensity. However, this of course depends on how reliable is the model used in predicting trade.

non-oil manufacturing sector in 1987 and 1995. The numbers clearly indicate that Indonesia has substantially reduced its manufacturing protection.

Table 5.4:
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)

Although it can be argued that the outcome-based measures of openness used in this study (export intensity and import penetration ratios) may not be the best measures on theoretical grounds, they are the most practical measures given data availability. In any case, other measures will most likely lead to similar conclusion. For example, Edwards (1998) uses nine alternative measures of openness to test the relationship between openness and total factor productivity (TFP) growth. His results indicate that TFP growth is faster in more open economies. These results are robust to the openness indicator used, where all nine measures of openness yield the same conclusion.

The trends in the export intensity and import penetration ratios, together with the index of real output, for Indonesian manufacturing sector from 1975 to 1993 have been calculated and are shown in Figure 5.6.[26] This figure indicates that the overall trend in the export intensity ratio has been increasing. It has increased from around 10 percent during the late 1970s to around 19 percent during the first half of 1980s, and to over 30

[26] The index of real output is calculated by converting the nominal values of output to their real values using the CPI (1990 = 1) as the deflator.

percent in the late 1980s and early 1990s. 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. Poot (1991) also attributes this rapid increase in the share of exports to the export promotion policies adopted in this period. The increase in export intensity is even more significant considering that, starting in the early 1980s, the real output has grown exponentially.

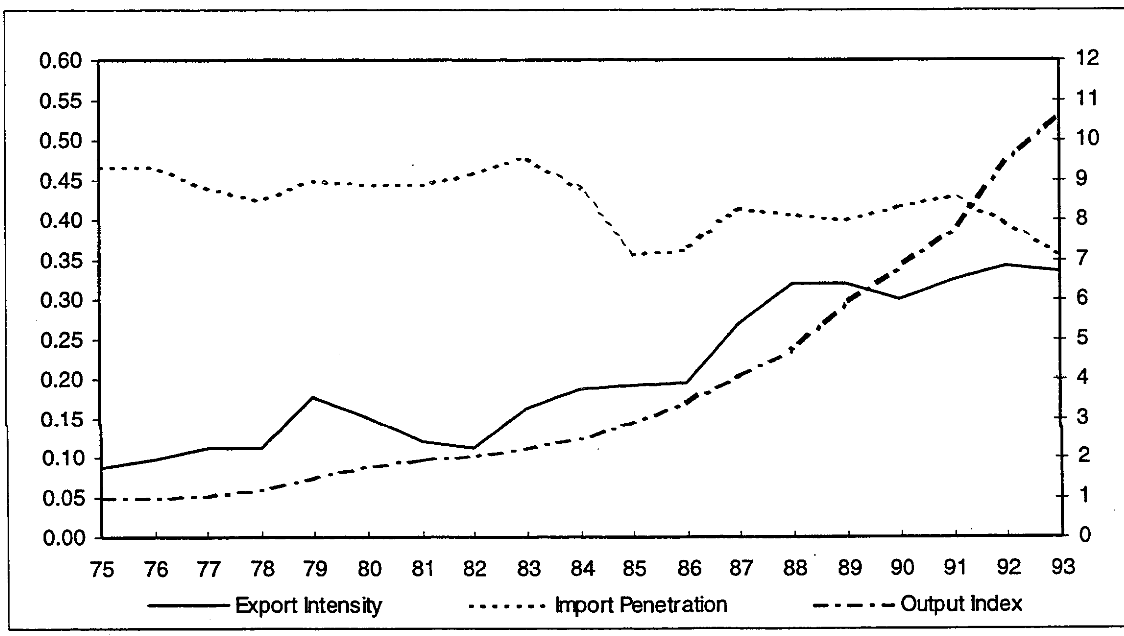

Figure 5.6:
Export Intensity and Import Penetration Ratios (left axis) and Index of Real Output (right axis) in Indonesian Manufacturing, 1975-93

The effects of increasing manufactured exports on employment creation, both directly and indirectly through backward linkages of industries, have been calculated by Fujita and James (1997). They find that in 1980 manufactured exports were associated with employment of only 1.26 percent of the total employed labour force. By 1985 this proportion had increased mildly to 2.7 percent. After this period, however, employment induced by manufacturing exports increased threefold in a five-year period, so that, by 1990, this sector accounted for 6.6 percent of the total work force.

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. From 1975 to 1984, the import penetration ratio was consistently high at around 45 percent. Following that, the ratio dropped from 44 percent in 1984 to 36 percent in 1985. Following an equally low import penetration ratio in 1986, the average ratio from 1987 to 1991 increased again, to over 40 percent. After that, however, the ratio dropped again to reach 36 percent in 1993. This drop, however, 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.

The drop in the import penetration during the early to mid 1980s was definitely not a result of a declining openness in this sector. 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 second half of the 1980s, on the other hand, does indicate greater openness. Poot (1991), for example, finds that liberalisation of import restrictions in the mid 1980s reversed the process of import substitution, resulting in increasing import shares, especially for intermediate products. Both indicators, therefore, consistently point to greater openness in this sector starting in the mid 1980s.

Technological Change

Technology and technological change are difficult to measure. A broad definition of technology refers to it as "a collection of knowledge, skill, and physical processes which transforms inputs into outputs".[27] Technological change, meanwhile, takes place because innovators find it profitable to apply new ways of doing things (Ruffin, 1993). Two most common indicators of technological change are total factor productivity (TFP) growth and research and development (R&D) expenditure. Data on both indicators in Indonesia are not readily available, however, on the scale required for this study (panel data of four-digit ISIC manufacturing industries from 1975 to 1993).

TFP measures have been controversial. Dynamic Singapore, for example, consistently records TFP growth that is low by Asia and global standards (Hill, 1998). Indonesia appears to have experienced high TFP growth, higher indeed than in its Southeast Asian neighbours (Ray, 1995). This cuts against the generalisation made by Krugman (1994) and others that capital accumulation explains most East Asian growth. Yet it is consistent with the analysis of technological change effects to be offered in Chapter 7.

In developing countries, most new technologies are foreign sourced, embodied in imported capital. Eaton and Kortum (1996) find that even in the most advanced developed countries, foreign sourced technologies constitute a large share in patent applications.[28] Therefore, concentrating on embodied technology, this study uses two indicators for technological change, namely the proportion of an industry's capital stock

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[27] For various definitions of technology, see Gomulka (1990, Chapter 1).

[28] They note that there are three opinions on the availability of technologies to countries. First, by its nature technology is freely available to all. Second, innovators produce new knowledge to maintain their growth above other countries. Third, new technologies gradually diffuse from innovators to other countries. The results of their own research support the third opinion.

that is new (less than 5 years old) and the extent of foreign participation in the industry, as measured by an industry's proportions of multinational firms and their output.[29]

The new proportion of an industry's capital stock measures the importance of new investments in the industry's productive capacity. The role of new investments in the diffusion and adaptation of new technologies is emphasised in Metcalfe (1990). In developing countries, however, most capital goods for new investments are often imported. This indicator, therefore, could interact with foreign participation, reflecting the importance of foreign sourced technological change embodied in imported capital.

The extent of foreign participation, meanwhile, measures the importance of foreign ownership in an industry's decision making. This is important because foreign direct investment is a form of trade in entrepreneurial services and ideas. Hence, one of the key advantages of foreign direct investment is that it brings in new knowledge and entrepreneurial skills. Consequently, many have found that industries that have been recipients of foreign direct investment have higher rates of technological change (Ruffin, 1993).

Figure 5.7 shows the proportion of investment and new capital in the total manufacturing capital stock.[30] Investment refers to cumulative additions to capital stock over a one year period, while "new capital" refers to cumulative investment over a five

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[29] Here, multinational firms include any firm with foreign equity.

[30] In this study, investment and the capital stock refer only to non-land investment and capital. The data on investment are available for the whole period from 1975 to 1993, while the data on the capital stock are only available for the period of 1987-93. To get a consistent estimate for the whole period, the capital stock identity is used:

$$K_t = K_{t-1} + I_t - \delta \cdot K_{t-1} \quad \text{or} \quad K_{t-1} = [1/(1 - \delta)][K_t - I_t]$$

where K_t is the capital stock at the end of year t, I_t is investment during the year t, and δ is the depreciation rate. Using the 1993 capital stock as the benchmark, capital stocks for the earlier years are estimated using the identity to 1975. To do this, the current price investment series is first deflated into real investment at 1993 prices. At the end of the estimation, the resulting real capital stock series is then inflated back to current prices. The depreciation rate, δ, is chosen to make the estimated capital stock series for the 1987-92 period closest to the available data. This estimation process is implemented for each industry of the four-digit ISIC code.

year period. Not surprisingly, new capital proportions are largely shaped by the pattern of investment. This suggests that the pattern would not change much if a threshold other than five year were chosen.

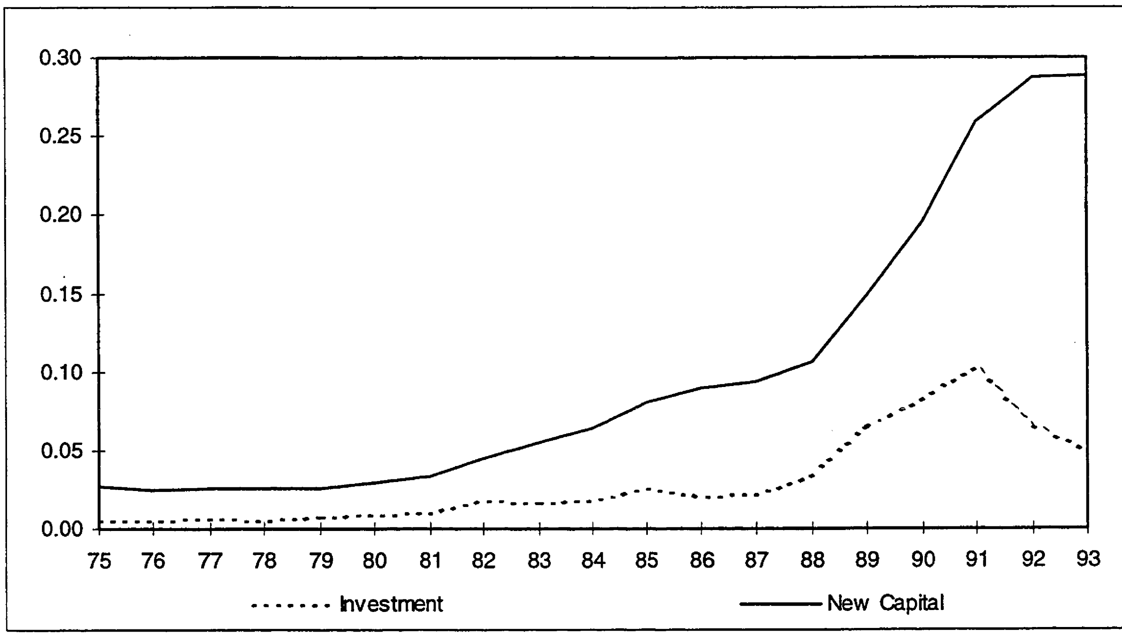

Figure 5.7:
Proportions of Investment and New Capital in the Total Capital Stock in Indonesian Manufacturing, 1975-93

The proportion of new capital was relatively stable, at around three percent of the total capital stock, during the whole second half of 1970s. Then, during the first half of 1980s, there was a steady increase in this proportion to around nine percent in the mid 1980s. Starting in 1988, it jumped up sharply, reaching 29 percent in 1992, and it then stabilised. The driving force behind this surge in new capital is the dramatic increase in investment, from around two percent of the total capital stock in 1987 to 10 percent in 1991.

Meanwhile, Figure 5.8 shows 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. During the period under study, the investment regulations required foreign investments to be in a 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. That is why, in this study, a firm which has foreign equity of any proportion is defined as a multinational.

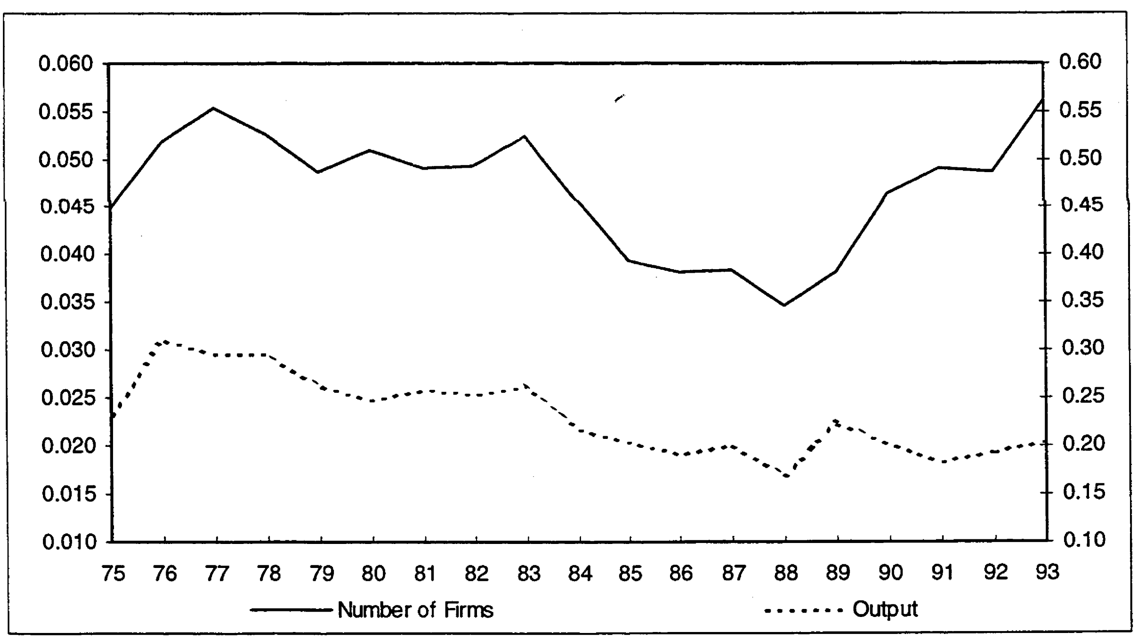

Figure 5.8:
Proportions of the Number of Firms (left axis) and Output (right axis) of Multinational Corporations in Indonesian Manufacturing Sector, 1975-93

For most of the period both indicators moved almost in parallel. Between late 1970s and late 1980s, the tendency was for foreign participation to decrease. The proportion of multinationals declined from 5.5 percent in 1977 to 3.5 percent in 1988, while their output proportion declined from 30 percent to 17 percent over the same period. This probably reflects the restrictive policy regime adopted by Indonesia on foreign direct investment during that period. Reflecting the change in policy, both indicators recorded an increase in foreign participation in 1989 to 3.8 percent in firm proportion and 22 percent in output proportion.

After 1989, however, there was a tendency for the two indicators to diverge. The firm proportion recorded a massive increase to 4.9 percent in 1991, while the output proportion fell back to 18 percent. This typified the foreign direct investment coming to Indonesia during that period. After investment liberalisation in the mid 1980s, a large number of multinationals began investing in Indonesia. They were mostly small firms, however. This is characteristically different from the large corporations which came to Indonesia in the earlier period.

The pattern of foreign investment in Indonesia after the investment licensing liberalisation in the mid 1980s is reviewed by Thee (1991). He finds that most of the surge in foreign investment after the mid 1980s come from the four Newly Industrialising Countries (NICs): Hong Kong, Taiwan, South Korea, and Singapore. The majority of this new foreign investment is export oriented and it occurs mainly in sectors in which Indonesia has strong comparative advantage, such as labour and resource intensive activities. This contrasts starkly with the earlier foreign investment which has strong domestic orientation and took place in capital and technology intensive sectors. He also confirms that the average size of the new foreign investments, after the mid 1980s, is much smaller than the earlier investments.

Both the proportion of new capital and foreign participation as technological change indicators increased markedly after the mid 1980s. This is attributed mainly to the deregulation policy adopted at the time. The very large level of new capital investment and the increases in foreign participation both suggest the possibility of significant technological change in the Indonesian manufacturing sector.

Concluding Remarks

The graphical analysis in this chapter finds that there is an increasing relative wage and decreasing relative employment of skilled to unskilled labour in the Indonesian manufacturing sector since the mid 1980s. On the supply side, there is a continuous increase in the relative supply of skilled to unskilled labour in the Indonesian economy since the late 1970s. On the demand side, meanwhile, the manufacturing sector experienced both increasing openness and technological changes since the mid 1980s due to the trade and investment liberalisation that commenced at the time.

The effects of the trend in the relative supply of labour on jobs and earnings between the mid 1970s and mid 1980s are analysed by Keyfitz (1989). He finds that the supply of university graduates in Indonesia tends to increase faster than industry's demand for them. This, he argues, has created a "pushdown" effect on jobs, where new graduates entering the labour market have to take jobs which previously only held by those with lower educational qualifications. Consequently, the return to education was reduced. He finds that the ratio of earnings between those with high education qualifications to those with low qualifications has continuously decreased during this period. This corresponds to the reduction in the wage ratio between skilled and unskilled labour from the late 1970s to mid 1980s shown in Figure 5.3.

As Figure 5.5 indicates, the trend in the relative supply of skilled to unskilled labour after the mid 1980s is increasing, a trend which has been sustained continuously since the late 1970s. There is therefore no indication of any structural break in relative supply of labour in the mid 1980s. Hence, the changes in the trends of both relative employment and relative wage that occurred starting in the mid 1980s are more likely to be attributable to the changes on the demand side.

This conclusion is similar to the one widely accepted in the developed country context. In fact, the debate there has concentrated on the question as to which of the two relative demand shifters, openness and technological change, are more important in explaining the poor market performance of unskilled labour in these countries (Feenstra, 1997). Hence, the next chapter concentrates on assessing how openness and technological change affect the relative demand for skilled to unskilled labour in the Indonesian manufacturing sector.

Chapter 6:

ESTIMATING THE EFFECTS OF OPENNESS AND TECHNOLOGICAL CHANGE ON SKILLED AND UNSKILLED LABOUR RELATIVE DEMAND: AN INTERRELATED FACTOR DEMAND ANALYSIS

The graphical analysis in Chapter 5 indicates that, starting from the mid 1980s, there was a tendency for the wage ratio between skilled and unskilled labour in the Indonesian manufacturing sector to increase, while the corresponding employment ratio tended to decrease. At the same time, this sector experienced increasing trade openness, reflected in increasing export intensity as well as import penetration ratios. This increase in openness followed a balance of payments (BOP) crisis in the mid 1980s associated with the fall in oil prices, the relative price shifts it caused, and the subsequent deregulation policy. Also as a result of the deregulation policy, starting from the late 1980s, manufacturing experienced a surge in new investment and increased foreign participation, suggesting the likelihood that considerable technological change may have taken place in this sector.

For the case of developed countries, there is wide agreement that the cause of rising skilled labour relative wages is increasing relative demand for their services (Johnson, 1997). Supply shocks, such as immigration and increased participation by women, have been seen as less important. The essence of the debate taking place concerns the relative roles of trade and technological change in affecting labour demand (Tyers *et al*, 1997). A key difference between developed and developing countries is the size of relative magnitudes to labour supply shocks. Nonetheless, both trade and technological change also act on labour demand in developing countries.

This chapter seeks to account for the effects of both openness and technological change on the relative demand for skilled and unskilled labour in developing countries, using Indonesia as a case study. The analysis is implemented using an interrelated factor demand model which is derived from a translog cost function. Before embarking on the model derivation and estimation, the following section reviews some empirical studies in developed countries, with emphasis on the methodology and performances of the models used.

Trade or Technology: Review of Empirical Studies

The purpose of this section is to review how the analysis of the factors affecting the relative demand for skilled to unskilled labour is implemented in other studies, particularly in the developed country context, and to assess the performances of the models used in estimations. Some of the studies referred to have been reviewed in Chapter 2. Here the intent is to establish the array of econometric methods employed and the strength of the results obtained. It will be seen that the results obtained for Indonesia are at least as significant as any in similar studies of other developed or developing countries. To organise this review, the studies are grouped according to the principal explanation they consider, whether it be import competition, export expansion, technological change, or outsourcing and foreign investment.

Import Competition

Grossman (1987) estimates the effects of import competition on the labour market 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. Revenga (1992), however, shows that similar reduced form equations for employment and wages can be derived from a simple competitive labour market model, where wages adjust to equate labour demand and supply. Both studies concentrate on production workers only. Lee (1995) uses the same model but he incorporates skilled and unskilled labour as distinct factors of production. He is therefore able to derive reduced form equations for the relative employment and wages of skilled to unskilled labour.

Grossman's (1987) original model is fitted to data from nine manufacturing industries in the United States (US) that appear to have suffered intense competition from imports. He estimates the model separately for each industry, using monthly time series data from 1967 to 1979. Because he presents only estimates of the elasticities of employment and wages to import prices, it is not possible to assess the performance of his model. Of the nine estimated elasticities of employment to import prices, one has the wrong sign, two are significant at the one percent level, while the rest are insignificant at the five percent level. Meanwhile, of the nine elasticities of the wage to import prices, one has the wrong sign, three are significant at the one percent level, one is significant at the five percent level, and the rest are insignificant. Based on the magnitudes of these elasticities, he concludes that wages are not very sensitive to competition from imports, whereas the responsiveness of employment to imports varies widely across sectors.

Revenga (1992) estimates the model using panel data from 38 US manufacturing industries for 1977-87 period. She uses two alternative definitions for employment: the number of production workers and average person-hours per week. Three alternative methods of estimation are employed: ordinary least squares (OLS), instrumental variables (IV) with source-weighted industry exchange rates as the instruments, and IV with endogenously weighted country exchange rates as instruments. The OLS model yields R-squares which range from 0.117 to 0.157, with coefficients of import price that are all insignificant and one has the wrong sign. The first IV estimate is rejected by specification tests. The coefficients of import prices in the employment equations are insignificant, but the corresponding coefficients are significant at the five percent level in the wage equation. The second IV estimate yields a person-hours employment equation passing the specification test at the five percent level, while the other two equations are rejected. The coefficients of import prices in both employment equations are significant at the five percent level, while in the wage equation it achieves significance at the one percent level. Based on the results of both IV estimates, she concludes that the impact of an adverse trade shock on average wages is quite small, with most of the adjustment occurring through employment.

Lee (1995), meanwhile, estimates the model for a panel of 21 Canadian manufacturing industries for the period of 1970-90. Two measures of employment are used: the number of workers and average person-hours per week. In addition, he uses a gross-output measure of multifactor productivity (or better known as total factor productivity) as an indicator of technological change. Two estimation methods are used: OLS and two-stage least squares (2SLS). The model yields R-squares which range from 0.079 to 0.16. While all the coefficients of technological change are significant at the one percent level, the coefficients of import prices that are significant (at the five percent level) are only those in person-hours and wages equations estimated using OLS. He concludes that there are indications that both technological change and import prices have negative effects on skilled workers relative employment and positive effects on their relative wages.

Export Expansion

Bernard and Jensen (1995) 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. Their models achieve between 0.311 and 0.525 of variation explained, and they find that exporters pay higher wages and benefits to their workers compared to non-exporters. One possible reason for this is that exporters employ more skilled labours than non-exporters. However, when they run separate regressions for production and non-production wages, they find that the export premium for production workers is slightly higher than for non-production workers. In the production wage regressions they achieve between 0.326 and 0.509 of variation explained, while for non-production wages, this is between 0.067 and 0.138.

They further analyse the same data set in Bernard and Jensen (1997). Besides exports, this time they add domestic shipments and technological change variables (the ratio of research and development (R&D) to total sales and computer investment per employee) as explanatory variables for relative labour demand changes. Furthermore, they disaggregate the changes in employment and wages into between and within plant changes. With explained variation ranging from 0.17 to 0.38, the results indicate that the between plant change in wages and employment toward skilled workers is positively related to increases in both domestic and foreign demand, with the effects of foreign demand much larger than domestic demand. The effects of technological change variables, however, are mixed. The coefficients of the ratio of R&D to sales are positive, while the coefficients of computer investment per employee are negative. Meanwhile, for within plant changes, both technological change variables and exports have positive coefficients, but the effect of domestic shipments is negative. These results lead the authors to conclude that demand changes across plants associated with exports are a major source of wage inequality between skilled and unskilled labour. Meanwhile, technological change is associated with skill-upgrading at the plant level.

Technological Change

Lawrence and Slaughter (1993) use graphical analysis to examine whether trade with developing countries or technological change is the factor behind the widening wage inequality observed in US manufacturing during the 1980s. The Stolper-Samuelson (SS) theorem predicts that, if trade is the main determining factor, then industries will substitute unskilled labour for skilled labour because the relative price of the latter has increased. Hence, this theorem implies that increasing wage inequality between skilled and unskilled labour will be observed simultaneously with declining employment ratio of skilled to unskilled labour across industries. To test this, they plot the percentage changes in the relative wages and relative employment of non-production to production workers. Contrary to the theorem, they find that most industries experienced both increasing relative wage and relative employment of non-production workers. Therefore, they conclude that the widening wage inequality between skilled and unskilled labour is not caused by trade. To test for the alternative, they calculate the Hicks-neutral total factor productivity increases in the 1980s, weighted by production and non-production labour. They find that technological change has been concentrated in industries that use non-production labour intensively. Hence, they conclude that technological change shifts the labour demand mix toward skilled labour and, thereby, raises its relative wage.

Berman *et al* (1994) also find that technological change is the main reason behind increasing relative demand for skilled labour in US manufacturing. They arrive at this conclusion by using two approaches. First, they disaggregate the changes in industry's relative employment of non-production workers into "between" and "within" industry changes. They find 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. Second, they estimate a non-production wage share equation derived from a translog cost function.[31] They assume that each industry employs three inputs: production labour, non-production labour, and capital. The latter is assumed to be a fixed input. Explained variation ranges between 0.029 and 0.129. By interpreting the residuals as representing biased technological change, they find that most of skill upgrading falls in this category. 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. Explained variation then ranges between 0.42 and 0.496. Both variables have positive and significant coefficients, supporting their conclusion that biased technological change is an important contributor to within industry skill upgrading.[32]

Contrary evidence on the role of technological change is offered by Mishel and Bernstein (1996), who estimate a model where wage inequality in the US is explained by various technology indicators. They define education levels as the share of workers in a given education category within an industry. Wage levels are measured as an industry's utilisation of low, middle, and high wage workers. Residual wage inequality is referred to as wage inequality that occurs among workers with similar observable qualities (such as

[31] This approach is similar to that employed here for the case of Indonesia.
[32] In applying this method to Indonesia, these indicators of technological change are, unfortunately, unavailable.

education). The technology indicators used, meanwhile, are the accumulation of equipment per worker, computers per worker, and R&D. In addition, they separate the regressions between male and female workers. The R-squares ranges between 0.02 and 0.55. One of their important findings is the insignificance of the coefficients of interaction terms between time period and technology indicator variables, implying that there is no evidence that technology has become more or less skill biased over time. The results are similar for education level, wage level, and residual wage inequality. They also apply equally to both male and female workers. Hence, they conclude that the findings of their study do not support the technology explanation of increasing wage inequality between skilled and unskilled labour.

Meanwhile, using two approaches, Doms *et al* (1997) arrive at contradictory conclusions as to the effects of technology on wages. In the first approach, they regress the average wage on the average characteristics of workers as well as plant characteristics, including technology indicators. They use cross-sectional data for US manufacturing plants. With the R-squares ranges from 0.129 to 0.75, the results from this method show that more technologically advanced plants employ more skilled workers and pay higher wages. In the second approach, they use panel data analysis to try to capture how the effects of technology evolve over time. With the R-squares now ranging between 0.033 and 0.146, various specifications they employ show consistently 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 technology use and worker wages may be due to time-invariant unobserved worker quality differences.

Outsourcing and Foreign Investment

Feenstra and Hanson (1996) develop a model which shows that capital movement from developed to developing countries increases wage inequality between skilled and unskilled labour 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. With explained variation ranging from 0.058 to 0.309, 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 labour.

Then, to test their hypothesis on developing countries, they select Mexico for a case study. This country experienced a sharp increase in relative wages between non-production and production workers starting in the mid 1980s. This contrasted with a steady decline during the previous decades. They regress the relative wages and the changes in relative wages on regional dummy variables. They do not present explained variation, but they 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, they conclude that this finding confirms the prediction of their model that foreign investments also increase wage inequality in developing countries.

Aitken *et al* (1996) investigate the effects of foreign direct investment on wages in Mexico, Venezuela, and the US. They do it by regressing wages on various factors including foreign investment, which is measured by the share of employment in enterprises with foreign equity investment. Explained variation ranges between 0.11 and

0.53 and they find that foreign investment raises wages in the three countries investigated. 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 labour for these countries. The results for both indicate consistently that the effect of foreign investment in raising wages is greater for skilled labour than for unskilled labour, with a much higher differential reported in the case of Mexico. They conclude that foreign investments in developing countries tend to increase wage inequality between skilled and unskilled labour.

Review Summary

In broad summary, this review of prior empirical studies indicates that the literature has given considerable prominence to studies that have yielded mixed results in terms of statistical significance and the estimated direction of effects. R-squares in the teens of percent or less are common and estimated coefficients frequently have signs that belie the underlying structural model. Overall, however, the studies do support the links explored in this thesis between trade, technological change, capital accumulation, and relative wages. In the remain of this chapter, it is found that the data for Indonesian manufacturing do likewise and that levels of statistical significance are at least as high as those achieved in prior studies.

An Interrelated Factor Demand Model

As shown by Berman *et al* (1994) and Feenstra and Hanson (1996), the effects of factors affecting relative demand for skilled to unskilled labour can be estimated using the interrelated factor demand model, in the form of input cost shares model which can be derived from a transcedental logarithmic (translog) cost function. The most general form of translog cost function is the non-homothetic translog cost function, which can be envisaged as a second-order Taylor's series approximation in logarithms to an arbitrary cost function (Berndt, 1991, pp. 469-479; Varian, 1992, pp. 209-210).

Both Berman *et al* (1994) and Feenstra and Hanson (1996) assume that each industry uses three production inputs of non-production labour, production labour, and capital which is assumed as fixed. These assumptions imply that the decision on the mix of skilled and unskilled labour employed depends only on their relative wages. To make the model more realistic, following Lee (1995), this study assumes that each industry in the manufacturing sector uses five production inputs, ie. unskilled labour (L), skilled labour (H), capital (K), energy (E), and intermediate materials (I). Each individual industry faces a fixed price of these five inputs, ie. P_L, P_H, P_K, P_E, and P_I, to produce an output Y with a price P_Y. To enter 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 from the total capital stock (T), and foreign participation ratio (F). Therefore, the non-homothetic translog cost function in this analysis is specified as:

$$\ln C = \ln\alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i \sum_j \beta_{ij} \ln P_i \ln P_j + \alpha_Y \ln Y + \frac{1}{2}\beta_{YY}(\ln Y)^2$$

$$+ \sum_i \beta_{iY} \ln P_i \ln Y + \sum_V \alpha_V \ln V + \frac{1}{2}\sum_V \sum_{V'} \gamma_{VV'} \ln V \ln V'$$

$$+ \sum_i \sum_V \gamma_{iV} \ln P_i \ln V + \sum_V \gamma_V \ln Y \ln V \qquad (6.1)$$

where C is industry's cost of production, i and j $\in$ {L, H, K, E, I}, V and V' $\in$ {X, M, T, F}, while α's, β's, and γ's are parameters.[33] It is assumed that $\beta_{ij} = \beta_{ji}$ and $\gamma_{VV'} = \gamma_{V'V}$.

A property of cost function is that, for given Y and V, it is homogeneous of degree 1 in input prices. This imposes the following restrictions on equation (6.1):

$$\sum_i \alpha_i = 1 \quad \text{and} \quad \sum_i \beta_{ij} = \sum_j \beta_{ji} = \sum_i \beta_{iY} = \sum_i \gamma_{iV} = 0 \tag{6.2}$$

In addition, other parameter restrictions can be imposed on the translog cost function. To get a homothetic translog cost function, it is necessary and sufficient that $\beta_{iY} = 0$ for all i. To get a translog cost function which is homogeneous of $1/\alpha_Y$ degree in output, then in addition to the homotheticity restrictions, it requires 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 is 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.

If a translog cost function is differentiated with respect to the log of input prices and then Shephard's lemma is employed, the resulting derivatives are the cost share (S) equations for each input, which all adds up to one. This can be seen as follows:

$$\frac{\partial \ln C}{\partial \ln P_i} = \frac{P_i}{C} \cdot \frac{\partial C}{\partial P_i} = \frac{P_i X_i}{C} = S_i \quad \text{and} \quad \sum_i S_i = 1 \tag{6.3}$$

[33] This model specification is analogous to the variable translog cost function, where a variable cost function is assumed to be shifted by the level of usage of fixed inputs. For a theoretical discussion on variable translog cost function, see McFadden (1978).

From equation (6.1), the cost share equations for all five inputs are as follow:

$$S_L = \alpha_L + \beta_{LL} \ln P_L + \beta_{LH} \ln P_H + \beta_{LK} \ln P_K + \beta_{LE} \ln P_E + \beta_{LI} \ln P_I$$
$$+ \beta_{LY} \ln Y + \gamma_{LX} \ln X + \gamma_{LM} \ln M + \gamma_{LT} \ln T + \gamma_{LF} \ln F$$
$$S_H = \alpha_H + \beta_{LH} \ln P_L + \beta_{HH} \ln P_H + \beta_{HK} \ln P_K + \beta_{HE} \ln P_E + \beta_{HI} \ln P_I$$
$$+ \beta_{HY} \ln Y + \gamma_{HX} \ln X + \gamma_{HM} \ln M + \gamma_{HT} \ln T + \gamma_{HF} \ln F$$
$$S_K = \alpha_K + \beta_{LK} \ln P_L + \beta_{HK} \ln P_H + \beta_{KK} \ln P_K + \beta_{KE} \ln P_E + \beta_{KI} \ln P_I$$
$$+ \beta_{KY} \ln Y + \gamma_{KX} \ln X + \gamma_{KM} \ln M + \gamma_{KT} \ln T + \gamma_{KF} \ln F$$
$$S_E = \alpha_E + \beta_{LE} \ln P_L + \beta_{HE} \ln P_H + \beta_{KE} \ln P_K + \beta_{EE} \ln P_E + \beta_{EI} \ln P_I$$
$$+ \beta_{EY} \ln Y + \gamma_{EX} \ln X + \gamma_{EM} \ln M + \gamma_{ET} \ln T + \gamma_{EF} \ln F$$
$$S_I = \alpha_I + \beta_{LI} \ln P_L + \beta_{HI} \ln P_H + \beta_{KI} \ln P_K + \beta_{EI} \ln P_E + \beta_{II} \ln P_I$$
$$+ \beta_{IY} \ln Y + \gamma_{IX} \ln X + \gamma_{IM} \ln M + \gamma_{IT} \ln T + \gamma_{IF} \ln F \qquad (6.4)$$

The underlying economic theory also requires the share equations to be homogeneous of degree 0 in input prices. In this five-input framework, the restrictions in equation (6.2) can be formulated as:

$$\alpha_L + \alpha_H + \alpha_K + \alpha_E + \alpha_I = 1$$
$$\beta_{LL} + \beta_{LH} + \beta_{LK} + \beta_{LE} + \beta_{LI} = 0$$
$$\beta_{LH} + \beta_{HH} + \beta_{HK} + \beta_{HE} + \beta_{HI} = 0$$
$$\beta_{LK} + \beta_{HK} + \beta_{KK} + \beta_{KE} + \beta_{KI} = 0$$
$$\beta_{LE} + \beta_{HE} + \beta_{KE} + \beta_{EE} + \beta_{EI} = 0$$
$$\beta_{LI} + \beta_{HI} + \beta_{KI} + \beta_{EI} + \beta_{II} = 0$$
$$\beta_{LY} + \beta_{HY} + \beta_{KY} + \beta_{EY} + \beta_{IY} = 0$$

$$\gamma_{LX} + \gamma_{HX} + \gamma_{KX} + \gamma_{EX} + \gamma_{IX} = 0$$

$$\gamma_{LM} + \gamma_{HM} + \gamma_{KM} + \gamma_{EM} + \gamma_{IM} = 0$$

$$\gamma_{LT} + \gamma_{HT} + \gamma_{KT} + \gamma_{ET} + \gamma_{IT} = 0$$

$$\gamma_{LF} + \gamma_{HF} + \gamma_{KF} + \gamma_{EF} + \gamma_{IF} = 0 \qquad (6.5)$$

Because the dependent variables, namely the input cost shares, are always adding up to one, of the five equations in (6.4) only four are linearly independent. Therefore, an arbitrary equation in (6.4) can be dropped and the rest four equations can be reformulated by using the parameter restriction equations in (6.5). If the S_I equation which is dropped, then the rest four equations become:

$$S_L = \alpha_L + \beta_{LL} \ln(P_L/P_I) + \beta_{LH} \ln(P_H/P_I) + \beta_{LK} \ln(P_K/P_I) + \beta_{LE} \ln(P_E/P_I)$$
$$+ \beta_{LY} \ln Y + \gamma_{LX} \ln X + \gamma_{LM} \ln M + \gamma_{LT} \ln T + \gamma_{LF} \ln F$$
$$S_H = \alpha_H + \beta_{LH} \ln(P_L/P_I) + \beta_{HH} \ln(P_H/P_I) + \beta_{HK} \ln(P_K/P_I) + \beta_{HE} \ln(P_E/P_I)$$
$$+ \beta_{HY} \ln Y + \gamma_{HX} \ln X + \gamma_{HM} \ln M + \gamma_{HT} \ln T + \gamma_{HF} \ln F$$
$$S_K = \alpha_K + \beta_{LK} \ln(P_L/P_I) + \beta_{HK} \ln(P_H/P_I) + \beta_{KK} \ln(P_K/P_I) + \beta_{KE} \ln(P_E/P_I)$$
$$+ \beta_{KY} \ln Y + \gamma_{KX} \ln X + \gamma_{KM} \ln M + \gamma_{KT} \ln T + \gamma_{KF} \ln F$$
$$S_E = \alpha_E + \beta_{LE} \ln(P_L/P_I) + \beta_{HE} \ln(P_H/P_I) + \beta_{KE} \ln(P_K/P_I) + \beta_{EE} \ln(P_E/P_I)$$
$$+ \beta_{EY} \ln Y + \gamma_{EX} \ln X + \gamma_{EM} \ln M + \gamma_{ET} \ln T + \gamma_{EF} \ln F \qquad (6.6)$$

If necessary, the parameters not directly estimated in the equation (6.6) can be indirectly estimated from the estimated parameters using the homogeneity restrictions in the equation (6.5).

Since the equation which is dropped from (6.4) to get (6.6) is chosen arbitrarily, the estimator which is used to estimate equation (6.6) should necessarily have a property where the estimates of parameters are invariant to which equation is dropped. Two estimators have this property, where the choice between these two methods depends on the exogeneity of the right hand side variables. If all right hand side variables are exogenous, the estimation method to use is the maximum likelihood estimation with the first round variance-covariance matrix obtained from equation-by-equation least squares estimation without the symmetry restrictions imposed. If some of the right hand side variables are endogenous, the estimation method to use is the three-stage least squares (3SLS) estimation with the first round variance-covariance matrix obtained from equation-by-equation two-stage least squares (2SLS) estimation without the symmetry restrictions imposed (Berndt, 1991, pp. 473-474).

Data and Estimations

To estimate the model, the data sets described in Chapter 5 are used. Both data sets of manufacturing survey and industrial trade are combined to form a panel data set of 82 three- and four-digit ISIC industries, covering a time period from 1975 to 1993. The list of industries included in the data set is provided in Table A6.1 in the appendix of this chapter, with definition of industries is taken from Biro Pusat Statistik (1994). The cost data for production workers, non-production workers, energy, and non-energy intermediate materials are obtained from the manufacturing survey data base. The cost of capital is calculated by multiplying total capital stock with six-month deposit interest rate. The interest rates data are obtained from the International Financial Statistics published by the International Monetary Fund (IMF).

For input prices, unskilled and skilled labour wages are calculated from the manufacturing survey data base, the price of capital is approximated by the six-month deposit interest rate, the price of energy is approximated by the wholesale price index of the petroleum refinery industries published by the Indonesia's Central Agency of Statistics (BPS), and the price of non-energy intermediate materials is approximated by the non-oil wholesale price index obtained from the IMF's International Financial Statistics.

The individual industry effects in the panel data base used in this study are assumed as fixed effects. This assumption implies that these time-invariant individual industry effects 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. Since there is no logarithm value for zero, this creates problems in calculating the logarithm values of these variables. To overcome these problems, a monotonic transformation of these variables in the form of $V' = 1 + V$ replaces the original definitions of these variables as they are described in Chapter 5. Consequently, the logarithm values of these variables are defined as $\ln V' = \ln(1 + V)$, where $V \in \{X, M, T, F\}$.[34]

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

[34] 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.

hypothesis is that there is no endogeneity on 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 becomes inefficient.

Using lag one period of input relative prices and output variables as the instrumental variables for the alternative hypothesis of 3SLS estimator, the test results produce a Chi-square value of 23.621, which is not significant at 5 percent level. Therefore, the result of this test accepts the null hypothesis of exogeneity of the right hand side variables, which implies that the maximum likelihood estimator is the consistent and efficient estimator for the model.

The results of estimation for the whole database is presented in Table A6.2 in the appendix of this chapter. With model fits range between 0.0567 and 0.4169, these estimation results are compared favourably with other empirical studies on this subject which are reviewed in the first section of this chapter. In addition, with critical values of $d_L = 1.675$ and $d_U = 1.863$, all Durbin-Watson statistics of the estimation, which range between 2.5175 and 2.6722, accept 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 difference of the variables. In fact, all subsequent estimation results accept the null hypothesis that there is no serial correlation in the data.

As the graphical analysis in Chapter 5 indicates, there is a possibility for a structural break in the data in 1986, which arisen due to the change in development strategy from import substitution to export orientation. To test for this structural break, the database is divided into two sub-period, with 1986 as the cutting off year. Separate estimations are conducted for each sub-period and then the estimates are tested using a Wald test to see whether they are significantly different or not. The resulting Chi-square value is 274.78, which is significant at one percent level, implying that indeed there is a structural break in the data. The estimation results for the 1975-86 period are presented in Table A6.3, while for the results for 1986-93 period are presented in Table A6.4. With model fits range between 0.0850 and 0.4889, there is a clear improvement in the fits of the model for the later period.[35]

Since the model is estimated on a database of 82 industries, another technical question arises as to whether the aggregation of these industries into a single cost function with the same parameter values does not suffer from aggregation bias. A study in the UK by Lee *et al* (1990) finds that there is a wide diversity in the responsiveness of labour demand to different influences across industries, which prompts them to strongly support the disaggregated analysis rather than aggregated analysis. Since this is basically a question of representativeness of the technology implied by the cost function, the natural way to approach this question is to divide industries into technological groups.

Using the average level of R&D expenditure per unit of production from OECD data, Ray (1995) divides Indonesian manufacturing industries into 4 technological groups: high, medium-high, medium-low, and low. Following this grouping, the 82 industries analysed in this study are grouped accordingly. However, because of the small

[35] For various treatments for structural change in econometrics, see Broemeling and Tsurumi (1987).

number of industries in the first three groups, they are then regrouped into two technological groups: higher and lower technology groups, where the first three original groups are lumped together as the higher technological group. This technological grouping of industries is presented in Table A6.5 in the appendix of this chapter. As can be seen from this table, the lower technology group consists mostly of agricultural processing, textile, wood, paper, and basic metal industries, while the higher technology group includes all the rest.

To test for industry aggregation, Wald tests comparing the estimated coefficients for higher and lower technology groups are conducted for each period. The results of this test is a Chi-square value of 124.55 for the 1975-86 period and 67.09 for the 1986-93 period, which both are significant at 1 percent level. Hence, the results of these tests imply that the two technological groups of industries should be estimated separately in both periods. For the 1975-86 period, the results of estimation for the higher technology industries are presented in Table A6.6, while for the lower technology industries are in Table A6.7. For the 1986-93 period, the results for each technology group are presented in Table A6.8 and A6.9 respectively. In general, there are tendencies for improvements in the model fits after disaggregation. The possibility of further industry disaggregation, although desirable, are restricted by the limited number of observations available. Meanwhile, means and standard deviations of the variables used in the estimations are presented in Table A6.10 in the chapter appendix.

Direction of the Relative Labour Demand Effect

The main purpose of the analysis in this chapter is to assess the effects of various openness and technological change indicators on the relative demand for skilled to unskilled labour. With respect to these indicators, 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 and the level of output are controlled, the changes in cost shares can arise only from changes in the relative demand for factors. Therefore, the difference of an indicator's coefficients on skilled and unskilled labour cost share equations indicates how that particular indicator affects the relative demand for skilled to unskilled labour. Table 6.1 calculates the differences of openness and technological change indicators' coefficients on skilled and unskilled labour cost share equations based on the results of estimations discussed earlier.

Export Expansion

The results for all industries in both periods indicates that increasing export intensity has a negative and significant effect on industries' relative demand for skilled to unskilled labour. In other words, export expansion is associated with greater relative demand for unskilled labour. The results for disaggregated industries, however, indicate that policy regimes significantly affect the positive association between export intensity and relative demand for unskilled labour in each industry group. During the import substitution period, this association significantly applies to lower technology industries, but not for higher technology industries. During the export orientation period, on the other hand, the association significantly applies to higher technology groups and not to the lower technology groups.

Table 6.1:
Openness and Technological Change Indicators' Coefficient Differences on Skilled and Unskilled Labour Cost Share Equations

Indicators	1975-86		1986-93	
	Coefficient Difference	Standard Error	Coefficient Difference	Standard Error
All Industries:				
ln X'	-0.0112**	0.0042	-0.0080*	0.0040
ln M'	0.0062	0.0047	-0.0161**	0.0049
ln T'	0.0171**	0.0057	0.0196**	0.0062
ln F'	0.0113	0.0161	-0.0393*	0.0188
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

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

During the import substitution period, manufacturing industries enjoyed protection from the government. Their domestic market is protected from international competition. As a result, industries which marketed their products domestically tended to be less efficient than otherwise would be, among other things by employing too much of skilled labour. Industries which wanted to export their products, however, had to be more competitive internationally, ie. by employing relatively more of the abundant and cheaper factor, which is the unskilled labour. This is clearly shown by the negative and significant coefficient of export intensity ratio in the lower technology industries. The very small and insignificant coefficient in higher technology industries is probably associated with the fact that these industries did not do much exporting during this period.

After the trade policy was switched to export orientation, the protection rapidly diminished, forcing industries to become more efficient. This is reflected in the coefficient for lower technology industries which is very small and insignificant, implying that there is no significant difference in relative labour employment between those industries which market their product domestically and those which are exporting. The higher technology industries, meanwhile, are naturally more skilled labour intensive. Therefore, these industries have a broader spectrum of their relative skill intensity. The negative and significant coefficient of these industries indicate that they increase their relative employment of unskilled labour when they compete in the export market.

Studies in developed countries which concentrate on the effects of export expansion on labour market (Bernard and Jensen, 1995 and 1997) find that, in general, export expansion increases the relative demand for skilled labour, hence increases wage inequality between skilled and unskilled labour. The results of this study indicate that export expansion in developing countries, in general, tends to increase the relative demand for unskilled labour. These opposite effects of export expansion on relative labour demand in developed and developing countries seems to support the Heckscher-Ohlin-Samuelson (HOS) model. This model predicts that countries export goods which are intensive in the relatively abundant factors. Therefore, increasing export expansion will tend to increase the relative demand for the relatively abundant factor.

Import Competition

The results for all industries indicate that the effects of increasing import penetration on relative labour demand changes from positive but insignificant during the import substitution period to become negative and significant in the export orientation period. These results are carried over to disaggregated industries, with the exception that the effects for lower technology industries in the export orientation period is not significant.

The protection given to industries during the import substitution period effectively insulated domestic industries from import competition. The insignificant coefficients of both industry groups indicate that there was no need for industries to substitute unskilled labour for skilled labour in order to compete with imports. But this is changed when the economy becomes more open during the export orientation period. This is clearly shown by the negative and significant coefficient in the higher technology industries. In the face of intensifying competition from imports, these industries reduce their skill intensity. The insignificant coefficient in lower technology industries again shows that these industries have become competitive internationally.

Studies in developed countries which concentrate on the effects of import competition on the labour market (Grossman, 1987; Lee, 1995; and Revenga, 1992) find that increasing import competition tend to reduce the relative demand for unskilled labour. The results of this study indicate that greater import competition in developing countries, in general, tend to reduce the relative demand for skilled labour. These opposite effects of import penetration on relative labour demand in developed and developing countries are also consistent with the HOS model. Since countries export goods which are intensive in the relatively abundant factors, in the importing countries these goods will compete with the goods which are intensive in the relatively scarce factors. Therefore, increasing import competition will tend to reduce the relative demand for the relatively scarce factor.

New Capital

The effect of increasing proportion of new capital from total capital stock on the relative demand for skilled to unskilled labour in all industries is relatively stable in both periods, ie. positive and significant. The disaggregated data, however, indicate that during the import substitution period it is significant only for the higher technology industries, while during the export orientation period it is significant only for the lower technology industries. Therefore, all estimated coefficients indicate that new capital tends to increase the relative demand for skilled labour, or at least neutral.

The differences in coefficient's significance probably indicates the changes in the patterns of investment. During the import substitution period, much of investment took place in higher technology industries. Therefore, it is in these industries the coefficient is significant. During the export orientation period, on the other hand, much of the investment took place in the lower technology industries. Hence, it is the coefficient in these industries which becomes significant.

Studies in developed countries have shown that technological change is unskilled labour saving, therefore tends to reduce the relative demand for unskilled labour, and hence, tends to increase wage inequality between skilled and unskilled labour (Berman *et al*, 1994; Lawrence and Slaughter, 1993). However, the model used here cannot verify whether the positive association between new capital and skilled labour relative demand is caused by biased technological change or by other factors.[36]

Foreign Participation

The estimation results for all industries indicate that the effect of increasing foreign participation in all industries is positive but insignificant during the import substitution period and negative and significant during the export orientation period. In the disaggregated estimations for the import substitution period, the effect is positive for higher technology industries and negative for lower technology industries, but both are not significant. For the export orientation period, the effects on both industry groups are negative, but insignificant for the higher technology industries and significant for the lower technology industries.

The changes in pattern of foreign investment tend to follow the changes in pattern of overall investment as represented by the new capital variable. During the import substitution period, much of foreign investment was directed toward the higher technology industries. It seems that during this period foreign investors came with the main purpose to exploit the domestic market by relying on the protection wall. In the

[36] In fact, the analysis in Chapter 7 indicates that there has been little bias. Furthermore, the analysis shows that the increase in total factor productivity is the main factor behind the increase in the relative wage of skilled labour.

export orientation period, on the other hand, most foreign investors who come want to exploit Indonesia's comparative advantage in unskilled labour intensive good for export market. Hence, most of foreign investment took place in the lower technology industries with a significant effect on increasing the relative demand for unskilled labour.

These results for export orientation period tend to support Wood (1994), who asserts that the type of capital which moves from developed to developing countries is the one which is suitable with unskilled labour. Therefore, he asserts that foreign investment in developing countries will result in higher relative demand for unskilled labour. These results, however, contradict the findings by Aitken *et al* (1996) that foreign investment in developing countries tend to increase wage inequality between skilled and unskilled labour. The difference probably arises because in their regressions there is no independent variable representing the extent of new capital investments by domestic firms. Hence, what the results of this study point out is that it is the newness of capital, and not its foreignness, which increases the relative demand for skilled labour.

Magnitude of the Relative Labour Demand Effect

The analysis of skilled and unskilled labour relative demand in the previous section shows that greater trade openness, both in the forms of increasing export intensity or import competition, as well as increasing foreign participation in industries, are largely associated with increasing relative demand for unskilled labour. This is particularly true for the export orientation period, when the economy was more open. On the other hand, new capital is largely associated with increasing relative demand for skilled labour.

To estimate how the developments in openness and technological change after the mid 1980s affected the overall relative demand for labour, the magnitude of each indicator's effect on relative labour cost share was calculated, yielding results summarised in Table 6.2. The coefficient difference of Table 6.1 is multiplied by the standard deviation of each indicator for the 1986-93 time period of Table A6.10. In Table 6.2, the first column reproduces the coefficient difference for the two industry groups in the 1986-93 period, the second column presents the standard deviation of each indicator, and the third column lists the product of the first and second. The values for all industries in this column, meanwhile, 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.

The table shows that, in the higher technology industries, the effects of increasing export intensity, import penetration, and foreign participation, which all increase the relative demand for unskilled labour, dominate the effect of the increasing proportion of new capital, which increases the relative demand for skilled labour. This is shown by the total effect for this industry group which is negative and statistically significant. For the lower technology industries, on the other hand, the latter slightly dominates the former. This is shown by the total effect which is positive but statistically insignificant.

The resulting weighted averages for all industries indicate that the effects of trade openness and foreign participation are indeed negative, which indicate that these factors tend to increase the relative demand for unskilled labour. The effect of export intensity ratio, however, is not statistically significant. The effect of new capital, meanwhile, is shown to be positive and statistically significant, which indicate the tendency of this indicator to increase the relative demand for skilled labour. The overall effect is negative, implying an overall slight increase in the demand for unskilled labour relative to the skilled, although statistically insignificant.

Table 6.2:
Magnitude of Openness and Technological Change Indicators' Effects on Relative Labour Demand, 1986-93

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

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

Concluding Remarks

The slight increase in relative demand for unskilled labour is consistent with the increase in relative employment of unskilled labour after the mid 1980s. However, this demand side changes by themselves cannot explain the shift toward increasing relative wage of skilled labour 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 labour is comparatively elastic in supply to manufacturing. Hence, despite the relative rise in the demand for unskilled labour, the increase in the skilled labour wage may still be greater than that in the unskilled wage. This is consistent with the dual labour market theory, which is described in Chapter 3. The conclusion that Indonesia is still in the labour surplus phase, in particular for the period under study, is confirmed by Manning (1994), who asserts that there remains an overall surplus of unskilled labour in the country.

Hence, what was going on in the Indonesian manufacturing labour market after the mid of 1980s can be illustrated by Figure 6.1. In this figure, W refers to wage, N is for employment level, S denotes labour supply, and D is labour demand. Meanwhile, the superscripts H and L indicates skilled labour and unskilled labour respectively. Note that the supply of unskilled labour, S^L, is very elastic, while the supply of skilled labour, S^H, is less elastic. Trade and investment liberalisation increases the demand for both skilled and unskilled labour, reflected by a rightward shift of both skilled labour demand

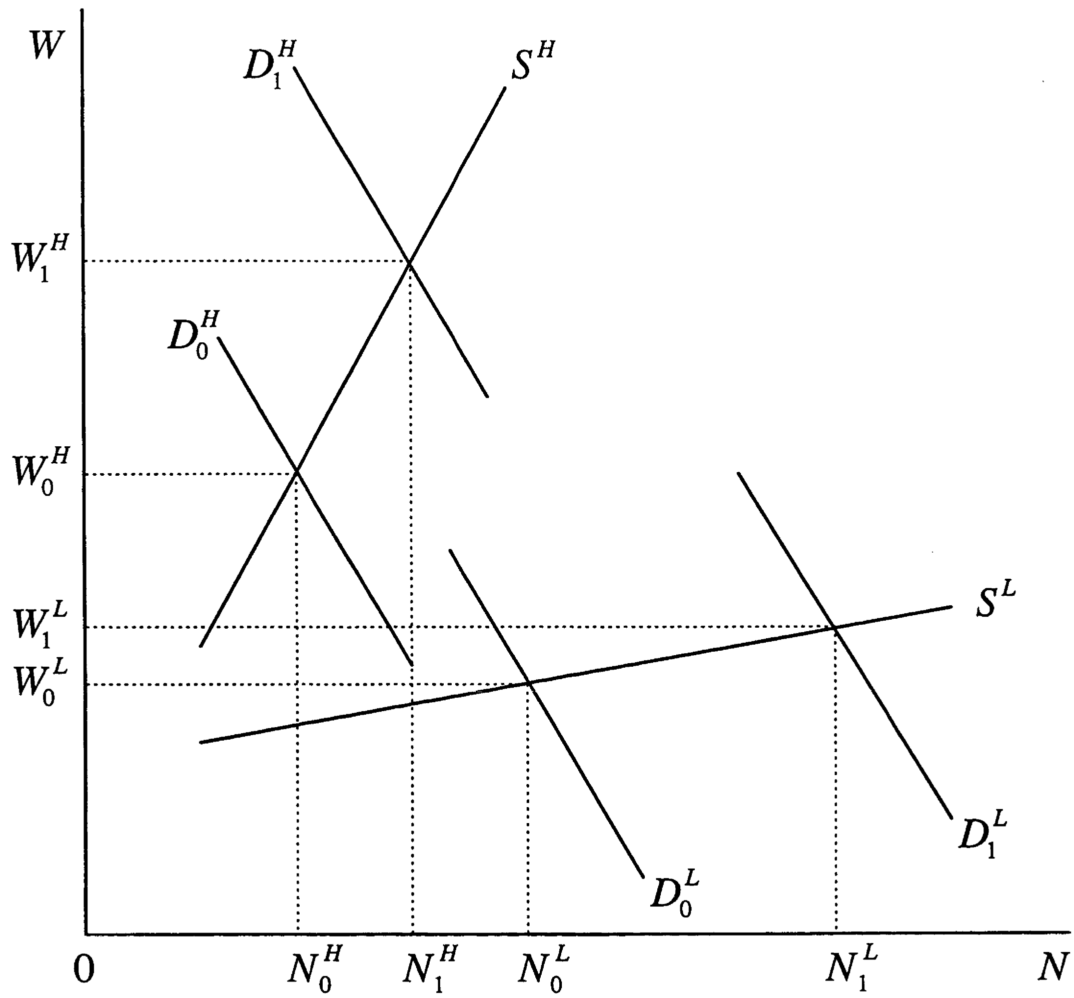

Figure 6.1:
Demand Increases and Changes in Employment and Wages of Skilled and Unskilled Labour

from D_0^H to D_1^H and unskilled labour demand from D_0^L to D_1^L. As the findings of this study point out, the increase in unskilled labour demand, measure as the horizontal shift, is slightly higher than the increase in skilled labour demand.

These shifts in labour demand increase the wages and employment of both skilled and unskilled labour. Skilled labour wage increases from W_0^H to W_1^H while their employment increases from N_0^H to N_1^H. Similarly, unskilled labour wage increases from W_0^L to W_1^L while their employment increases from N_0^L to N_1^L. However, due to the differences in labour supply elasticities, $\frac{W_0^H W_1^H}{0W_0^H}$ is greater than $\frac{W_0^L W_1^L}{0W_0^L}$, which implies that the relative wage of skilled to unskilled labour has increased. On the other hand, $\frac{N_0^H N_1^H}{0N_0^H}$ is less than $\frac{N_0^L N_1^L}{0N_0^L}$, which implies that the relative employment of unskilled to skilled labour has increased.

Chapter Appendix

Table A6.1:
List of Industries Included in The Estimation

ISIC Code	Definition
3111	Slaughtering, processing, and preserving of meat
3112	Manufacture of dairy products
3113	Manufacture of processed and preserved fruits and vegetables
3114	Manufacture of processed and preserved fish and its similar products
3115	Manufacture of cooking oil and fat made of vegetables and animals
3116	Manufacture of grain mill products
3117	Manufacture of noodle and bakery products
3118	Manufacture of sugar and processed sugar
3119	Manufacture of chocolate powder and food made of chocolate and sugar confectionery
3121	Manufacture of starch
3122	Manufacture of processed tea and coffee
3123	Manufacture of ice
3124	Manufacture of food made of soya bean
3125	Manufacture of chips and food similar to chips
3126	Manufacture of prepared food spices and seasoning
3127	Manufacture of other food products
3128	Manufacture of prepared animal feeds
3131	Manufacture of liquors
3132	Manufacture of wines and its similar products

Table A6.1:
Continued

ISIC Code	Definition
3133	Manufacture of malt liquors and malt
3134	Manufacture of soft drinks and carbonated water
3140	Manufacture of tobacco products
3211	Spinning, weaving, finishing textiles
3212	Manufacture of made-up textile goods except wearing apparels
3213	Knitting mills
3214	Manufacture of carpets and rugs
3215	Manufacture of rope, twine, and goods made of rope or twine
3216	Manufacture of capoc
3219	Manufacture of textiles not elsewhere classified
3220	Manufacture of clothes except footwear
3231	Manufacture of preserved leather and leather tanneries
3233	Manufacture of products of leather and substitutes
3240	Manufacture of footwear
3311	Sawmills and manufacture of wood products
3312	Manufacture of wood containers except coffin
3313	Manufacture of plaits from plants
3314	Manufacture of wood carving except furniture
3319	Manufacture of products of wood, cork, rattan not elsewhere classified
3320	Manufacture of furniture and fixtures; kitchen utensils of wood, bamboo, and rattan
3411	Manufacture of pulp, paper, and cardboard

Table A6.1:
Continued

ISIC Code	Definition
3412	Manufacture of boxes made of paper or cardboard
3419	Manufacture of products of paper or cardboard not elsewhere classified
3420	Printing, publishing, and allied industries
3511	Manufacture of basic chemicals
3512	Manufacture of fertilisers
3513	Manufacture of synthetic resins, rubber, and fibres
3514	Manufacture of pesticides and plant generating chemicals
3521	Manufacture of paints, varnishes, and lacquers
3522	Manufacture of drugs and medicines
3523	Manufacture of soap, cleaning preparations, and cosmetics
3529	Manufacture of chemical products not elsewhere classified
3551	Manufacture of tire and inner tubes
3559	Manufacture of products of rubber not elsewhere classified
3560	Manufacture of plastic products
3610	Manufacture of porcelain
3620	Manufacture of glass and glass products
3631	Manufacture of cement
3632	Manufacture of products of cement
3633	Manufacture of lime products
3640	Manufacture of clay products
3690	Manufacture of other non-metallic mineral products
3710	Iron and steel basic industries

Table A6.1:
Continued

ISIC Code	Definition
3811	Manufacture of agricultural tools, hand tools, cutlery, and kitchen wares
3812	Manufacture of furniture and fixtures primarily made of metal
3813	Manufacture of fabricated metal products
3819	Manufacture of products of metal not elsewhere classified
3820	Manufacture of machineries except electrical
3831	Manufacture of electrical machineries
3832	Manufacture of radio, television, and communication equipment
3833	Manufacture of household electronical appliances
3839	Manufacture of other electrical apparatus and components
3841	Manufacture and repair of ships/boats
3843	Manufacture of motor vehicles and their components
3844	Manufacture of motor cycles, bicycles, and their components
3845	Manufacture and repair of aircraft and its components
3850	Manufacture of professional, scientific, measuring, and controlling equipment
3901	Manufacture of jewellery and related articles
3902	Manufacture of musical instruments
3903	Manufacture of sporting and athletics goods
3904	Manufacture of toys
3906	Manufacture of artist's materials not elsewhere classified
3909	Manufacture industries not elsewhere classified
n = 82	

Table A6.2:
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 A6.3:
Estimation Results for All Industries, 1975-86

Independent Variables	Dependent Variables			
	S_L	S_H	S_K	S_E
Constant	-0.0005	-0.0003	0.0061*	0.0011
	(0.0010)	(0.0006)	(0.0036)	(0.0008)
$\ln(P_L/P_I)$	0.0318**	-0.0051**	-0.0085**	-0.0041*
	(0.0030)	(0.0016)	(0.0027)	(0.0024)
$\ln(P_H/P_I)$	-0.0051**	0.0103**	-0.0028*	-0.0047**
	(0.0016)	(0.0013)	(0.0016)	(0.0017)
$\ln(P_K/P_I)$	-0.0085**	-0.0028*	0.1616**	-0.0003
	(0.0027)	(0.0016)	(0.0097)	(0.0022)
$\ln(P_E/P_I)$	-0.0041*	-0.0047**	-0.0003	0.0263**
	(0.0024)	(0.0017)	(0.0022)	(0.0051)
ln Y	-0.0006	0.0028**	-0.0815**	0.0054**
	(0.0015)	(0.0009)	(0.0049)	(0.0011)
ln X'	0.0020	-0.0092**	0.0411*	-0.0023
	(0.0054)	(0.0033)	(0.0188)	(0.0042)
ln M'	-0.0137*	-0.0075*	0.0001	-0.0087*
	(0.0060)	(0.0037)	(0.0210)	(0.0047)
ln T'	-0.0413**	-0.0242**	-0.1094**	-0.0228**
	(0.0073)	(0.0044)	(0.0252)	(0.0057)
ln F'	-0.0016	0.0096	-0.1553*	0.0303*
	(0.0207)	(0.0126)	(0.0714)	(0.0162)
R^2	0.0966	0.1351	0.4201	0.0868
Durbin-Watson	2.5986	2.6430	2.5913	2.5150
n = 82 x 11 = 902				

Note: numbers in parentheses are standard error,
** is significant at 1 percent level,
* is significant at 5 percent level.

Table A6.4:
Estimation Results for All Industries, 1986-93

Independent Variables	Dependent Variables			
	S_L	S_H	S_K	S_E
Constant	-0.0004 (0.0008)	0.0006 (0.0004)	0.0120** (0.0024)	-0.0008 (0.0012)
$\ln(P_L/P_I)$	0.0265** (0.0028)	0.0039** (0.0011)	-0.0070* (0.0035)	0.0077** (0.0032)
$\ln(P_H/P_I)$	0.0039** (0.0011)	0.0186** (0.0010)	-0.0023 (0.0016)	-0.0070** (0.0023)
$\ln(P_K/P_I)$	-0.0070* (0.0035)	-0.0023 (0.0016)	0.1057** (0.0108)	-0.0083* (0.0045)
$\ln(P_E/P_I)$	0.0077** (0.0032)	-0.0070** (0.0023)	-0.0083* (0.0045)	-0.0399** (0.0129)
ln Y	-0.0082** (0.0020)	-0.0085** (0.0009)	-0.1109** (0.0054)	0.0095** (0.0023)
ln X'	0.0078* (0.0043)	-0.0001 (0.0019)	-0.0109 (0.0118)	0.0060 (0.0049)
ln M'	0.0089* (0.0052)	-0.0072** (0.0023)	-0.0041 (0.0144)	0.0025 (0.0060)
ln T'	-0.0193** (0.0067)	0.0003 (0.0030)	0.0445** (0.0184)	-0.0068 (0.0076)
ln F'	0.0367* (0.0202)	-0.0027 (0.0090)	-0.0059 (0.0556)	-0.0199 (0.0231)
R^2	0.1880	0.4002	0.4889	0.0850
Durbin-Watson	2.4031	2.5920	2.0877	2.4781
n = 82 x 7 = 574				

Note: numbers in parentheses are standard error,
** is significant at 1 percent level,
* is significant at 5 percent level.

Table A6.5:

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 A6.6:
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 A6.7:
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 A6.8:
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 A6.9:
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 A6.10:
Means and Standard Deviation of Variables in Estimation

Variables	All Industries 1975-93	1975-86	1986-93
S_L	0.0533	0.0544	0.0517
	(0.0439)	(0.0456)	(0.0418)
S_H	0.0270	0.0276	0.0261
	(0.0204)	(0.0226)	(0.0164)
S_K	0.2758	0.3332	0.1835
	(0.2765)	(0.3074)	(0.1823)
S_E	0.0440	0.0421	0.0484
	(0.0709)	(0.0723)	(0.0693)
$\ln(P_L/P_I)$	0.1898	0.1051	0.3297
	(0.4148)	(0.3886)	(0.4165)
$\ln(P_H/P_I)$	0.2305	0.1256	0.3982
	(0.5614)	(0.5348)	(0.5586)
$\ln(P_K/P_I)$	-1.2141	-1.1019	-1.3812
	(0.4932)	(0.5754)	(0.1856)
$\ln(P_E/P_I)$	0.3881	0.2123	0.6596
	(0.3078)	(0.2537)	(0.0935)
ln Y	1.5844	0.8823	2.7104
	(1.8225)	(1.4942)	(1.6928)
ln X'	0.1716	0.1237	0.2428
	(0.3332)	(0.2803)	(0.3931)
ln M'	0.2590	0.2647	0.2445
	(0.2758)	(0.2672)	(0.2840)
ln T'	0.2805	0.2175	0.3759
	(0.3244)	(0.3376)	(0.2645)
ln F'	0.0683	0.0713	0.0625
	(0.0849)	(0.0913)	(0.0730)

Note: numbers in parentheses are standard deviations

Table A6.10:
Continued

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 A6.10:
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

Chapter 7:

GLOBALISATION AND WAGE INEQUALITY IN INDONESIA: A GLOBAL CGE APPROACH

Indonesia has considerable ethnic diversity and socio-economic stratification. The distribution of income and wealth is, therefore, an important policy issue. Some studies note concerns among policy makers that labour has been left behind in the distribution of "national cake", especially in the deregulation period since the mid 1980s (Agrawal, 1996; Manning, 1994). To some, therefore, the finding in Chapter 5 that wage inequality between skilled and unskilled labour has increased might suggest a return to protectionism.

This chapter offers a qualitative analysis of the effects of globalisation on Indonesian labour markets and of the effects of future policy change. An empirical global computable general equilibrium (CGE) framework is used, wherein Indonesia is identified as a distinct region. The objectives of the analysis are twofold. The first is to reproduce the effects of globalisation on Indonesian labour markets by replicating observed shocks and using the results to apportion significance to each. The second is to assess various possible policy responses to globalisation, particularly policy responses to increasing wage inequality between skilled and unskilled labour.

The analysis of this chapter combines the model and data used as well as the results obtained in Chapters 4, 5, and 6. In Chapter 4, analytical results for the archetype of developing countries are derived, but they do not permit the direct assessment of particular shocks in Indonesia. In Chapter 5, both labour market changes and the changes in indicators representing globalisation are established, with the analysis on causality is exercised in Chapter 6. The emphasis is on the role of openness and embodied technological change. The effects of productivity gain and biased technological change are not directly considered. Even so, the use of the variable "new capital" suggests some role for the technology embodied in acquired machinery and equipment. Hence, this chapter combines the analytical method of Chapter 4 with the data analysed in Chapters 5 and 6 to address, first, the roles of openness, capital accumulation, productivity change, and biased technological change. In the same context, then, the effects of further potential policy changes are considered.

The Model and Database

The analytical structure of the model used in this chapter is the same as the "alternative formulation" in Chapter 4. The demand structure, as illustrated in Figure 7.1, is the same as Figure 4.1, except that now there are n = 4 goods and the private household expenditure has a constant difference elasticity (CDE) function. This functional form permits non-homothetic preferences, so that marginal budget shares may vary with income (Hanoch, 1975). The supply structure, illustrated in Figure 7.2, is very similar to that of Figure 4.3, with the difference that land is added as a sector specific primary factor. To do this, another layer is added at the top of primary factors composite tree. From Figure 7.2, it is clear that firms combine land and the skilled-unskilled composite to form a value added composite, which is then combined with a composite of intermediate goods in the production process.

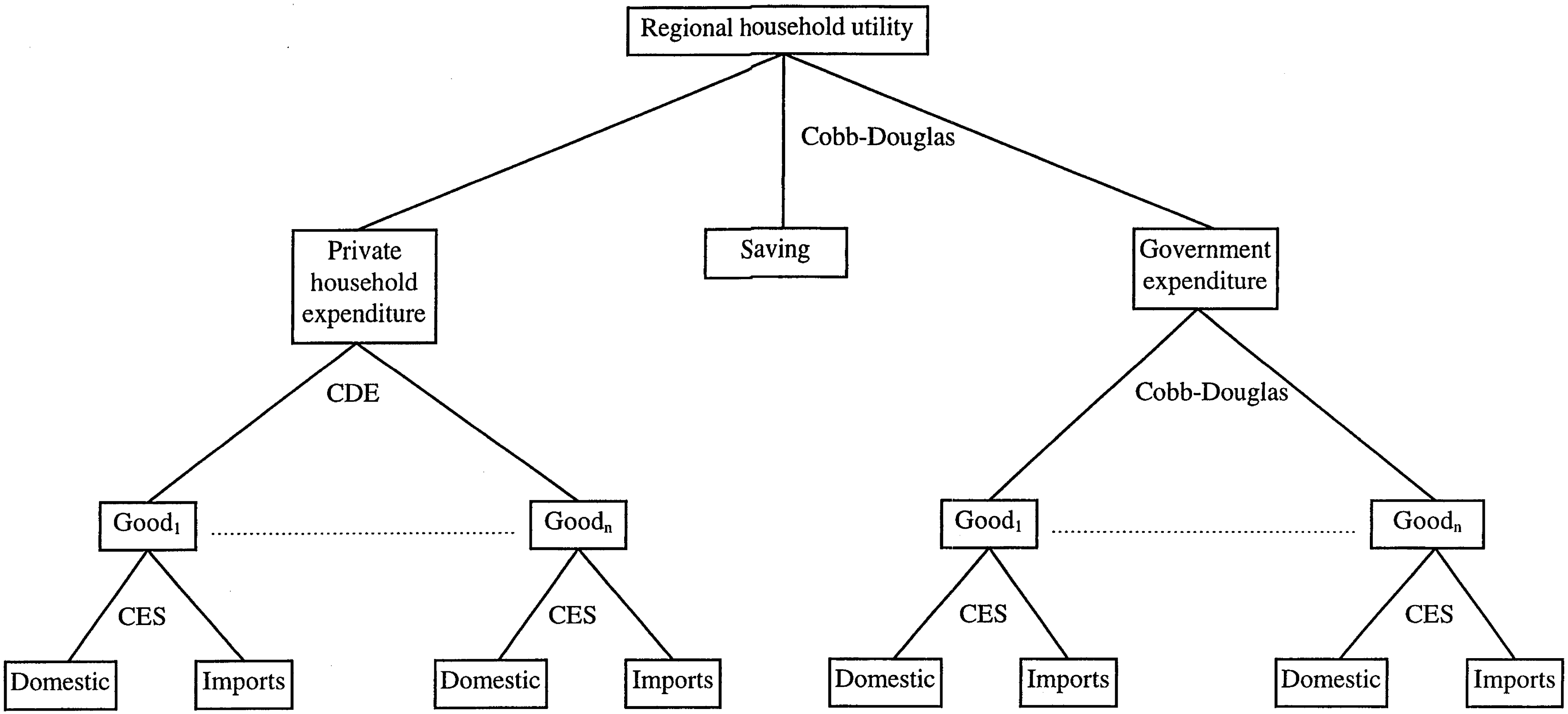

Figure 7.1:
Demand Structure

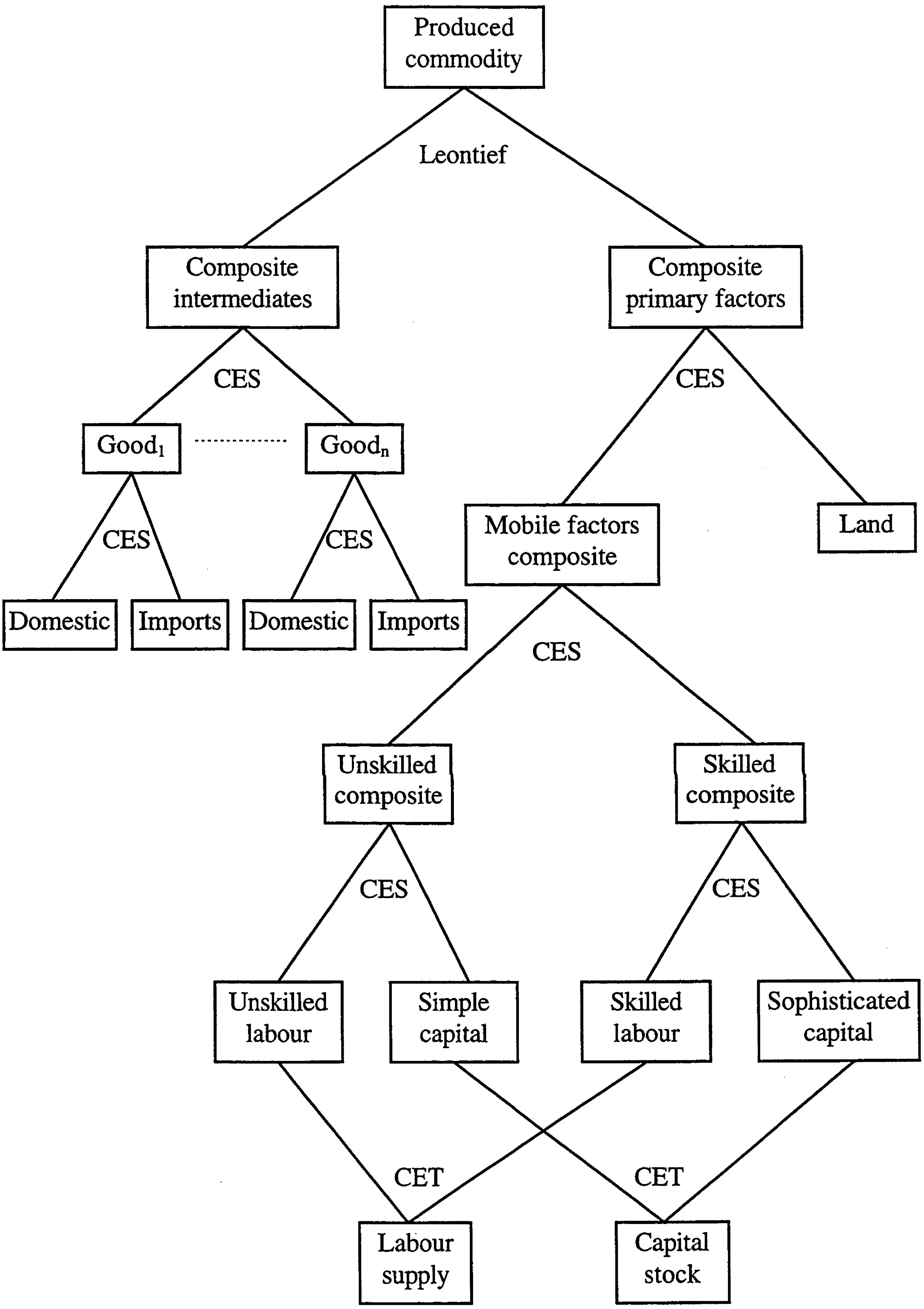

Figure 7.2:
Supply Structure

As emphasised in Chapter 4, this analytical structure is developed to accommodate different types of capital, where each type of capital has different complementarity and substitutability with different types of labour. Like in Chapter 4, this analytical structure and the values of elasticities used make simple capital and unskilled labour as complementary to each other, likewise sophisticated capital and skilled labour. On the other hand, each composite of capital and labour are substitute for each other.

Different from Chapter 4, however, the analysis in this chapter uses real data in the form of intertemporal changes drawn from the sources of Chapters 5 and 6 and the GTAP global data base version 3.[37] The model structure in terms of regions, industries, and primary factors is described in Table 7.1.[38] The table also shows how this structure is aggregated or disaggregated from the GTAP global data base version 3.

Because the original GTAP data base does not differentiate between skilled and unskilled labour or between simple and sophisticated capital, a disaggregation of labour and capital payments was required. This was based on Liu *et al* (1998). The disaggregation is assumed to be the same across regions, except for the developed countries. Table 7.2 shows the proportion of skilled labour payments from the total labour payments, which is assumed to be equal to the proportion of sophisticated capital payments from the total capital payments.

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[37] Overview of the GTAP data base is provided in Gehlhar *et al* (1997).

[38] To run the model using the "Tablo" of the alternative model in Chapter 4, appropriate changes to the dimensions of the sets should be made first.

Table 7.1
Regions, Industries, and Primary Factors in the Model Structure

Model Structure	GTAP Global Data Base Version 3
Regions:	
Indonesia	Indonesia
ASEAN3	Malaysia; Thailand; Philippines
East Asia	Japan; Republic of Korea; China; Hong Kong; Taiwan; Singapore
Developed Countries	United States of America; Canada; Mexico; European Union 12; Australia; New Zealand
Rest of the World	India; Rest of South Asia; Central America and Caribbean; Argentina; Brazil; Chile; Rest of South America; Austria, Finland and Sweden; European Free Trade Area; Central European Associates; Former Soviet Union; Middle East and North Africa; Sub Saharan Africa; Rest of World
Industries:	
Primary	paddy rice; wheat; grains; non grain crops; wool; other livestock; forestry; fisheries; coal; oil; gas; other minerals
Unskilled manufacturing	processed rice; meat products; milk products; other food products; beverages and tobacco; textiles; wearing apparels; lumber; pulp paper etc; petroleum and coal; nonmetallic minerals; primary ferrous metals; nonferrous metals
Skilled manufacturing	leather etc; chemicals rubbers and plastics; fabricated metal products; transport industries; machinery equipment; other manufacturing
Services	electricity, water and gas; construction; trade and transport; other services (private); other services (government); ownerships of dwellings
Primary Factors:	
Land	Land
Unskilled labour	Labour
Skilled labour	
Simple capital	Capital
Sophisticated capital	

Table 7.2
Proportion of Skilled Labour Payments from the Total Labour Payments or
Proportion of Sophisticated Capital Payments from the Total Capital Payments

Industry	Developed Countries		Other Regions	
	Typical Industry	Proportion of Payments	Typical Industry	Proportion of Payments
Primary	grains (Canada)	0.20	grains (Taiwan)	0.12
Unskilled manufacturing	wearing apparels (US)	0.20	wearing apparels (Korea)	0.12
Skilled manufacturing	transport equipment (US)	0.48	transport equipment (Korea)	0.27
Services	electricity, water and gas (US)	0.33	electricity, water and gas (Korea)	0.15

Source: Liu *et al* (1998)

The resulting distribution of value added in the data base for the Indonesian region is shown in Table 7.3, while for other regions are provided in Table A7.1 in the chapter appendix. The tables show that the services sector is by far the largest sector in all regions. The share of primary industry output in Indonesia is the highest among regions, but its skilled manufacturing output share is the lowest.

Table 7.3:
Distribution of Value Added in Data Base for the Indonesian Region (%)

Factor of Production	Industry: Primary	Unskilled Manufacturing	Skilled Manufacturing	Services	Total
Agricultural land	26.8	0.0	0.0	0.0	8.9
Unskilled labour	24.2	23.7	24.6	31.5	27.4
Skilled labour	3.3	3.2	9.1	5.6	4.8
Simple capital	40.2	64.3	48.4	53.5	50.2
Sophisticated capital	5.5	8.8	17.9	9.4	8.7
Total (US$ billion)	39.3	16.4	9.6	53.2	118.6
Row percent of total	33.2	13.9	8.1	44.9	100.0

Source: Aggregated and disaggregated from GTAP Data Base version 3.

The parameter values used in the simulations are also obtained from the GTAP data base version 3 and presented in Table A7.2 to A7.6 in the appendix of this chapter. The exceptions are the import substitution elasticities presented in Table A7.4, which are twice the original GTAP values. This change accords with model validation experiments by Gehlhar (1997) and the analysis by Yang *et al* (1998).

The data base used includes interregional trade flows. Since the analysis concentrates on Indonesia, however, only Indonesian trade is discussed here. Table 7.4 summarises Indonesia's direction of trade. It is clear from this table that Indonesian exports stem mostly from the primary and unskilled manufacturing sectors. From the total exports of around US$ 37 billion in 1992, primary and unskilled manufacturing commodities contribute almost 40 percent each. In terms of export destination, most of Indonesian exports are destined for East Asia and developed countries. Imports, on the other hand, are mostly skilled manufacturing products, sourced mostly also from the developed countries and East Asia.

Table 7.4:
Indonesia's Direction of Trade, 1992 (%)

Commodity	Importing/Exporting Region				
	ASEAN3	East Asia	Developed Countries	Rest of World	Total
Exports:					
Primary	30.0	55.2	20.7	11.1	39.4
Unskilled manufacturing	48.4	31.0	41.4	59.1	37.3
Skilled manufacturing	20.8	10.3	25.7	20.1	16.5
Services	0.8	3.5	12.3	9.8	6.8
Total (US$ billion)	1.1	20.4	11.8	3.2	36.5
Row percent of total	3.0	55.9	32.3	8.8	100.0
Imports:					
Primary	18.9	1.7	7.3	33.2	8.6
Unskilled manufacturing	45.5	27.3	11.6	19.2	19.5
Skilled manufacturing	33.5	66.3	52.2	28.8	54.3
Services	2.2	4.6	29.0	18.8	17.7
Total (US$ billion)	0.9	12.0	14.7	3.7	31.4
Row percent of total	2.9	38.2	46.8	11.8	100.0

Source: GTAP Data Base version 3.

Integrated labour market is the only labour market closure used in this analysis. Different from Chapter 4, there is no need to use the dual labour market closure now because the data base already contains the primary sector, in which a large number of unskilled workers are employed. The global capital market closure used, meanwhile, is the one in which the allocation of regional investment equates the expected rate of return on investment across regions. Hence, capital is mobile internationally.

Replicating the Effects of Globalisation on Wage Inequality

As discussed in Chapter 2, The Heckscher-Ohlin-Samuelson (HOS) model predicts that openness will be beneficial for unskilled labour in developing countries. A generalisation of this model that incorporates a non-tradeable sector and developing country labour market characteristics in a CGE framework, discussed in Chapter 4, indicates that the result still hold as long as the labour market is integrated. Because the unskilled wage remains low when "surplus labour" is available in a dual economy, this result is weakened. The empirical evidence in developing countries, as reviewed in Chapter 3, indicates the effects of openness on labour markets are mixed. For the case of Indonesia, as analysed in Chapter 5 and 6, there is an indication that the overall effect of openness is toward higher relative demand for unskilled labour. However, because the supply of unskilled labour is very elastic, the relative wage of skilled labour is still increased.

In this section, the effects on the Indonesian labour market of economic shocks associated with globalisation are quantified. Following Chapters 5 and 6, three types of economic shocks are introduced: trade liberalisation, capital accumulation, and technological change. The objectives of these simulations are to validate the model by comparing the results of these simulations on the Indonesian economy, particularly in the labour market, to the results of empirical analysis in Chapters 5 and 6, and to decompose the aggregate change in the Indonesian labour market during the liberalisation period from the mid 1980s. The latter analysis allow the apportionment of these effects across contributing shocks.

Trade Liberalisation

Trade liberalisation was the most significant step taken by Indonesia when it shifted its development strategy from import substitution to export orientation in the mid 1980s. The effects of this trade liberalisation on real factor returns are examined in two simulations. The first imposes on the model the reduction in import tariffs between 1987 and 1992. The second exercise subjects it to further trade liberalisation, reducing tariff equivalents according to commitments made by the government for the period to 2003. The changes in tariff structure between 1987 and 2003 are shown in Table 7.5. The tariff structure in 1987 is estimated based on Fane and Phillips (1991), the 1992 tariff structure is calculated from the data base, while the estimate for 2003 is based on Fane and Condon (1996).[39]

Comparing the 1987 with the 1992 tariff structure, it is clear that during the 1987-92 period trade liberalisation in Indonesia took place mostly on skilled manufacturing commodity. Meanwhile, if the scheduled liberalisation until the year 2003 is implemented, it will cover broader commodities. The results of the simulations for real

[39] Tariff here refers to tariff equivalent reflected in the differences between across border prices.

factor returns as well as income and utility are presented in Table 7.6, while for other selected variables are presented in Table A7.7 in the chapter appendix.[40]

Table 7.5
Indonesia's Tariff Structure (%)

Commodity	1987	1992	2003
Primary	18	19	4
Unskilled manufacturing	14	14	3
Skilled manufacturing	40	14	3

Source: For 1987, Fane and Phillips (1991); for 1992, GTAP Data Base version 3; for 2003, Fane and Condon (1996).

Table 7.6:
Changes in Real Factor Returns in Indonesia from Trade Liberalisation (%)[a]

	1987-1992 shock	1992-2003 shock
Real Factor Returns:		
Land	6.2	-2.7
Unskilled labour	1.2	2.8
Skilled labour	-0.2	2.9
Simple capital	1.3	3.3
Sophisticated capital	-0.6	3.3

[a]Comparative static analysis using model based on 1992 data subjected to different tariff reduction shocks.

Source: Model simulations discussed in the text.

[40] Due to they way tariff specified in the model, it is the power of tariff which is shocked to simulate the actual trade liberalisation. The term power of tariff refers to the ratio of the value of imports valued at domestic price to the value of imports valued at CIF price.

Table 7.6 shows that trade liberalisation in the 1987-92 period reduced real returns to skilled labour and sophisticated capital, but it increased returns to other factors. The greatest benefit, however, is obtained by land owners. This is not surprising considering that it was skilled manufacturing products that lost the most tariff protection during this period. Hence, as Table A7.7 shows, output in the skilled manufacturing sector contracts by about a quarter, while all other sectors expand. The unskilled manufacturing sector expands the most.

In terms of relative wages, because unskilled labour enjoyed an increase in its real wage while that of skilled labour decreased, the wage inequality was reduced. This is due to the fact that the skilled manufacturing sector, which is the most liberalised industry during this period, is relatively intensive in skilled labour. These results are consistent with both the hypothesis developed in Chapter 4 and the estimates of the effects of openness indicators on relative labour demand in Chapter 6.

Meanwhile, the simulation results for the 1992-2003 liberalisation, given in the second column of Table 7.6, show that land will be the loser and capital of both types will gain the most. In terms of production, Table A7.7 shows that, although skilled manufacturing industry will still continue to contract, now the primary industry will contract the most. The unskilled manufacturing industry, meanwhile, will continue to expand most rapidly. This reflects the fact that the scheduled liberalisation covers commodities more broadly, including primary industry. The results, therefore, indicate that the scheduled trade liberalisation will very slightly increase the relative wage of skilled labour.

Capital Accumulation

As shown by Figure 5.7 in Chapter 5, Indonesia experienced a rapid increase in capital accumulation, starting in the late 1980s, due to investment liberalisation in the mid 1980s. This is true for domestic as well as foreign direct investment. Calculated from the data base used in Chapter 6, the estimated increase in the manufacturing sector of simple capital stock during the 1986-92 period was around 15 percent, while the sophisticated capital stock grew by 14 percent. To examine the effects of capital accumulation on wage inequality, simulations representing the increases in both types of capital stock are carried out. The effects on real factor returns are presented in Table 7.7, while those on other selected variables are presented in Table A7.8 in the chapter appendix.

Table 7.7:
Changes in Real Factor Returns in Indonesia from a 15 Percent Increase in Simple Capital Stock and a 14 Percent Increase in Sophisticated Capital Stock (%)

Factor of Production	Capital Accumulation Effect
Land	9.8
Unskilled labour	17.9
Skilled labour	17.4
Simple capital	-13.1
Sophisticated capital	-11.2

Source: Model simulation discussed in the text.

The changes in real factor rewards are consistent with intuition. Because the stocks of both simple and sophisticated capital are increased, the real returns to both factors decrease while the real returns to other factors increase. In terms of relative wage, the real wage of unskilled labour increases slightly more than that of skilled labour, resulting in a slight reduction in wage inequality. This is probably because the growth in simple capital is slightly higher than that of sophisticated capital.

As shown in Table A7.8, an increase in the overall capital stock induces all industries to expand, with both manufacturing industries expand the most. Therefore, manufacturing absorbs more of both skilled and unskilled labour, which have to be released from other sectors. The increase in outputs induces more of both domestic and international trade, except for primary good exports. With the domestic and therefore export prices go down, except for primary, while import prices remain the same, there is unfavourable change in the terms of trade. Because of the increase in outputs, however, real income and utility still increase by large proportions.

Technological Change

Another aspect of globalisation which has featured predominantly is technological change. With globalisation, technologies move easily across country boundaries. Indeed, as discussed in Chapters 5 and 6, new technologies are embodied in the capital accumulated by developing countries. Because technological change is difficult to measure, however, empirical analyses like the one implemented in Chapter 6 tend to concentrate on factor accumulation. The model of Chapter 6 does allow production technology to change through time. Indeed, it is directed at the way in which openness and capital accumulation have affected technology, as indicated by the relative demand for skilled and unskilled labour. But the analysis of Chapter 6 does not readily provide estimates of parameter changes in a production structure such as that used in this chapter.

In this model, as shown in Chapter 4, technological change can be analysed as an autonomous factor which can be controlled exogenously. Furthermore, the model can separate the neutral from biased technological change. A neutral technological change is a change in the productivity of all factors in a certain industry by the same proportion. A biased technological change, meanwhile, implies the augmentation of some factor relative to others.

Both types of technological change, as experienced by the Indonesian manufacturing sector during the 1986-92 period, are estimated from the data base of Chapters 5 and 6. For neutral technological change, the estimation is based on the Solow residual method, calculated as the growth in output which is not accounted for by the growth in inputs (Solow, 1957).[41] The results of this growth accounting indicates that the unskilled manufacturing industry experienced a 14 percent increase in total factor productivity, while the skilled manufacturing industry experienced a productivity increase of 26 percent. This high total factor productivity growth in Indonesian manufacturing supports the finding by Ray (1995). It does, however, contradict the view that the East Asian economic growth is primarily driven by input growth with little efficiency improvement (Krugman, 1994).

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[41] Assume an aggregate Cobb-Douglas production function: $Y = A \cdot \prod_i X_i^{\alpha_i}$, where Y is output, X_i are inputs, and A is an index of technology. Then impose $\sum_i \alpha_i = 1$ to get constant returns to scale. In proportional change form, this is: $y = a + \sum_i \alpha_i x_i$, where lower case y, x, and a are proportional changes in Y, X, and A, respectively. By rearranging this equation, total factor productivity growth can be estimated as: $a = y - \sum_i \alpha_i x_i$, which is the growth of output minus the average growth of inputs weighted by their cost shares.

Meanwhile, adapting from Arrow *et al* (1961), the biased technological change is estimated as the residual change in the employment ratio between skilled and unskilled labour after taking into account the change in their wage ratio. Assuming that the elasticity of substitution between skilled and unskilled labour is 1.5, it is estimated that the unskilled manufacturing industry experienced an unskilled labour using technological change of only 2 percent during 1986-92, while the skilled manufacturing industry experienced an unskilled labour saving technological change of 4 percent.[42] This very small bias is contrary to the findings in developed countries which suggest that biased technological change is an important factor in the reduction of demand for unskilled labour (Berman *et al*, 1994).

To examine the effect of these technological changes on wage inequality, two simulations are conducted, addressing the neutral and biased components separately. The neutral technological change is simulated as a 14 percent increase in total factor productivity in the unskilled manufacturing industry and a 26 percent increase in total factor productivity in the skilled manufacturing industry. The biased technological change is simulated as follows. The unskilled manufacturing sector requires 2 percent more unskilled labour input, while the skilled manufacturing sector requires 4 percent

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[42] The firms labour allocation problem is to minimise a wage cost function: $C = w_s L_s + w_u L_u$, subject to a labour value added production function: $Q = \left(\alpha_s^{-\rho} L_s^{-\rho} + \alpha_u^{-\rho} L_u^{-\rho}\right)^{-\frac{1}{\rho}}$, where C is wage cost, L_s and L_u are the employment of skilled and unskilled labour, w_s and w_u are their respective wages, Q is labour value added, while α_s and α_u are skilled and unskilled labour augmenting technology indices respectively. After solving the problem and defining $\sigma = -\dfrac{1}{1+\rho}$ as the elasticity of substitution between skilled and unskilled labour, the bias (with reference to unskilled labour) can be established from: $\dfrac{\alpha_u}{\alpha_s} = \left(\dfrac{L_u}{L_s}\right)^{\frac{1}{1+\sigma}} \left[\dfrac{w_u}{w_s}\right]^{-\frac{\sigma}{1+\sigma}}$.
Meanwhile, the choice of the value 1.5 for the elasticity of substitution is guided only by the broader literature on factor substitution (Dixon, 1992, p. 220). In further research, a formal estimate and some sensitivity analysis will be needed.

less unskilled labour input. The simulated effects on factor rewards are summarised in Table 7.8. Associated changes in other selected variables are presented in Table A7.9 in the chapter appendix.

Table 7.8:
Changes in Real Factor Returns in Indonesia from Technological Change in Manufacturing Industries (%)

Factor of Production	Technological Change Component	
	Neutral	Bias
Land	-23.4	-0.01
Unskilled labour	13.9	0.04
Skilled labour	17.8	0.00
Simple capital	17.2	-0.02
Sophisticated capital	21.2	0.00

Note: The neutral technological change is 14 and 26 percent increases in total factor productivity in the unskilled and skilled manufacturing industries respectively. The biased technological change is 2 percent more and 4 percent less unskilled labour input in the unskilled and skilled manufacturing industries respectively.

Source: Model simulations discussed in the text.

These results show that the neutral technological change in manufacturing industries is beneficial for all factors except land, while the biased technological change in the same industries has very small effects on real factor returns. The latter seems due to the small magnitudes of the biased technological changes that appear to have occurred during the period. As shown by Table A7.9, the neutral technological change increases output in manufacturing and services, but reduces the output of the primary sector. In a small open economy, an increase in productivity generally increases real factor returns because the increase in output induces no or very small changes in product prices, implying no or very small changes in returns to per unit of effective inputs. Since an increase in productivity is equal to an increase in effective units per unit of input, real factor returns increase.

In terms of wage inequality, the neutral technological change increases the real wage of skilled labour by more than the real wage of unskilled labour, so wage inequality rises.[43] Meanwhile, the biased technological change has no effect on the real wage of skilled labour and only very slightly increases the real wage of unskilled labour, resulting in a very slight reduction in wage inequality. With neutral technological change, the relative wage of skilled labour increases because the skilled manufacturing industry, which is relatively intensive in skilled labour, experiences a much larger increase in productivity. With biased technological change, the relative wage of unskilled labour slightly increases because the increase in demand for unskilled labour in the unskilled manufacturing industry is offset by the slightly larger decrease in its demand in the skilled manufacturing industry.

The Cumulative Effects

The effects on real factor returns of globalisation shocks, as shown by simulation results in Tables 7.6 to Table 7.8, show considerable variation. In this subsection, the effects of all the shocks are examined in combination. In particular, this exercise is conducted to compare the simulated change on wage inequality to the observed change discussed in Chapter 5. Figure 5.3 suggests that the wage ratio between skilled and

[43] In Chapter 4, neutral technological change reduces wage inequality because it takes place only in the unskilled labour intensive sector.

unskilled labour increased by 4.9 percent during the 1986-92 period.[44] The "cocktail" of shocks simulated here includes trade liberalisation (as per 1987-92), capital accumulation, and both the neutral and biased technological changes.[45] The effects of this cocktail on real factor returns are presented in Table 7.9, while the results for other variables are presented in Table A7.10.

Table 7.9:
Changes in Real Factor Returns in Indonesia from Combination of Shocks (%)

Factor of Production	Combination of Shocks
Land	-2.7
Unskilled labour	30.9
Skilled labour	32.7
Simple capital	8.2
Sophisticated capital	12.6
Wage Ratio	1.4

Source: Model simulation discussed in the text.

The results show that labour and capital of all types gain. Land owners lose, however. In terms of the relative wage, skilled labour enjoys a higher real wage increase than does unskilled labour. This increase in the relative wage of skilled labour is consistent with the observed increase in wage inequality during the period. Furthermore,

[44] Although this may seem small, the much touted US relative wage change was only 10 percent between 1979 and 1989 (Lawrence and Slaughter, 1993). See chapter 5 for more discussion on this.
[45] Note that the technological change shocks are only in manufacturing and do not extend to the primary and services sectors.

the implied increase in the wage ratio by 1.4 percent is about 30 percent of the observed increase of 4.9 percent.[46] The observed increase in wage ratio is much higher than the implied increase because the simulation does not take into account developments in the non-manufacturing sectors.[47] However, using the model, it is possible to predict the contribution of each aspect of globalisation to overall wage inequality. Table 7.10 summarises the results from Table 7.6 through 7.9.

Table 7.10 shows that the cumulative effect of various shocks is not the same as the arithmetical summation of the effect of each shock individually. This is due to the non-linear nature of the model. To get the adding up effects of the cocktail shock components, each shock is imposed successively and the incremental increase in the effects are attributed to the added shock. Therefore, in the first run, only trade liberalisation is imposed. All the effects that result are attributed to this shock alone. Then, in the second run, the combination of trade liberalisation and capital accumulation are imposed. The effects of these two shocks minus the effects of the first are attributed to capital accumulation. The process is repeated by subsequently adding neutral and biased technological changes. The results of these incremental simulations are presented in Table 7.11.

[46] The implied change in the wage ratio is calculated as: (1.327/1.309) - 1 = 0.014.

[47] The actual increase in real wages during the 1986-92 period was 24.5 percent for unskilled wage and 33.4 percent for skilled wage. This means that the estimated increase in skilled real wage is close to the actual, but the estimated increase in unskilled real wage is too high compared to the actual.

Table 7.10
The Effects of Trade Liberalisation, Capital Accumulation, Technological Change, and Their Combination on Changes in Real Factor Returns and Wage Inequality (%)

Factor of Production	Cumulative Effect	Trade Liberalisation	Capital Accumulation	Technological Change	
				Neutral	Biased
Land	-2.7	6.2	9.8	-23.4	-0.01
Unskilled labour	30.9	1.2	17.9	13.9	0.04
Skilled labour	32.7	-0.2	17.4	17.8	0.00
Simple capital	8.2	1.3	-13.1	17.2	-0.02
Sophisticated capital	12.6	-0.6	-11.2	21.2	0.00
Wage ratio	1.4	-1.4	-0.4	3.4	-0.04

Source: Model simulations discussed in the text.

Table 7.11

Contributions of Trade Liberalisation, Capital Accumulation, and Technological Change on the Cumulative Changes in Real Factor Returns (%)

	Cumulative	Trade	Capital	Technological Change	
Factor of Production	Effect	Liberalisation	Accumulation	Neutral	Biased
Land	-2.7	6.2	9.7	-18.6	0.00
	(100)	(-230)	(-359)	(689)	(0)
Unskilled labour	30.9	1.2	17.7	12.0	-0.02
	(100)	(4)	(57)	(39)	(0)
Skilled labour	32.7	-0.2	17.4	15.5	0.01
	(100)	(-1)	(53)	(47)	(0)
Simple capital	8.2	1.3	-13.0	19.9	0.01
	(100)	(16)	(-159)	(243)	(0)
Sophisticated capital	12.6	-0.6	-11.4	24.5	0.01
	(100)	(-5)	(-90)	(194)	(0)

Note: Numbers in parentheses are percentages of the cumulative effect.

Source: Model simulations discussed in the text.

From these results, it is possible, roughly, to estimate the proportional contribution of each shock to the cumulative effect. It is important to note that the cumulative results are robust to the order of incremental shocks, but the contributions of component shocks are path dependent. The path adopted here follows the historical sequence: trade reform, capital accumulation, technological changes. Nonetheless, it is clear from Tables 7.10 and 7.11 that one cause stands out in shaping the observed increase in wage inequality in Indonesia since the mid 1980s. This is the increase in total factor productivity in manufacturing. Trade liberalisation has the opposite effect. It tends to reduce wage inequality. Capital accumulation has a large effect on the changes in real factor returns, but its effect on relative wage is small and it tends to reduce wage inequality. Meanwhile, the effect of the small amount of observed bias in technological change is negligible.

Possible Policy Responses to Globalisation

The observed increase in wage inequality between skilled and unskilled labour in Indonesia since the mid 1980s has both social and economic implications. Though small as measured here, it reflects a more considerable separation of the tails of the wage distribution. Had the "Asian crisis" not occurred, this would have created social tensions, though obviously not on the scale observed in the late 1990s. Clearly, inequality is more tolerable when the economic pie is expanding than when it is contracting. Nonetheless, it remains relevant to ask the effects of policies proposed by some to mitigate the wage inequality associated with rapid growth. In this section, therefore, the analysis is concerned with whether policies designed to reduce wage inequality will be successful in achieving their objective and whether they have positive or negative overall welfare implications.

New Protectionism

As the results in the previous section indicate, the trade reforms introduced in Indonesia between the mid 1980s and early 1990s actually reduced wage inequality. Reforms considered since then, which would apply through the early 2000s show may increase wage inequality, particularly if the liberalised industries are the unskilled labour intensive industries. Hence, if such trade liberalisation were viewed as responsible for disadvantaging unskilled labour, pressures for a return to protectionism might have forced the government to back track on its reform agenda. In fact, the notion that a liberalised economy does not "fairly" benefit all the people has always been at the heart of the argument for a return to protectionism both in Indonesia and elsewhere.

To examine the possibility of a policy reversal on trade liberalisation, a hypothetical policy under which the Indonesian government increases the tariffs on primary, unskilled manufacturing, or both industries is examined here. This is simulated as an increase in the power of tariffs by 10 percent in these industries. The effects on real factor returns are presented in Table 7.12, while the changes in other selected variables are presented in Table A7.11 in the chapter appendix.

Table 7.12:
Changes in Real Factor Returns in Indonesia from a 10 Percent Increase in the Power of Tariff in Primary, Unskilled Manufacturing, and Both Industries (%)

Factor of Production	Protected Industry		
	Primary	Unskilled manufacturing	Both
Land	1.7	-0.4	1.4
Unskilled labour	-0.3	-0.6	-0.9
Skilled labour	-0.3	-0.8	-1.2
Simple capital	-0.6	-0.3	-0.9
Sophisticated capital	-0.6	-0.6	-1.2

Source: Model simulations discussed in the text.

The simulation results in Table 7.12 show that tariff reinstitution in the unskilled manufacturing industry reduces the real returns to all factors, while tariff reinstitution in the primary or both industries reduces the real returns to all factors except land. As a specific factor to primary sector, land benefits from tariff imposed on this sector. Furthermore, Table A7.11 show that tariff reinstitution in the primary industry increases the output of this industry and tariff reinstitution in the unskilled manufacturing or both industries increases output in both industries, but output of other industries are depressed. By erecting barriers to import, a tariff induces domestic production substituting imports.

These results suggest that the new protectionism policy can reduce wage inequality between skilled and unskilled labour, but the reductions are small. In each tariff reinstitution scenario, the real wage of skilled labour is decreased by a slightly higher proportion than the corresponding reduction in the unskilled labour real wage.

However, not only should this minimal achievement of the policy objective be weighted against the fall in both real wages of skilled and unskilled labour, but also against the fall in regional real income and utility as shown in Table A7.11. Therefore, it can be concluded that a return to protectionism will not help unskilled workers. Instead, it will condemn them, as well as the economy as a whole, to be worse off.

Tax or Subsidy on Capital

The simulation results on capital accumulation in the previous section indicate that, if the new capital invested is a complement of skilled labour, then wage inequality will increase. If, on the other hand, the new capital invested is a complement of unskilled labour, then the effect on wage inequality is reversed. One policy response to this takes the form of a tax on the use of capital complementary with skilled labour, namely sophisticated capital. An alternative would be to subsidise the use capital complementary with unskilled labour, namely simple capital.

To simulate these possible policy responses, two different capital tax and subsidy shocks are applied to the model. First, a tax of 10 percent is levied on the use of sophisticated capital in the unskilled labour intensive industries, namely the primary and unskilled manufacturing industries. Second, a subsidy of 10 percent is applied to the use of simple capital in the same industries. The measured effects of these simulations on real factor returns are presented in Table 7.13, while the corresponding effects on other selected variables are presented in Table A7.12 in the appendix.

Table 7.13:
Changes in Real Factor Returns in Indonesia from a 10 Percent Increase Tax on the Use of Sophisticated Capital and a 10 Percent Subsidy on the Use of Simple Capital in Primary and Unskilled Manufacturing Industries (%)

Factor of Production	Tax on Sophisticated Capital	Subsidy on Simple Capital
Land	-0.4	1.3
Unskilled labour	-0.1	0.4
Skilled labour	0.1	0.6
Simple capital	0.0	5.3
Sophisticated capital	-3.2	-0.1

Note: Changes in "power of" tax or subsidy is proportional changes in the ratio of prices upstream and downstream of the tax.

Source: Model simulations discussed in the text.

The simulation results in Table 7.13 clearly show that both policies of taxing the use of sophisticated capital and subsidising the use of simple capital cause the relative wage of skilled labour to increase. In the case of the tax, the real wage of unskilled labour actually declines. In the case of the subsidy, although the real wage of unskilled labour increases, the real wage of skilled labour still increases by a higher proportion. This means that instead of achieving its objective to reduce wage inequality between skilled and unskilled labour, both of these policies lead to an even higher wage inequality.

Labour Supply Response

Hitherto the model has been implemented with a closure which fixes the supply of both skilled and unskilled labour. In the longer term, a widening of wage inequality between skilled and unskilled labour will invite a labour supply response where some unskilled workers will transform themselves into skilled workers. This, in effect, will increase the relative supply of skilled labour and, hence, lower their relative wage. The most common mode of labour transformation is through education and training. The government can enhance the labour supply response through, for example, a mass training program or an immigration policy which emphasises skilled migrants.

To analyse the effects of such labour supply responses, a cocktail shock is simulated to get the wage inequality widening effect.[48] Three different simulations are conducted. The first simulation only represents the cocktail shock, while the other two simulations are a combination of the cocktail shock with two different labour supply responses. The first labour supply response is an increase in the labour transformation elasticity from a negligible 0.0001 to 0.5, hence allowing labour supply to respond endogenously to the widening wage inequality. The second is an exogenous labour supply response. It is an increase in total labour supply by 1 percent, but all the new labour is of the skilled type. The measured effects of these changes are presented in Table 7.14, while the associated changes in other selected variables are presented in Table A7.13 in the appendix.

A comparison of the first simulation results with the other two clearly indicates that a labour supply response has the potential to mitigate or even eliminate any increase in wage inequality. With the endogenous labour supply response, the effect on wage inequality of the cocktail shock becomes smaller. The reason can be seen by comparing the first with the second column of Table A7.13. With the endogenous labour supply response, more unskilled labour can be released from primary industry, but other

[48] The cocktail shock includes trade liberalisation, capital accumulation of the sophisticated type, and both neutral and biased technological change.

industries can absorb less, because some of them are transformed into skilled labour, so that all industries can now employ more of skilled labour and less of unskilled labour.

Table 7.14:
Changes in Real Factor Returns in Indonesia from Labour Supply Responses to Increased Wage Inequality (%)

	Labour Supply Response		
Factor of Production	No Response	Endogenous	Exogenous
Land	-14.9	-15.0	-14.5
Unskilled labour	17.0	17.5	17.1
Skilled labour	25.5	22.5	17.3
Simple capital	20.0	19.9	20.2
Sophisticated capital	14.7	15.7	17.5
Wage Ratio	7.3	4.3	0.2

Note: Endogenous labour supply response is when unskilled labour can transform itself into skilled labour. Exogenous labour supply response is an exogenous increase in the supply of skilled labour.

Source: Model simulations discussed in the text.

With the exogenous labour supply response, the effect of the cocktail shock on wage inequality is almost eliminated. But, of course, this is determined by the magnitude of the exogenous increase in skilled labour supply. As shown by Table A7.13, the simulated shock of 1 percent increase in total supply of labour, where all of the additional supply is assumed as of the skilled type, turns out to be roughly equal to a 7 percent increase in total skilled labour supply. This is quite a large increase in skilled labour supply compared to the endogenous response scenario, which only generates around 3 percent increase in the supply of skilled labour. The magnitude of the shock notwithstanding, the effect of an exogenous skilled labour supply increase is always to mitigate the wage inequality.

The results in this section indicate that enhancing the labour supply response to mitigate any increase in wage inequality is the most feasible policy option. Backtracking on economic reform or imposing a tax or subsidy to induce increased relative demand for unskilled labour are either ineffective or cause negative welfare consequences for unskilled labour and the economy as a whole.

Special Case: The Asian Economic Crisis

Starting in mid 1997, the East Asian region was assailed by a financial crisis and subsequent recession. The countries particularly hard hit were Thailand, Malaysia, South Korea, and Indonesia. The crisis began with a currency attack on Thailand's baht, which ultimately forced the Thai authority to float the baht on 2 July 1997. This floating of baht sent a warning to the Indonesian business community, which had accumulated relatively large short-term private foreign debt on the expectation of exchange rate stability, that they were facing an unhedged foreign exchange risk. In panic, they rushed to buy US dollars. The panic soon spread to the wider community, inducing wealthy Indonesians to transfer their financial assets abroad, while foreign investors followed suit later (Johnson, 1998; Soesastro and Basri, 1998).

This placed heavy pressure on the managed exchange rate regime, the then exchange rate policy in Indonesia. Having learned that market intervention by the Thai authority had little effect on the slide in the baht, the Indonesian central bank did not try to defend the rupiah value through intervention in the foreign exchange market. Instead, they opted to widen the intervention band from 8 percent to 12 percent on 11 July 1997. But the pressure on rupiah continued and the new intervention floor was soon reached, forcing the government to change to a free float on 14 August 1997. Massive capital flight caused a large depreciation in the value of rupiah. The nominal exchange rate, which was around Rp. 2,400 per US$ before the crisis, hit a record low of around Rp. 17,000 per US$ on 22 January 1998 (Soesastro and Basri, 1998). Unhedged debt denominated in US dollars was so widespread that this drove banks and vast numbers of other domestic firms into technical insolvency.

The effects of this financial crisis on the real sector of the Indonesian economy have been substantial. Not only have many firms with foreign exchange denominated debt been made insolvent, but also firms with imported materials face four fold rises in rupiah input costs. These negative effects on the real sector are made worse by the fact that the associated insolvency of banks has made it very difficult for firms to obtain financing for their activities. There has, therefore, been a substantial contraction in the real sector of the economy.

To examine the effects of the economic crisis on the Indonesian labour market, a set of economic shocks simulating the crisis are imposed on the model. The simulation is designed following Adams (1998). He simulates the effects of the crisis in the full GTAP model by imposing two sets of shocks on the directly affected economies in the East Asian region. The first is a series of negative shocks to real investment which represents the effects of the withdrawal of foreign investment and the flight of domestic savings. The second set of shocks is a series of negative "supply-side" shocks, reducing total factor productivity across all sectors in the affected countries. This latter set of productivity changes were based on observations of estimated national output contraction, but they were imposed uniformly across all sectors.

Aggregating from the original shocks used by Adams (1998), the investment shocks are -50 percent for Indonesia, -30 percent for ASEAN3, and -10 percent for East Asia, while the productivity shocks are -25 percent for Indonesia, -10 percent for ASEAN3, and -5 percent for East Asia. In light of some newer information available, some adjustments are made to the shocks imposed in this exercise. First, since there was practically no new investment in Indonesia between the mid 1997 and the mid 1998, the investment shock for Indonesia is increased to -100 percent. Second, since there is evidence that the primary sector, in particular the Indonesian agricultural sector, has not contracted in response to the crisis, the primary industries in all regions are spared from the negative productivity shocks. Third, evidence in the press that insolvency in Indonesia has been prevalent amongst larger firms and that these are mostly in the skilled manufacturing industry, the productivity shock in Indonesia in the skilled manufacturing industry is increased by a half to 37.5 percent, while the same shock in the unskilled manufacturing sector is reduced by a half to 12.5 percent. The effects of these adjusted shocks on real factor returns are shown in Table 7.15, while the associated changes in other variables are shown in Table A7.14.

The simulation results in Table 7.15 indicate that, because of the economic crisis, labour and owners of capital of all types suffered from a large decrease in real returns, but land owners gained. This reflects the fact that the primary industry does not suffer from the negative productivity shock. This is also reflected in the effects of the crisis on output as shown in Table A7.14. While all other industries experience a contraction in output, the primary industry expands its production. As has been observed, returns to land rise since labour is absorbed by agriculture and the relative scarcity of land increases. Since the skilled manufacturing industries experience most of the firm level insolvencies and, hence, the largest negative productivity shocks, this industry contracts the most.

Table 7.15:
Changes in Real Factor Returns in Indonesia from the Asian Crisis (%)

Factor of Production	Asian Crisis Shocks
Land	53.7
Unskilled labour	-34.5
Skilled labour	-40.0
Simple capital	-36.3
Sophisticated capital	-42.0

Note: The Asian crisis shocks are represented by a set of negative investment shocks and a series of negative productivity shocks.

Source: Model simulation discussed in the text.

In the labour market, it is clear that, because of the economic crisis, both skilled and unskilled workers suffer a large decrease in their real wages. In relative terms, however, the decrease in skilled labour real wage is greater than the decrease in unskilled labour real wage. Therefore, the economic crisis tends to reduce wage inequality between skilled and unskilled labour. This is related to the fact that the crisis hits the skilled manufacturing industry, which is relatively intensive in skilled labour, more than other industries. On the other hand, the primary industry, which is relatively intensive in unskilled labour, expands because of the crisis.

Concluding Remarks

The analysis in the first section shows that the combined effects of various globalisation shocks can increase wage inequality between skilled and unskilled workers in a manner consistent with observed changes in Indonesia since the mid 1980s. The analysis of possible policy responses to globalisation in the second section indicates that the feasible policy option for the government to mitigate widening wage inequality is through enhancing the labour supply response. Policy responses in the forms of a reversal of trade liberalisation or tax and subsidy policy are either ineffective or reduce welfare both for labour and the economy as a whole.

The government can enhance the endogenous labour supply response by making it easier for households to transform unskilled labour into skilled labour. This could be done, for example, by providing education and training schemes, or by supporting the on-the-job-training schemes provided by companies. Alternatively, the government can enhance the exogenous increase in the supply of skilled labour. This could be done, for example, by creating large scale training programs for new labour market entrants to produce a large supply of skilled labour. Alternatively, the government can allow for a larger in-migration of skilled labour, which will also increase the supply of skilled labour.

These issues have, however, been rendered a low priority by the advent of the Asian financial crisis. No longer is wage and more general inequality a mere side effect of rapid growth. Now, financial losses have reduced wealth and income amongst capital owners and an associated real contraction of the economy has made both skilled and unskilled workers worse off. Wage and more general inequality has been reduced, but at a considerable price.

Chapter Appendix

The Data Base

Table A7.1:
Distribution of Value Added in Data Base (%)

Factor of Production	Industry				
	Primary	Unskilled manufacturing	Skilled manufacturing	Services	Total
ASEAN3:					
Agricultural land	24.5	0.0	0.0	0.0	5.8
Unskilled labour	27.4	21.4	17.7	27.1	25.4
Skilled labour	3.7	2.9	6.6	4.8	4.4
Simple capital	39.0	66.6	55.3	57.9	54.5
Sophisticated capital	5.3	9.1	20.4	10.2	10.0
Total (US$ billion)	42.7	26.6	18.9	92.8	180.9
Row percent of total	23.6	14.7	10.4	51.3	100.0
East Asia:					
Agricultural land	24.2	0.0	0.0	0.0	1.8
Unskilled labour	46.6	48.0	40.7	50.3	48.2
Skilled labour	6.4	6.5	15.1	8.9	9.4
Simple capital	20.1	40.0	32.3	34.7	33.8
Sophisticated capital	2.7	5.5	11.9	6.1	6.7
Total (US$ billion)	305.6	463.0	683.2	2,766.1	4,217.9
Row percent of total	7.2	11.0	16.2	65.6	100.0

Table A7.1:
Continued

Factor of Production	Industry: Primary	Unskilled manufacturing	Skilled manufacturing	Services	Total
Developed Countries:					
Agricultural land	7.5	0.0	0.0	0.0	0.4
Unskilled labour	36.8	45.9	34.3	40.1	39.7
Skilled labour	9.2	11.5	31.7	19.8	20.0
Simple capital	37.3	34.1	17.7	26.9	26.9
Sophisticated capital	9.3	8.5	16.3	13.2	13.0
Total (US$ billion)	751.8	1,177.3	1,706.6	9,682.8	13,318.5
Row percent of total	5.6	8.8	12.8	72.7	100.0
Rest of World:					
Agricultural land	12.7	0.0	0.0	0.0	2.3
Unskilled labour	32.3	41.0	41.6	46.7	42.9
Skilled labour	4.4	5.6	15.4	8.2	7.9
Simple capital	44.6	47.0	31.4	38.3	39.8
Sophisticated capital	6.1	6.4	11.6	6.8	7.1
Total (US$ billion)	651.1	455.2	364.3	2,143.5	3,614.1
Row percent of total	18.0	12.6	10.1	59.3	100.0

Source: Aggregated and disaggregated from GTAP Data Base version 3.

Parameter Values Used in The Model

Table A7.2:
Substitution Parameter in The CDE Minimum Expenditure Function

Commodity	Indonesia	ASEAN3	East Asia	Developed Countries	Rest of World
Primary	0.9	0.8	0.8	0.4	0.9
Unskilled manufacturing	0.9	0.9	0.6	0.6	0.8
Skilled manufacturing	0.7	0.5	0.2	0.1	0.6
Services	0.4	0.3	0.0	0.0	0.0

Table A7.3:
Expansion Parameter in The CDE Minimum Expenditure Function

Commodity	Indonesia	ASEAN3	East Asia	Developed Countries	Rest of World
Primary	0.6	0.7	0.5	0.8	0.4
Unskilled manufacturing	0.5	0.5	0.3	0.5	0.5
Skilled manufacturing	1.2	1.3	1.3	1.1	1.1
Services	1.4	1.3	1.2	1.1	1.4

Table A7.4:
Substitution Elasticities in Final and Intermediate Demand

Commodity	Import-Domestic	Import -Import
Primary	4.9	9.7
Unskilled manufacturing	5.5	11.3
Skilled manufacturing	6.1	12.7
Services	3.9	7.6

Table A7.5:
Regional Specific Parameter

Parameter	Indonesia	ASEAN3	East Asia	Developed Countries	Rest of World
Expected Rate of Return Flexibility	10	10	10	10	10
Initial Income (US$ billion)	118	207	4,082	12,578	3,550

Table A7.6:
Substitution Elasticites in Production

Produced Commodity	Unskilled Commodities Substitution Elasticity	Skilled Commodities Substitution Elasticity	Skilled-Unskilled Composite Substitution Elasticity	Value Added Composite Substitution Elasticity
Primary	0.5	0.5	1.5	0.7
Unskilled manufacturing	0.5	0.5	1.5	1.2
Skilled manufacturing	0.5	0.5	1.5	1.3
Service	0.5	0.5	1.5	1.4
Capital goods	0.0	0.0	0.0	0.0

Simulation Results

Table A7.7:
Changes in the Indonesian Region from Trade Liberalisation (%)

	1987-1992 shock	1992-2003 shock
Output:		
Primary	2.9	-3.1
Unskilled manufacturing	5.3	3.1
Skilled manufacturing	-24.8	-1.4
Services	0.7	1.6
Industry Demand for Unskilled Labour:		
Primary	3.6	-4.0
Unskilled manufacturing	5.0	3.2
Skilled manufacturing	-25.6	-1.2
Services	0.4	1.7
Industry Demand for Skilled Labour:		
Primary	5.9	-4.1
Unskilled manufacturing	7.3	3.2
Skilled manufacturing	-22.6	-1.3
Services	2.8	1.6
Domestic Sales:		
Primary	2.5	-8.1
Unskilled manufacturing	1.5	-6.3
Skilled manufacturing	-46.6	-18.4
Services	0.3	1.5
Imports:		
Primary	0.8	101.2
Unskilled manufacturing	-8.7	46.1
Skilled manufacturing	35.7	23.4
Exports:		
Primary	3.8	8.5
Unskilled manufacturing	17.1	32.5
Skilled manufacturing	54.4	60.6
Market Prices:		
Primary	-0.4	-0.9
Unskilled manufacturing	-1.5	-2.3
Skilled manufacturing	-5.9	-3.3
Services	-2.3	-0.7
Consumer price index	-2.4	-2.1

Table A7.7:
Continued

	1987-1992 shock	1992-2003 shock
Price of Imports:		
Primary	0.1	-16.0
Unskilled manufacturing	0.1	-10.4
Skilled manufacturing	-22.2	-10.0
Price of Exports:		
Primary	-0.4	-0.9
Unskilled manufacturing	-1.5	-2.3
Skilled manufacturing	-5.9	-3.3
Terms of Trade:		
Index of prices received for tradeables	-3.5	-2.3
Index of prices paid for tradeables	0.0	0.0
Terms of Trade	-3.5	-2.3
Income and Utility:		
Regional real income	0.4	0.6
Per capita utility	-0.2	0.0

Source: Model simulations discussed in the text.

Table A7.8:

Changes in the Indonesian Region from a 15 Percent Increase in Simple Capital Stock and a 14 Percent Increase in Sophisticated Capital Stock(%)

	Capital Accumulation Effect
Output:	
Primary	5.8
Unskilled manufacturing	12.7
Skilled manufacturing	16.4
Services	9.4
Industry Demand for Unskilled Labour:	
Primary	-2.0
Unskilled manufacturing	2.0
Skilled manufacturing	7.2
Services	-0.4
Industry Demand for Skilled Labour:	
Primary	-2.6
Unskilled manufacturing	1.1
Skilled manufacturing	6.5
Services	-1.0
Domestic Sales:	
Primary	9.9
Unskilled manufacturing	9.8
Skilled manufacturing	14.8
Services	9.3
Imports:	
Primary	13.4
Unskilled manufacturing	1.5
Skilled manufacturing	4.9
Exports:	
Primary	-3.6
Unskilled manufacturing	22.5
Skilled manufacturing	22.5

Table A7.8:
Continued

	Capital Accumulation Effect
Market Prices:	
Primary	0.4
Unskilled manufacturing	-2.2
Skilled manufacturing	-1.9
Services	-2.0
Consumer price index	-1.5
Price of Imports:	
Primary	0.0
Unskilled manufacturing	0.0
Skilled manufacturing	0.0
Price of Exports:	
Primary	0.4
Unskilled manufacturing	-2.2
Skilled manufacturing	-1.9
Terms of Trade:	
Index of prices received for tradeables	-1.3
Index of prices paid for tradeables	0.0
Terms of Trade	-1.3
Income and Utility:	
Regional real income	8.7
Per capita utility	8.4

Source: Model simulation discussed in the text.

Table A7.9:
Changes in the Indonesian Region from Technological Change in Manufacturing Industries (%)

	Technological Change Component	
	Neutral	Bias
Output:		
Primary	-23.0	-0.01
Unskilled manufacturing	26.2	-0.01
Skilled manufacturing	73.7	-0.02
Services	2.1	0.00
Industry Demand for Unskilled Labour:		
Primary	-30.5	-0.03
Unskilled manufacturing	16.2	-1.02
Skilled manufacturing	65.6	1.98
Services	4.3	-0.02
Industry Demand for Skilled Labour:		
Primary	-40.2	0.00
Unskilled manufacturing	10.0	-0.01
Skilled manufacturing	63.1	-0.01
Services	-2.8	0.01
Domestic Sales:		
Primary	7.6	-0.01
Unskilled manufacturing	16.2	0.00
Skilled manufacturing	67.4	-0.01
Services	6.3	0.00
Imports:		
Primary	39.0	0.00
Unskilled manufacturing	-15.9	0.00
Skilled manufacturing	-35.7	0.01
Exports:		
Primary	-94.0	-0.02
Unskilled manufacturing	57.7	-0.02
Skilled manufacturing	96.7	-0.03
Market Prices:		
Primary	7.3	0.00
Unskilled manufacturing	-7.7	0.00
Skilled manufacturing	-29.9	0.00
Services	11.1	0.00
Consumer price index	2.3	0.00

Table A7.9:
Continued

	Technological Change Component	
	Neutral	Bias
Price of Imports:		
Primary	0.0	0.00
Unskilled manufacturing	0.0	0.00
Skilled manufacturing	-0.1	0.00
Price of Exports:		
Primary	7.3	0.00
Unskilled manufacturing	-7.7	0.00
Skilled manufacturing	-29.9	0.00
Terms of Trade:		
Index of prices received for tradeables	3.4	0.00
Index of prices paid for tradeables	0.0	0.00
Terms of Trade	3.4	0.00
Income and Utility:		
Regional real income	13.1	0.00
Per capita utility	13.2	0.00

Source: Model simulations discussed in the text.

Table A7.10:
Changes in the Indonesian Region from Combination of Shocks
(%)

	Combination of Shocks
Output:	
Primary	-12.5
Unskilled manufacturing	37.7
Skilled manufacturing	64.8
Services	11.9
Industry Demand for Unskilled Labour:	
Primary	-27.8
Unskilled manufacturing	19.3
Skilled manufacturing	49.6
Services	4.3
Industry Demand for Skilled Labour:	
Primary	-34.8
Unskilled manufacturing	15.5
Skilled manufacturing	45.6
Services	-1.0
Domestic Sales:	
Primary	17.5
Unskilled manufacturing	25.8
Skilled manufacturing	55.4
Services	14.0
Imports:	
Primary	44.8
Unskilled manufacturing	-29.2
Skilled manufacturing	-13.4
Exports:	
Primary	-81.8
Unskilled manufacturing	75.1
Skilled manufacturing	99.2

Table A7.10:
Continued

	Combination of Shocks
Market Prices:	
Primary	6.7
Unskilled manufacturing	-12.6
Skilled manufacturing	-44.6
Services	5.9
Consumer price index	-3.1
Price of Imports:	
Primary	0.1
Unskilled manufacturing	0.1
Skilled manufacturing	-22.2
Price of Exports:	
Primary	6.7
Unskilled manufacturing	-12.6
Skilled manufacturing	-44.6
Terms of Trade:	
Index of prices received for tradeables	-2.0
Index of prices paid for tradeables	0.1
Terms of Trade	-2.1
Income and Utility:	
Regional real income	19.3
Per capita utility	18.4

Source: Model simulation discussed in the text.

Table A7.11:

Changes in the Indonesian Region from a 10 Percent Increase in the Power of Tariff in Primary, Unskilled Manufacturing, and Skilled Manufacturing Industries (%)

	Protected Industry		
	Primary	Unskilled manufacturing	Both
Output:			
Primary	1.1	0.1	1.2
Unskilled manufacturing	-1.9	2.9	1.1
Skilled manufacturing	-0.1	-3.6	-3.8
Services	-0.2	-0.3	-0.6
Industry Demand for Unskilled Labour:			
Primary	1.5	0.1	1.6
Unskilled manufacturing	-2.0	3.0	1.0
Skilled manufacturing	-0.2	-3.6	-3.9
Services	-0.3	-0.3	-0.6
Industry Demand for Skilled Labour:			
Primary	1.5	0.5	2.1
Unskilled manufacturing	-2.0	3.4	1.5
Skilled manufacturing	-0.1	-3.2	-3.5
Services	-0.3	0.1	-0.2
Domestic Sales:			
Primary	2.7	1.1	3.9
Unskilled manufacturing	-0.9	6.3	5.5
Skilled manufacturing	-0.2	-2.5	-2.7
Services	-0.3	-0.2	-0.5
Imports:			
Primary	-34.1	3.1	-32.0
Unskilled manufacturing	1.2	-33.0	-32.0
Skilled manufacturing	-0.4	0.8	0.4
Exports:			
Primary	-2.4	-2.4	-4.9
Unskilled manufacturing	-5.1	-7.8	-12.8
Skilled manufacturing	0.3	-7.7	-7.7

Table A7.11:
Continued

	Protected Industry		
	Primary	Unskilled manufacturing	Both
Market Prices:			
Primary	0.3	0.3	0.6
Unskilled manufacturing	0.5	0.7	1.2
Skilled manufacturing	0.0	0.6	0.6
Services	-0.1	0.4	0.4
Consumer price index	0.2	0.6	0.8
Price of Imports:			
Primary	10.0	0.0	10.0
Unskilled manufacturing	0.0	10.0	10.0
Skilled manufacturing	0.0	0.0	0.0
Price of Exports:			
Primary	0.3	0.3	0.6
Unskilled manufacturing	0.5	0.7	1.2
Skilled manufacturing	0.0	0.6	0.6
Terms of Trade:			
Index of prices received for tradeables	0.1	0.4	0.6
Index of prices paid for tradeables	0.0	0.0	0.0
Terms of Trade	0.1	0.4	0.6
Income and Utility:			
Regional real income	-0.3	-0.3	-0.6
Per capita utility	-0.2	-0.1	-0.3

Source: Model simulations discussed in the text.

Table A7.12:
Changes in the Indonesian Region from a 10 Percent Increase in the Power of Tax on the Use of Sophisticated Capital and a 10 Percent Increase in the Power of Subsidy on the Use of Simple Capital in Primary and Unskilled Manufacturing Industries (%)

	Tax on Sophisticated Capital	Subsidy on Simple Capital
Output:		
Primary	-0.4	2.3
Unskilled manufacturing	-0.5	2.5
Skilled manufacturing	2.0	-10.0
Services	0.1	-0.7
Industry Demand for Unskilled Labour:		
Primary	0.2	1.9
Unskilled manufacturing	0.4	1.0
Skilled manufacturing	1.2	-9.8
Services	-0.3	0.1
Industry Demand for Skilled Labour:		
Primary	-3.9	-1.6
Unskilled manufacturing	-4.3	-3.0
Skilled manufacturing	3.2	-6.8
Services	1.5	3.3
Domestic Sales:		
Primary	-0.3	1.5
Unskilled manufacturing	-0.2	0.8
Skilled manufacturing	1.3	-6.6
Services	0.0	-0.2
Imports:		
Primary	0.1	-0.4
Unskilled manufacturing	0.7	-3.2
Skilled manufacturing	-0.6	3.9
Exports:		
Primary	-0.7	3.9
Unskilled manufacturing	-1.6	7.6
Skilled manufacturing	4.7	-22.5

Table A7.12:
Continued

	Tax on Sophisticated Capital	Subsidy on Simple Capital
Market Prices:		
Primary	0.1	-0.5
Unskilled manufacturing	0.1	-0.7
Skilled manufacturing	-0.3	1.9
Services	-0.3	2.7
Consumer price index	-0.1	1.0
Price of Imports:		
Primary	0.0	0.0
Unskilled manufacturing	0.0	0.0
Skilled manufacturing	0.0	0.0
Price of Exports:		
Primary	0.1	-0.5
Unskilled manufacturing	0.1	-0.7
Skilled manufacturing	-0.3	1.9
Terms of Trade:		
Index of prices received for tradeables	-0.1	0.9
Index of prices paid for tradeables	0.0	0.0
Terms of Trade	-0.1	0.9
Income and Utility:		
Regional real income	-0.1	0.4
Per capita utility	-0.1	0.5

Source: Model simulations discussed in the text.

Table A7.13:
Changes in the Indonesian Region from Labour Supply Responses to Increased Wage Inequality (%)

	Type of Labour Supply Response		
	No Response	Endogenous	Exogenous
Output:			
Primary	-20.4	-20.4	-20.1
Unskilled manufacturing	29.3	29.3	29.5
Skilled manufacturing	59.1	59.1	59.4
Services	4.0	4.0	4.3
Industry Demand for Unskilled Labour:			
Primary	-27.8	-28.4	-27.8
Unskilled manufacturing	19.5	19.2	19.6
Skilled manufacturing	44.1	43.9	44.2
Services	5.1	4.6	5.0
Total employment	0.0	-0.4	0.0
Industry Demand for Skilled Labour:			
Primary	-34.8	-31.2	-25.4
Unskilled manufacturing	15.7	17.5	20.6
Skilled manufacturing	42.6	44.0	46.4
Services	0.1	2.6	6.7
Total employment	0.0	2.6	6.8
Domestic Sales:			
Primary	8.9	8.9	9.2
Unskilled manufacturing	17.6	17.6	17.8
Skilled manufacturing	48.1	48.2	48.5
Services	6.8	6.8	7.1
Imports:			
Primary	39.1	39.1	39.2
Unskilled manufacturing	-27.0	-27.0	-26.8
Skilled manufacturing	-17.1	-17.1	-17.0
Exports:			
Primary	-88.3	-88.4	-87.9
Unskilled manufacturing	66.0	66.0	66.1
Skilled manufacturing	98.9	98.9	99.0

Table A7.13:
Continued

	Type of Labour Supply Response		
	No Response	Endogenous	Exogenous
Market Prices:			
Primary	7.0	7.0	7.0
Unskilled manufacturing	-9.6	-9.6	-9.6
Skilled manufacturing	-41.9	-41.9	-42.0
Services	8.5	8.5	8.3
Consumer price index	-1.0	-1.0	-1.1
Price of Imports:			
Primary	0.1	0.1	0.1
Unskilled manufacturing	0.1	0.1	0.1
Skilled manufacturing	-22.3	-22.3	-22.3
Price of Exports:			
Primary	7.0	7.0	7.0
Unskilled manufacturing	-9.6	-9.6	-9.6
Skilled manufacturing	-41.9	-41.9	-42.0
Terms of Trade:			
Index of prices received for tradeables	-0.5	-0.5	-0.6
Index of prices paid for tradeables	0.0	0.0	0.0
Terms of Trade	-0.5	-0.5	-0.6
Income and Utility:			
Regional real income	11.8	11.8	12.1
Per capita utility	11.1	11.1	11.4

Source: Model simulations discussed in the text.

Table A7.14:

Changes in the Indonesian Region from the Asian Crisis (%)

	Asian Crisis Shocks
Output:	
Primary	58.5
Unskilled manufacturing	-10.9
Skilled manufacturing	-90.2
Services	-51.3
Industry Demand for Unskilled Labour:	
Primary	86.7
Unskilled manufacturing	-0.9
Skilled manufacturing	-85.1
Services	-37.0
Industry Demand for Skilled Labour:	
Primary	113.8
Unskilled manufacturing	13.6
Skilled manufacturing	-82.9
Services	-27.9
Domestic Sales:	
Primary	-2.5
Unskilled manufacturing	-22.3
Skilled manufacturing	-87.8
Services	-52.8
Imports:	
Primary	-52.2
Unskilled manufacturing	-15.2
Skilled manufacturing	-22.0
Exports:	
Primary	199.6
Unskilled manufacturing	27.9
Skilled manufacturing	-99.1

Table A7.14:
Continued

	Asian Crisis Shocks
Market Prices:	
Primary	-17.2
Unskilled manufacturing	-6.8
Skilled manufacturing	37.3
Services	2.3
Consumer price index	-3.7
Price of Imports:	
Primary	-3.9
Unskilled manufacturing	-9.1
Skilled manufacturing	-9.2
Price of Exports:	
Primary	-17.2
Unskilled manufacturing	-6.8
Skilled manufacturing	37.3
Terms of Trade:	
Index of prices received for tradeables	-12.3
Index of prices paid for tradeables	-4.2
Terms of Trade	-8.1
Income and Utility:	
Regional real income	-34.4
Per capita utility	-35.9

Source: Model simulation discussed in the text.

Chapter 8:

SUMMARY AND CONCLUSIONS

The relationship between openness and changes in labour markets has gained considerable attention in recent years. This arises following changes in developed country labour markets, where unskilled labour has become worse off relative to skilled labour. In countries with relatively flexible labour markets, such as the United States, the poor market performance of unskilled labour mainly takes the form of widening wage inequality between skilled and unskilled labour. Meanwhile, in countries with more regulated labour markets such as the European Union, unskilled labour has experienced increasing unemployment rates.

The timing of these developments in labour markets coincides with increasing openness in both developed and developing countries. This has intensified international economic links between the two country groups, leading some developed country economists to believe that there is a causal connection. The reasoning behind this belief is that openness forces unskilled workers in developed countries to compete with the unskilled workers from developing countries in a globalised world market. Because workers in developed countries are paid much higher wages than those in developing countries, the competition is an unwinable one for the workers in the developed countries.

It is argued that, as a result of trade liberalisation, cheaply produced unskilled labour intensive goods from developing countries flood the developed country markets. This directly suppresses the production of similar but more expensive goods produced in developed countries, which then causes a reduction in the demand for the services of unskilled workers. Hence, developed countries experience decreasing real wages and increasing unemployment of unskilled labour. Furthermore, to exploit their comparative advantage, developed countries have to turn to the production of skilled labour intensive goods. This increases the demand for skilled labour, which is translated into higher wages for them, in turn widening wage inequality between skilled and unskilled workers.

The theoretical support for this line of reasoning comes from the Stolper-Samuelson (SS) theorem, an international trade theorem based on the Heckscher-Ohlin-Samuelson (HOS) model, which relates changes in goods markets to corresponding changes in factor rewards. The basic HOS model is a two-country two-product two-factor general equilibrium model. The SS theorem, as derived from the basic HOS model, states that an increase (decrease) in the price of a product which is relatively intensive in one factor will increase (decrease) real return to that factor more proportionately and decrease (increase) real return to the other factor.

Since developed countries are relatively scarce in unskilled labour, trade protection in these countries is usually given to goods that are relatively intensive in unskilled labour. The domestic prices of these goods in developed countries are therefore higher than world prices. When these countries liberalise their trade, the prices of these unskilled labour intensive goods invariably fall. By virtue of the Stolper-Samuelson theorem, this is translated into falling real wages for unskilled labour and increasing real wages for skilled labour, with widening wage inequality between them as a consequence.

However, there are many other economists who believe that the HOS model is too simple and its assumptions are too restrictive. In any case, if trade liberalisation and the Stolper-Samuelson theorem were at work behind the widening wage inequality between skilled and unskilled labour in developed countries, then all industries in these countries would employ relatively more unskilled workers and less skilled workers, because now the relative wage of unskilled labour is lower. However, this is not observed in reality. In fact, most industries in developed countries now employ relatively more skilled labour and less unskilled labour compared to a decade or so ago. Therefore, it is argued, some other factors must have been at work behind the poor market performance of unskilled labour in developed countries.

One factor which has been prominently singled out as the reason for falling relative demand for unskilled labour is technological change. In particular, the advent of computer technology has shifted up the demand for skilled labour while reducing the demand for unskilled labour in all sectors. Because of these shifts in demand, both relative employment and the relative wage of skilled labour increase, while those of unskilled labour decrease. And so a range of empirical studies has arisen to address this point and the debate between those who see globalisation as the major contributor and those who blame spontaneous technological change continues.

Research on this subject in the context of developing countries is still rare. This is unfortunate since it may help answer the related questions that have arisen in the developed countries context as well. Some early work, finds that the observed tendency for wage inequality to increase is also observed in some developing countries after they liberalise their economies. This is quite contrary to the prediction of the Stolper-Samuelson theorem. Since developing countries are relatively abundant in unskilled labour, opening to trade causes them to realise their comparative advantage and results in higher unskilled wages.

There are many reasons why the Stolper-Samuelson theorem may not apply in developing countries. For a start, the structure of labour markets in developing countries, particularly the ones that are still in the surplus labour phase, may prevent this theorem from working. When a country has a large pool of unskilled workers in the traditional sector, who are prepared to enter the labour market in the modern sector at the reservation wage level, then the potential increase in the real wage of unskilled labour, resulting from higher export prices, may be small or negligible due to the very elastic nature of the unskilled labour supply.

Another factor in developing countries which may cause the real wage of skilled workers to increase faster than that of unskilled labour, just as in developed countries, is technological change. The adoption by developing countries of new technologies that are relatively less intensive on the use of unskilled labour compared to the current technology will increase the relative demand for skilled labour. The adoption of such technology may arise because it is embodied in new capital invested by both domestic as well as foreign firms, or be spurred by interactions between domestic and foreign firms.

This study is an effort to contribute to the understanding of how trade openness and technological change affect wage inequality between skilled and unskilled workers in developing countries, both theoretically and empirically. The available theory is first extended using numerical general equilibrium analysis. The empirical part combines a case study of the Indonesian manufacturing sector with an applied general equilibrium analysis of shocks to the Indonesian economy as a whole.

The theoretical analysis extends the HOS framework by deriving numerical solutions to a two-region model with multiple goods and factors and the differentiation of goods by region of origin. The stylised data base used has three different goods: an unskilled labour intensive good, a skilled labour intensive good, and services. The first two are internationally tradeable, while services is a non-tradeable good. Each good is produced using a combination of three primary factors: unskilled labour, skilled labour, and capital, in addition to intermediate goods of all types. The data base is set so as to make the developed region relatively abundant in skilled labour, while the developing region is relatively abundant in unskilled labour.

To take into account the possibility of the existence of a dual labour market in the developing region, two closures are used. The first gives an integrated labour market in which both skilled and unskilled labour supply and demand adjust to equate wages for each type of workers in all sectors. The second gives a dual labour market where the real wage of unskilled labour is fixed, due to the assumption that its supply is perfectly elastic. The results indicate that, if the developing region has an integrated labour market, then both trade liberalisation and neutral technological change reduce wage inequality. Biased technological change, however, increases it. Yet if there is Lewis type duality in the labour market, all trade and technology shocks result in widening wage inequality in the region.

Meanwhile, the effect of capital accumulation depends on what is assumed about the nature of capital. When it is assumed that there is only one capital, which is neither a gross complement of nor a substitute for any type of labour, then capital accumulation has little effect on wage inequality. When it is assumed that there are two types of capital, one of which is a complement for unskilled labour and the other is a complement of skilled labour, then capital accumulation of the first type reduces wage inequality but capital accumulation of the second type increases it. Again, when the dual labour market closure is used, capital accumulation of both types increases wage inequality.

Turning to the empirical part of the study, the Indonesian manufacturing sector is shown to have experienced increasing relative employment and decreasing relative wage of unskilled labour since the mid 1980s. During this period, the Indonesian economy opened in earnest. Of this economic deregulation, the manufacturing sector was the main beneficiary. This is reflected in the sector's significant increases in trade-orientation and technological change indicators. Important gains were achieved as measured by the export intensity ratio, the import penetration ratio, the proportion of new capital, and the foreign participation rate.

On the supply side, meanwhile, since the late 1970s Indonesia experienced a steady increase in the relative supply of skilled labour, as measured by the education level of the work force. The large majority of Indonesia's workers, however, are still employed in the agricultural sector. This implies that there is a large pool of agricultural workers which form a potential supply of unskilled labour for the modern sector. The industrial sector's contribution to employment, meanwhile, is still relatively small.

An interrelated factor demand analysis is used which takes the form of a system of input cost share equations derived from a translog cost function. These equations are fitted to a detailed data base covering Indonesian manufacturing over 19 years down to the level of four-digit ISIC industries. The results suggest that generally openness has increased the relative demand for unskilled labour. This result is consistent with the prediction given by the Stolper-Samuelson theorem. Technological change indicators, on the other hand, have mixed effects on the relative demand for unskilled labour. Although foreign participation is found to increase the relative demand for unskilled labour, the accumulation of new capital tends to be biased against unskilled labour. Foreign direct investment in the manufacturing sector since the late 1980s has taken place mostly in the unskilled labour intensive industries. That is why increasing foreign participation has lead to an increase in the relative demand for unskilled labour. However, the accumulation of new capital in general tends to reduce the relative demand for unskilled labour.

The increasing trend in relative employment of unskilled labour since the mid 1980s, therefore, can be explained by a surge in the relative demand for unskilled labour. This arises from both greater trade openness and increasing foreign participation in unskilled labour intensive industries. The decreasing trend in the relative wage of unskilled labour, however, suggests that Indonesia is still in the unskilled labour surplus phase. Despite increasing relative demand for unskilled labour, there is no increase in the unskilled wage relative to the skilled wage because the large pool of available unskilled workers makes the supply of unskilled labour very elastic. As a result, the wages of skilled workers still increase faster than the wages of unskilled workers.

The final part of the empirical analysis is an applied general equilibrium analysis, carried out using a global data base in which the focus region is Indonesia. The combined effect of various globalisation shocks is found to be an increase in wage inequality between skilled and unskilled labour, consistent with observations in Indonesia since the mid 1980s. The decomposition of these shocks indicates that one cause stands out in shaping the observed increase in wage inequality. This is the increase in total factor productivity in manufacturing. Trade liberalisation has the opposite effect, tending to reduce wage inequality. Capital accumulation has a large effect on the changes in real factor returns, but its effect on the relative wage is small and it tends to reduce wage inequality. Meanwhile, the effect of the small amount of observed bias in technological change is negligible.

Meanwhile, an analysis of possible policy responses to globalisation using this framework indicates that the most attractive option for the government to mitigate growth induced wage inequality is to enhance the skilled labour supply response. Policy responses in the form of a reversal of trade liberalisation or taxes and subsidies that shift labour demand are either ineffective or reduce welfare both of labour and the economy as a whole.

The government can enhance the endogenous labour supply response by making it easier for household to transform unskilled labour into skilled labour. This could be done, for example, by expanding education and training schemes or by supporting the on-the-job-training schemes provided by companies. Alternatively, the government can enhance the exogenous increase in the supply of skilled labour. This could be done, for example, by creating large scale training programs for new labour market entrants to produce a large supply of skilled labour. Alternatively, the government could allow for a larger in-migration of skilled labour.

The Indonesian economy, along with other East Asian countries, was assailed by a financial crisis and subsequent recession starting in mid 1997. An analysis of the crisis using the same general equilibrium framework shows that both skilled and unskilled workers suffer a large decrease in their real wages. In relative terms, however, the decrease in skilled labour real wage is greater than the decrease in unskilled labour real wage. Hence, wage inequality has been reduced, but at a considerable price.

To conclude, the findings of this study shed some new light on the effects of openness and globalisation in developing countries, on the factors most important in Indonesia's experience, and on the options for policy. Both openness and technological change are found to affect relative labour demand in developing countries, with openness tending to favour unskilled labour, while capital accumulation and technological change tend to militate against it. This implies that it is more likely that both factors also play a role in the poor market performance of unskilled labour in developed countries, where both openness and technological change tend to be biased against unskilled labour.

The findings of this study also provide some insights into the question of the effects of economic liberalisation on wage, or more generally income and wealth, distribution. In recent years, popular belief has emerged in Indonesia that economic liberalisation has led to widening gap between the rich and the poor. Another version of this belief states that labour has not benefited from the high and steady economic growth experienced by Indonesia during the past decades. The finding of this study that there has been some increase in wage inequality between skilled and unskilled labour since the mid 1980s lends some support to these popular beliefs.

However, this is only a half of the picture. The simultaneous increasing relative employment of unskilled labour indicates that economic liberalisation has resulted in a faster increase in the demand for unskilled labour relative to the skilled. The core cause of increasing wage inequality is the abundance of unskilled labour, which makes its supply in the modern sectors very elastic. Hence, as long as Indonesia has not passed its labour surplus turning point, more unequal wage and possibly income distribution may become a necessary feature of economic growth.

Finally, the period of analysis is one during which the Indonesian economy enjoyed unprecedented overall growth. The wage inequality that has been the focus of this study is one consequence of this growth. It is, however, a mere sideshow compared with the consequences of the current Asian recession. It will be during the recovery phase that the results from this analysis will come into play. In that phase, the policy regime should remain open and, where possible, facilitate skill acquisition.

THESIS APPENDIX

Tablo Input File of the Basic Model

```
!-----------------------------------------------------------!
!              Tablo Input File - Basic Model               !
!         (Modified from the GTAP 1994a Model)              !
!-----------------------------------------------------------!

!-----------------------------------------------------------!
!                          SETS                             !
!-----------------------------------------------------------!
```

FILE GTAPSETS # File with set specification # ;

SET REG # Regions in the model # MAXIMUM SIZE 2
READ ELEMENTS from FILE GTAPSETS header "H1" ;

SET TRAD_COMM # Traded commodities # MAXIMUM SIZE 3
READ ELEMENTS from FILE GTAPSETS header "H2" ;

SET NSAV_COMM # Non-savings commodities # MAXIMUM SIZE 8
READ ELEMENTS from FILE GTAPSETS header "H3" ;

SET DEMD_COMM # Demanded commodities # MAXIMUM SIZE 7
READ ELEMENTS from FILE GTAPSETS header "H4" ;

SET PROD_COMM # Produced commodities # MAXIMUM SIZE 4
READ ELEMENTS from FILE GTAPSETS header "H5" ;

SET ENDW_COMM # Endowment commodities # MAXIMUM SIZE 4
READ ELEMENTS from FILE GTAPSETS header "H6" ;

SET ENDWS_COMM # Sluggish endowment commodities # MAXIMUM SIZE 1
READ ELEMENTS from FILE GTAPSETS header "H7" ;

SET ENDWM_COMM # Mobile endowment commodities # MAXIMUM SIZE 3
READ ELEMENTS from FILE GTAPSETS header "H8" ;

SET CGDS_COMM # Capital goods commodities # MAXIMUM SIZE 1
READ ELEMENTS from FILE GTAPSETS header "H9" ;

SET ENDWC_COMM # Capital endowment commodity # (capital) ;

SET LABR_COMM # Types of labour # MAXIMUM SIZE 2
READ ELEMENTS from FILE GTAPSETS header "HA" ;

```
!-----------------------------------------------------------!
!                          Subsets                          !
!-----------------------------------------------------------!
```

SUBSET PROD_COMM is subset of NSAV_COMM ;

SUBSET DEMD_COMM is subset of NSAV_COMM ;

SUBSET TRAD_COMM is subset of DEMD_COMM ;

SUBSET TRAD_COMM is subset of PROD_COMM ;

SUBSET ENDW_COMM is subset of DEMD_COMM ;

SUBSET CGDS_COMM is subset of NSAV_COMM ;

SUBSET CGDS_COMM is subset of PROD_COMM ;

SUBSET ENDWS_COMM is subset of ENDW_COMM ;

SUBSET ENDWM_COMM is subset of ENDW_COMM ;

SUBSET ENDWC_COMM is subset of NSAV_COMM ;

SUBSET LABR_COMM is subset of ENDW_COMM ;

```
!-----------------------------------------------------------!
!                           FILES                           !
!-----------------------------------------------------------!
```

FILE GTAPDATA # The file containing all base data. # ;

FILE (TEXT) GTAPPARM # The file containing behavioral parameters. # ;

```
!-----------------------------------------------------------!
!                         VARIABLES                         !
!-----------------------------------------------------------!

!-----------------------------------------------------------!
!                    Quantity Variables                     !
!-----------------------------------------------------------!
```

VARIABLE (all,i,NSAV_COMM)(all,r,REG) qo(i,r)
industry output of commodity i in region r # ;

VARIABLE (all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG) qoes(i,j,r)
supply of sluggish endowment i used in j, in r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) qxs(i,r,s)
export sales of commodity i from r to region s # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) qst(i,r)
sales of i from r to international transport # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) qds(i,r)
domestic sales of commodity i in r # ;

VARIABLE (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG) qfe(i,j,r)
demand for endowment i for use in j in region r # ;

VARIABLE (all,j,PROD_COMM)(all,r,REG) qva(j,r)
value-added in industry j of region r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG) qf(i,j,r)
demand for commodity i for use in j in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG) qfm(i,j,s)
Industry demands for aggregate imports # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG) qfd(i,j,s)
Industry demands for domestic goods # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) qp(i,r)
private household demand for commodity i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) qg(i,r)
government household demand for commodity i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) qpm(i,s)
private hhld demand for imports of i in region s # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) qpd(i,s)
private hhld demand for domestic i in region s # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) qgm(i,s)
government hhld demand for imports of i in region s # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) qgd(i,s)
government hhld demand for domestic i in region s # ;

VARIABLE (all, r, REG) ksvces(r)
capital services = qo("capital",r) # ;

VARIABLE (all, r, REG) qcgds(r)
Output of capital goods sector = qo("cgds",r) [GROSS basis] # ;

VARIABLE (all,r,REG) qsave(r)
regional demand for NET savings # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) qim(i,s)
aggregate imports of i in region s # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) qex(i,r)
aggregate exports of i from region r # ;

VARIABLE (all,r,REG) qexreg(r)
volume of merchandise exports, by region # ;

VARIABLE (all,r,REG) qimreg(r)
volume of merchandise imports, by region # ;

VARIABLE (all,i,TRAD_COMM) qexcom(i)
volume of global merchandise exports by commodity # ;

VARIABLE (all,i,TRAD_COMM) qimcom(i)
volume of global merchandise imports by commodity # ;

VARIABLE qexwld
volume of world trade # ;

VARIABLE (all, r, REG) kb(r)
Beginning-of-period capital stock, in r # ;

VARIABLE (all, r, REG) ke(r)
End-of-period capital stock, in r # ;

VARIABLE globalcgds
Global supply of capital goods for NET investment # ;

VARIABLE qt
quantity of global shipping services provided # ;

VARIABLE (all,r,REG) pop(r)
regional population # ;

VARIABLE walras_dem
demand in the omitted market--global demand for savings # ;

VARIABLE walras_sup
supply in omitted market--global supply of cgds composite # ;

```
!-------------------------------------------------------!
!                  Price Variables                      !
!-------------------------------------------------------!
```

VARIABLE (all,i,NSAV_COMM)(all,r,REG) ps(i,r)
supply price of commodity i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG) pf(i,j,r)
firms' price for commodity i for use in j, in r # ;

VARIABLE (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG) pfe(i,j,r)
firms' price for endowment commodity i in j of r # ;

VARIABLE (all,j,PROD_COMM)(all,r,REG) pva(j,r)
firms' price of value-added in industry j of region r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG) pfm(i,j,s)
price index for imports of i by j in region s # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG) pfd(i,j,s)
price index for domestic purchases of i by j in region s # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) pp(i,r)
private household price for commodity i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) ppm(i,s)
price of imports of i by private households in s # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) ppd(i,s)
price of domestic i to private households in s # ;

VARIABLE (all,r,REG) pgov(r)
price index for govt hhld expenditures in region r # ;

VARIABLE (all,r,REG) ppriv(r)
price index for private household expenditures in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) pg(i,r)
government household price for commodity i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) pgm(i,s)
price of imports of i by government households in s # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) pgd(i,s)
price of domestic i to government households in s # ;

VARIABLE (all,i,NSAV_COMM)(all,r,REG) pm(i,r)
market price of commodity i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) pim(i,r)
market price of composite import i in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) pex(i,r)
aggregate exports price index of i from region r # ;

VARIABLE (all,r,REG) pexreg(r)
price index of merchandise exports, by region # ;

VARIABLE (all,r,REG) pimreg(r)
price index of merchandise imports, by region # ;

VARIABLE (all,i,TRAD_COMM) pexcom(i)
price index of global merchandise exports by commodity # ;

VARIABLE (all,i,TRAD_COMM) pimcom(i)
price index of global merchandise imports by commodity # ;

VARIABLE pexwld
price index of world trade # ;

VARIABLE (all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG) pmes(i,j,r)
market price of sluggish endowment used by j, in r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) pms(i,r,s)
domestic price for good i supplied from r to region s # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) pfob(i,r,s)
FOB world price of commodity i supplied from r to s # ;
! i.e., prior to incorporation of transportation margin !

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) pcif(i,r,s)
CIF world price of commodity i supplied from r to s # ;
! i.e., subsequent to incorporation of transportation margin !

VARIABLE pt
price of global shipping services provided # ;

VARIABLE (all, r, REG) rental(r)
rental rate on capital = ps("capital",r) # ;

VARIABLE (all, r, REG) rorc(r)
Current net rate of return on capital stock, in r # ;

VARIABLE (all, r, REG) rore(r)
Expected net rate of return on capital stock, in r # ;

VARIABLE rorg
Global net rate of return on capital stock # ;

VARIABLE psave
price of capital goods supplied to savers # ;

VARIABLE (all, r, REG) pcgds(r)
price of investment goods = ps("cgds",r) # ;

```
VARIABLE (all,r,REG)                                              psw(r)
# Index of prices received for tradeables produced in r # ;
! Note: this includes sales of net investment in r !

VARIABLE (all,r,REG)                                              pdw(r)
# Index of prices paid for tradeables used in region r # ;
! Note: this includes purchases of net savings in region r !

VARIABLE (all,i,TRAD_COMM)(all,r,REG)                             pr(i,r)
# ratio of domestic to imported prices in r # ;

!-------------------------------------------------------------------!
!                  Technical Change Variables                       !
!-------------------------------------------------------------------!

! Specification: If, for example, technical progress is Hicks-neutral across all inputs at the
  rate of 1 percent, then ao(j,r) = 1. !

VARIABLE (all,j,PROD_COMM)(all,r,REG)                             ao(j,r)
# output augmenting technical change in sector j of r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)            af(i,j,r)
# composite interm. input i augmenting tech change in j of r # ;

VARIABLE (all,i,PROD_COMM)(all,r,REG)                             ava(i,r)
# Value added augmenting tech change in sector i of r # ;

VARIABLE (all,i,PROD_COMM)(all,r,REG)                             favari(i,r)
# region- and industry-specific shift in factor-using technology # ;

VARIABLE (all,r,REG)                                              favar(r)
# region-specific shift in factor-using technology # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                  atr(i,r,s)
# tech change parameter in shipping of i from region r to s # ;

!-------------------------------------------------------------------!
!                       Policy Variables                            !
!-------------------------------------------------------------------!

VARIABLE (all,i,NSAV_COMM)(all,r,REG)                             to(i,r)
# output (or income) tax in region r # ;

VARIABLE (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)            tf(i,j,r)
# tax on primary factor i used by j in region r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)                             tpm(i,r)
# tax on imported i purchased by private hhlds in r # ;
```

VARIABLE (all,i,TRAD_COMM)(all,r,REG) tpd(i,r)
tax on domestic i purchased by private hhld in r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) tgm(i,r)
tax on imported i purchased by gov't hhld in r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) tgd(i,r)
tax on domestic i purchased by government hhlds in r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG) tfm(i,j,r)
tax on imported i purchased by j in r # ;

VARIABLE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG) tfd(i,j,r)
tax on domestic i purchased by j in r # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) txs(i,r,s)
combined tax in r on good i bound for region s # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) tms(i,r,s)
import tax in s on good i imported from region r # ;

VARIABLE (all,i,TRAD_COMM)(all,s,REG) tm(i,s)
variable import levy -- source generic # ;

VARIABLE (all,s,REG) ftm(s)
tariff shift -- source and commodity generic # ;

VARIABLE (all,i,TRAD_COMM)(all,r,REG) tx(i,r)
variable export tax (subsidy) -- destination generic # ;

```
!------------------------------------------------------------!
!           Value, Income and Utility Variables              !
!------------------------------------------------------------!
```

VARIABLE (all,r,REG) vexreg(r)
value of merchandise exports, by region # ;

VARIABLE (all,r,REG) vimreg(r)
value of merchandise imports, by region # ;

VARIABLE (all,i,TRAD_COMM) vexcom(i)
value of global merchandise exports by commodity # ;

VARIABLE (all,i,TRAD_COMM) vimcom(i)
value of global merchandise imports by commodity # ;

VARIABLE vexwld
value of world trade # ;

```
VARIABLE (all,r,REG)                                                    y(r)
# regional household income, in region r # ;

VARIABLE (all,r,REG)                                                   yp(r)
# regional private household expenditure, in region r # ;

VARIABLE (all,r,REG)                                                   up(r)
# per capita utility from private expend., in region r # ;

VARIABLE (all,r,REG)                                                   ug(r)
# per capita utility from gov't expend., in region r # ;

VARIABLE (all,r,REG)                                                    u(r)
# per capita utility from aggregate hhld expend., in region r # ;

VARIABLE (CHANGE)(all,r,REG)                                           EV(r)
# Equivalent Variation, $ US million # ;
! Hicksian equivalent variation. Positive figure indicates welfare improvement !

VARIABLE (CHANGE)                                                        WEV
# Equivalent variation for the world # ;

VARIABLE
(all, r, REG)                                                         qpr(r)
# quantity index for private consumption, by region # ;

(all, r, REG)                                                         qgr(r)
# quantity index for government consumption, by region # ;

(all, r, REG)                                                         qxr(r)
# quantity index for exports, by region # ;

(all, r, REG)                                                         qmr(r)
# quantity index for imports, by region # ;

(all, r, REG)                                                       qgdpr(r)
# quantity index for GDP, by region # ;

(all, r, REG)                                                         vgr(r)
# government consumption expenditure, by region # ;

(all, r, REG)                                                       vabsr(r)
# expenditure on GDP, by region # ;

(all, r, REG)                                                        rxar(r)
# ratio of exports to absorption, by region # ;
```

```
!----------------------------------------------------------!
!                     Slack Variables                      !
!----------------------------------------------------------!

VARIABLE (all,j,PROD_COMM)(all,r,REG)          profitslack(j,r)
# slack variable in the zero profit equation # ;
! This is exogenous, unless the user wishes to specify output in a given region
  exogenously. !

VARIABLE (all,r,REG)                           incomeslack(r)
# slack variable in the expression for regional income # ;
! This is exogenous, unless the user wishes to fix regional income !

VARIABLE (all,i,ENDW_COMM)(all,r,REG)          endwslack(i,r)
# slack variable in the endowment market clearing condition # ;
! This is exogenous, unless the user wishes to fix the wage rate for one of the primary
  factors !

VARIABLE (all, r, REG)                         cgdslack(r)
# slack variable for qcgds(r) # ;
! this is exogenous, unless the user wishes to specify the level of new capital goods in a
  region !

VARIABLE (all,r,REG)                           saveslack(r)
# slack variable in regional demand for savings # ;
! This is exogenous unless the user wishes to fix the level of savings in a region. !

VARIABLE (all,r,REG)                           govslack(r)
# slack variable to permit fixing of real govt purchases # ;
! This is exogenous unless the user wishes to fix the level of government purchases. !

VARIABLE (all,i,TRAD_COMM)(all,r,REG)          tradslack(i,r)
# slack variable in the tradeables market clearing condition # ;
! This is exogenous unless the user wishes to specify the price of tradeables
  exogenously !

VARIABLE                                       walraslack
# slack variable in the omitted market # ;
! This is endogenous under normal, GE closure. If the GE links are broken, then this
  must be swapped with the numeraire, thereby forcing global savings to explicitly equal
  global investment. !
```

```
!----------------------------------------------------------------!
!                          DATA BASE                             !
!----------------------------------------------------------------!

!----------------------------------------------------------------!
!     Base Revenues and Expenditures at Agent's Prices           !
!----------------------------------------------------------------!
```

```
COEFFICIENT (all,i,ENDW_COMM)(all,r,REG)                                EVOA(i,r)
! value of commodity i output in region r. ! ;

UPDATE (all,i,ENDW_COMM)(all,r,REG)
        EVOA(i,r) = ps(i,r) * qo(i,r) ;

COEFFICIENT (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)      EVFA(i,j,r)
! producer expenditure on i by industry j, in region r, valued at agent's prices ! ;

UPDATE (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
        EVFA(i,j,r) = pfe(i,j,r) * qfe(i,j,r) ;

COEFFICIENT (all,r,REG)                                                   SAVE(r)
! expenditure on NET savings in region r valued at agent's prices ! ;

UPDATE (all,r,REG)
        SAVE(r) = psave * qsave(r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)      VDFA(i,j,r)
! purchases of domestic i r for use in j in region r ! ;

UPDATE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
        VDFA(i,j,r) = pfd(i,j,r) * qfd(i,j,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)      VIFA(i,j,r)
! purchases of imported i r for use in j in region r ! ;

UPDATE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
        VIFA(i,j,r) = pfm(i,j,r) * qfm(i,j,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                               VDPA(i,r)
! private household expenditure on domestic i in r ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
        VDPA(i,r) = ppd(i,r) * qpd(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VIPA(i,r)
! private household expenditure on imported i ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
        VIPA(i,r) = ppm(i,r) * qpm(i,r) ;
```

```
COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VDGA(i,r)
! government household expenditure on domestic i in r ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
        VDGA(i,r) = pgd(i,r) * qgd(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VIGA(i,r)
! government household expenditure on imported i ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
        VIGA(i,r) = pgm(i,r) * qgm(i,r) ;

COEFFICIENT (all, r, REG)                                                VKB(r)
! value of beginning-of-period capital stock, in region r ! ;

UPDATE (all, r, REG)
        VKB(r) = kb(r) * pcgds(r) ;

COEFFICIENT (all, r, REG)                                                VDEP(r)
! value of capital depreciation, in r (depreciation rate is exogenous and therefore does
  not appear in update) ! ;

UPDATE (all, r, REG)
        VDEP(r) = kb(r) * pcgds(r) ;

!-----------------------------------------------------------------!
!      Base Revenues and Expenditures at Market Prices             !
!-----------------------------------------------------------------!

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                     VXMD(i,r,s)
! exports of commodity i from region r to destination s valued at market prices
  (tradeables only) ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        VXMD(i,r,s) = pm(i,r) * qxs(i,r,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VST(i,r)
! exports of commodity i from region r for international transportation valued at market
  prices (tradeables only) ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
        VST(i,r) = pm(i,r) * qst(i,r) ;

COEFFICIENT (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)              VFM(i,j,r)
! producer expenditure on i by industry j, in region r, valued at market prices ! ;

UPDATE (all,i,ENDWM_COMM)(all,j,PROD_COMM)(all,r,REG)
        VFM(i,j,r) = pm(i,r) * qfe(i,j,r) ;
```

```
UPDATE (all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG)
       VFM(i,j,r) = pmes(i,j,r) * qfe(i,j,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)      VIFM(i,j,r)
! purchases of imports i for use in j in region r ! ;

UPDATE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
       VIFM(i,j,r) = pim(i,r) * qfm(i,j,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)      VDFM(i,j,r)
! purchases of domestic i r for use in j in region r ! ;

UPDATE (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
       VDFM(i,j,r) = pm(i,r) * qfd(i,j,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       VIPM(i,r)
! private household expenditure on i in r ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
       VIPM(i,r)= pim(i,r) * qpm(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       VDPM(i,r)
! private household expenditure on domestic i in r ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
       VDPM(i,r) = pm(i,r) * qpd(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       VIGM(i,r)
! gov't household expenditure on i in r ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
       VIGM(i,r) = pim(i,r) * qgm(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       VDGM(i,r)
! government household expenditure on domestic i in r ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)
       VDGM(i,r) = pm(i,r) * qgd(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)            VIMS(i,r,s)
! imports of commodity i from region r to s, valued at domestic market prices ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
       VIMS(i,r,s) = pms(i,r,s) * qxs(i,r,s) ;
```

```
!-----------------------------------------------------------!
!      Base Revenues and Expenditures at World Prices      !
!-----------------------------------------------------------!
```

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) VXWD(i,r,s)
! exports of commodity i from region r to destinations valued fob (tradeables only) ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
VXWD(i,r,s) = pfob(i,r,s) * qxs(i,r,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG) VIWS(i,r,s)
! imports of commodity i from region r to s, valued cif (tradeables only) ! ;

UPDATE (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
VIWS(i,r,s) = pcif(i,r,s) * qxs(i,r,s) ;

```
!-----------------------------------------------------------!
!          Regional Income for Calculating EV               !
!-----------------------------------------------------------!
```

COEFFICIENT (all,r,REG) INC(r)
! initial equilibrium regional income data ! ;

```
!-----------------------------------------------------------!
!          Technology and Preference Parameters             !
!-----------------------------------------------------------!
```

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG) SUBPAR(i,r)
! the substitution parameter in the CDE minimum expenditure function ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG) INCPAR(i,r)
! expansion parameter in the CDE minimum expenditure function ! ;

COEFFICIENT (all,i,TRAD_COMM) ESUBD(i)
! the elasticity of substitution between domestic and imported goods in the Armington aggregation structure for all agents in all regions. ! ;

COEFFICIENT (all,i,TRAD_COMM) ESUBM(i)
! the elasticity of substitution among imports from different destinations in the Armington aggregation structure of all agents in all regions. !;

COEFFICIENT (all,i,ENDWS_COMM) ETRAE(i)
! ETRAE is the elasticity of transformation for sluggish primary factor endowments. It is non-positive, by definition. ! ;

COEFFICIENT (all, r, REG) RORFLEX(r)
! RORFLEX is the flexibility of expected net rate of return on capital stock, in region r, with respect to investment. If a region's capital stock increases by 1%, then it is expected that the net rate of return on capital will decline by RORFLEX % ! ;

```
COEFFICIENT                                                    ELTROC
! labour transformation elasticity ! ;

!-----------------------------------------------------------------!
!           Reading Model Parameters and Basedata.                !
!-----------------------------------------------------------------!

READ SUBPAR from FILE GTAPPARM ;

READ INCPAR from FILE GTAPPARM ;

READ ESUBD from FILE GTAPPARM ;

READ ESUBM from FILE GTAPPARM ;

READ ETRAE from FILE GTAPPARM ;

READ RORFLEX from FILE GTAPPARM ;

READ INC from FILE GTAPPARM ;

READ ELTROC from FILE GTAPPARM ;

READ (all,i,ENDW_COMM)(all,r,REG)                              EVOA(i,r)
        from FILE GTAPDATA header "EVOA" ;

READ (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)             EVFA(i,j,r)
        from FILE GTAPDATA header "EVFA" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)             VIFA(i,j,r)
        from FILE GTAPDATA header "VIFA" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)             VDFA(i,j,r)
        from FILE GTAPDATA header "VDFA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                              VIPA(i,r)
        from FILE GTAPDATA header "VIPA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                              VDPA(i,r)
        from FILE GTAPDATA header "VDPA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                              VIGA(i,r)
        from FILE GTAPDATA header "VIGA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                              VDGA(i,r)
        from FILE GTAPDATA header "VDGA" ;

READ (all,r,REG)                                               SAVE(r)
        from FILE GTAPDATA header "SAVE" ;
```

```
READ (all,r,REG)                                                      VKB(r)
        from FILE GTAPDATA header "VKB" ;

READ (all,r,REG)                                                      VDEP(r)
        from FILE GTAPDATA header "VDEP" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                          VXMD(i,r,s)
        from FILE GTAPDATA header "VXMD" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                     VST(i,r)
        from FILE GTAPDATA header "VST" ;

READ (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)                    VFM(i,j,r)
        from FILE GTAPDATA header "VFM" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)                    VIFM(i,j,r)
        from FILE GTAPDATA header "VIFM" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)                    VDFM(i,j,r)
        from FILE GTAPDATA header "VDFM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                     VIPM(i,r)
        from FILE GTAPDATA header "VIPM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                     VDPM(i,r)
        from FILE GTAPDATA header "VDPM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                     VIGM(i,r)
        from FILE GTAPDATA header "VIGM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                     VDGM(i,r)
        from FILE GTAPDATA header "VDGM" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                          VIMS(i,r,s)
        from FILE GTAPDATA header "VIMS" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                          VXWD(i,r,s)
        from FILE GTAPDATA header "VXWD" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                          VIWS(i,r,s)
        from FILE GTAPDATA header "VIWS" ;
```

```
!-----------------------------------------------------------!
!                Derivatives of the Base Data               !
!-----------------------------------------------------------!

ZERODIVIDE (ZERO_BY_ZERO) DEFAULT 0 ;

COEFFICIENT (all,i,DEMD_COMM)(all,j,PROD_COMM)(all,r,REG)          VFA(i,j,r)
! producer expenditure on i by industry j, in region r, valued at agent's prices ! ;

FORMULA (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
        VFA(i,j,r) = EVFA(i,j,r) ;

FORMULA (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG)
        VFA(i,j,s) = VDFA(i,j,s) + VIFA(i,j,s) ;

COEFFICIENT (all,i,NSAV_COMM)(all,r,REG)                           VOA(i,r)
! value of commodity i output in region r. ! ;

FORMULA (all,i,ENDW_COMM)(all,r,REG)
        VOA(i,r) = EVOA(i,r) ;

FORMULA (all,i,PROD_COMM)(all,r,REG)
        VOA(i,r) = sum(j,DEMD_COMM, VFA(j,i,r)) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                           VDM(i,r)
! domestic sales of commodity i in region r valued at market prices (tradeables only) ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        VDM(i,r) = VDPM(i,r) + VDGM(i,r) + sum(j,PROD_COMM, VDFM(i,j,r)) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                           VIM(i,r)
! value of imports of commodity i in r at domestic market prices ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        VIM(i,r) = sum(j,PROD_COMM, VIFM(i,j,r)) + VIPM(i,r) + VIGM(i,r) ;

COEFFICIENT (all,i,NSAV_COMM)(all,r,REG)                           VOM(i,r)
! value of commodity i output in region r. ! ;

FORMULA (all,i,ENDW_COMM)(all,r,REG)
        VOM(i,r) = sum(j,PROD_COMM, VFM(i,j,r)) ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        VOM(i,r) = VDM(i,r) + sum(s,REG, VXMD(i,r,s)) + VST(i,r) ;

FORMULA (all,h,CGDS_COMM)(all,r,REG)
        VOM(h,r) = VOA(h,r) ;
```

```
COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VPA(i,r)
! private household expenditure on commodity i in region r valued at agent's prices ! ;

FORMULA (all,i,TRAD_COMM)(all,s,REG)
        VPA(i,s) = VDPA(i,s) + VIPA(i,s) ;

COEFFICIENT (all,r,REG)                                                PRIVEXP(r)
! private consumption expenditure in region r ! ;

FORMULA (all,r,REG)
        PRIVEXP(r) = sum(i,TRAD_COMM, VPA(i,r)) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VGA(i,r)
! government household expenditure on commodity i in region r valued at agent's
  prices ! ;

FORMULA (all,i,TRAD_COMM)(all,s,REG)
        VGA(i,s) = VDGA(i,s) + VIGA(i,s) ;

COEFFICIENT (all,r,REG)                                                 GOVEXP(r)
! government expenditure in region r ! ;

FORMULA (all,r,REG)
        GOVEXP(r) = sum(i,TRAD_COMM, VGA(i,r)) ;

COEFFICIENT (all,r,REG)                                                 INCOME(r)
! level of NET income in region r (i.e., net of capital depreciation) ! ;

FORMULA (all,r,REG)
        INCOME(r) = sum(i,TRAD_COMM, VPA(i,r) + VGA(i,r)) + SAVE(r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                   VTWR(i,r,s)
! value of transportation services associated with the shipment of commodity i from r to
  s ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        VTWR(i,r,s) = VIWS(i,r,s) - VXWD(i,r,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                 FOBSHR(i,r,s)
! The fob share in VIW. ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        FOBSHR(i,r,s) = VXWD(i,r,s)/VIWS(i,r,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                 TRNSHR(i,r,s)
! The transport share in VIW. ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        TRNSHR(i,r,s) = VTWR(i,r,s)/VIWS(i,r,s) ;
```

```
COEFFICIENT                                                          VT
! The value of total international transportation services. !;

FORMULA
       VT = sum(i,TRAD_COMM, sum(r,REG, sum(s,REG, VTWR(i,r,s)))) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)  SHRDFM(i,j,r)
! the share, at market prices, of domestic products used by sector j ! ;

FORMULA (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
       SHRDFM(i,j,r) = VDFM(i,j,r)/VDM(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       SHRDPM(i,r)
! the share of domestic production used by private hhlds ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
       SHRDPM(i,r) = VDPM(i,r)/VDM(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       SHRDGM(i,r)
! the share of imports from r in s used by gov't hhlds ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
       SHRDGM(i,r) = VDGM(i,r)/VDM(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)  SHRIFM(i,j,r)
! the share of imports in r used by sector j ! ;

FORMULA (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
       SHRIFM(i,j,r) = VIFM(i,j,r)/VIM(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       SHRIPM(i,r)
! the share of imports in rused by private households ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
       SHRIPM(i,r) = VIPM(i,r)/VIM(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       SHRIGM(i,r)
! the share of imports from r used by government households! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
       SHRIGM(i,r) = VIGM(i,r)/VIM(i,r) ;

COEFFICIENT (all, r, REG)                                        REGINV(r)
! regional GROSS investment in region r, i.e. value of output of sector "cgds" ! ;

FORMULA (all, r, REG)
       REGINV(r) = sum(k,CGDS_COMM, VOA(k,r)) ;
```

```
COEFFICIENT (all, r, REG)                                      NETINV(r)
! regional NET investment in region r ! ;

FORMULA (all, r, REG)
        NETINV(r) = sum(k,CGDS_COMM, VOA(k,r)) - VDEP(r) ;

COEFFICIENT                                                    GLOBINV
! global expenditures on net investment ! ;

FORMULA
        GLOBINV = sum(r,REG, NETINV(r));

! alternatively GLOBINV = sum(r,REG,  SAVE(r))            !

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                       VXW(i,r)
! The value of commodity exports, fob, by commodity !
! Note: it does not include Transportation Services ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        VXW(i,r) = sum(s,REG, VXWD(i,r,s)) ;

COEFFICIENT (all,r,REG)                                        VXWREG(r)
! The value of commodity exports, fob, by region ! ;

FORMULA (all,r,REG)
        VXWREG(r) = sum(i,TRAD_COMM, VXW(i,r)) ;

COEFFICIENT (all,i,TRAD_COMM)                                  VXWCOM(i)
! The value of world exports, fob, by commodity ! ;

FORMULA (all,i,TRAD_COMM)
        VXWCOM(i) = sum(r,REG, VXW(i,r)) ;

COEFFICIENT (all,i,TRAD_COMM)(all,s,REG)                       VIW(i,s)
! The value of commodity imports, cif, by commodity ! ;

FORMULA (all,i,TRAD_COMM)(all,s,REG)
        VIW(i,s) = sum(r,REG, VIWS(i,r,s)) ;

COEFFICIENT (all,r,REG)                                        VIWREG(r)
! The value of commodity imports, cif, by region ! ;

FORMULA (all,r,REG)
        VIWREG(r) = sum(i,TRAD_COMM, VIW(i,r)) ;

COEFFICIENT (all,i,TRAD_COMM)                                  VIWCOM(i)
! The global value of commodity imports, cif, by commodity ! ;
```

```
FORMULA (all,i,TRAD_COMM)
        VIWCOM(i) = sum(r,REG, VIW(i,r)) ;

COEFFICIENT                                                          VXWLD
! The value of commodity exports, fob, globally ! ;

FORMULA
        VXWLD = sum(r,REG, VXWREG(r)) ;

COEFFICIENT (all,r,REG)                                         VWLDSALES(r)
! The value of sales/purchases to/from the world market from/by r. ! ;

FORMULA (all,r,REG)
        VWLDSALES(r) = sum(i,TRAD_COMM, sum(s,REG, VXWD(i,r,s))
                + VST(i,r)) + NETINV(r) ;

COEFFICIENT (all, r, REG)                                          EXPEXP(r)
# exports FOB, by region # ;

FORMULA (all, r, REG)
        EXPEXP(r) = SUM(s, REG, SUM(i, TRAD_COMM, VXWD(i,r,s)))
                + SUM(i, TRAD_COMM, VST(i,r)) ;

COEFFICIENT (all, r, REG)                                          IMPEXP(r)
# imports CIF, by region # ;

FORMULA (all, r, REG)
        IMPEXP(r) = SUM(s, REG, SUM(i, TRAD_COMM, VIWS(i,s,r))) ;

COEFFICIENT (all, r, REG)                                          GDPEXP(r)
# expenditure on GDP, by region # ;

FORMULA (all, r, REG)
        GDPEXP(r) = PRIVEXP(r) + REGINV(r) + GOVEXP(r) + EXPEXP(r)
                - IMPEXP(r) ;

COEFFICIENT (all, r, REG)                                          ABSEXP(r)
# absorption, by region # ;

FORMULA (all, r, REG)
        ABSEXP(r) = PRIVEXP(r) + REGINV(r) + GOVEXP(r) ;

COEFFICIENT (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)          SVA(i,j,r)
! The share of i in total value-added in j in r.! ;

FORMULA (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
        SVA(i,j,r) = VFA(i,j,r)/sum(k,ENDW_COMM, VFA(k,j,r)) ;
```

```
COEFFICIENT (all,i,TRAD_COMM)(all,s,REG)                              PMSHR(i,s)
! The share of aggregate imports in the domestic composite for private households,
  evaluated at agent's prices. ! ;

FORMULA (all,i,TRAD_COMM)(all,s,REG)
        PMSHR(i,s) = VIPA(i,s) / VPA(i,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,s,REG)                              GMSHR(i,s)
! The share of aggregate imports in the domestic composite for gov't households,
  evaluated at agent's prices. ! ;

FORMULA (all,i,TRAD_COMM)(all,s,REG)
        GMSHR(i,s) = VIGA(i,s) / VGA(i,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG)    FMSHR(i,j,s)
! The share of aggregate imports in the domestic composite for firms, evaluated at
  agents' prices. ! ;

FORMULA (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG)
        FMSHR(i,j,s) = VIFA(i,j,s) / VFA(i,j,s) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)            MSHRS(i,r,s)
! The share of imports by source, r, in the aggregate import bill of region s evaluated at
  market prices. ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        MSHRS(i,r,s) = VIMS(i,r,s) / sum(k,REG, VIMS(i,k,s)) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                              CONSHR(i,r)
! The share of private household consumption devoted to good i in region r. ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        CONSHR(i,r) = VPA(i,r) / sum(m, TRAD_COMM, VPA(m,r)) ;

COEFFICIENT (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG) REVSHR(i,j,r);

FORMULA (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
        REVSHR(i,j,r) = VFM(i,j,r)/sum(k,PROD_COMM, VFM(i,k,r));

COEFFICIENT (all, r, REG)                                             INVKERATIO(r)
! ratio of gross investment to end-of-period capital stock, in region r ! ;

FORMULA (all, r, REG)
        INVKERATIO(r) = REGINV(r) / [VKB(r) + NETINV(r)] ;

COEFFICIENT (all, r, REG)                                             GRNETRATIO(r)
! ratio of GROSS/NET rates of return on capital, in region r !
! NOTE: VOA("capital",r) is GROSS returns to capital ! ;
```

```
FORMULA (all, r, REG)
        GRNETRATIO(r) = sum(h, ENDWC_COMM, VOA(h,r)) /
                [ sum(h, ENDWC_COMM, VOA(h,r)) - VDEP(r) ] ;

! Next, compute the Allen partials, price and income elasticities, for the consumption
  commodities.!

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                    ALPHA(i,r)
! one minus the substitution parameter in CDE minimum expenditure function ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        ALPHA(i,r) = (1 - SUBPAR(i,r)) ;

COEFFICIENT (all,i,TRAD_COMM)(all,k,TRAD_COMM)(all,r,REG)          APE(i,k,r)
! the allen partial elasticity of substitution between composite goods i and k in region r ! ;

FORMULA (all,i,TRAD_COMM)(all,k,TRAD_COMM)(all,r,REG)
        APE(i,k,r) = ALPHA(i,r) + ALPHA(k,r)
                - sum(m,TRAD_COMM, CONSHR(m,r) * ALPHA(m,r)) ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        APE(i,i,r) = 2.0 * ALPHA(i,r)
                - sum(m,TRAD_COMM, CONSHR(m,r) * ALPHA(m,r))
                - ALPHA(i,r) / CONSHR(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                COMPDEM(i,r)
! the own-price compensated elasticity of household demand for composite commodity
  i ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        COMPDEM(i,r) = APE(i,i,r) * CONSHR(i,r) ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                        EY(i,r)
! the income elasticity of household demand for composite good i in region r ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
        EY(i,r) = {1.0/[sum(m,TRAD_COMM, CONSHR(m,r) * INCPAR(m,r))]}
                * (INCPAR(i,r) * (1.0 - ALPHA(i,r))
                + sum(m,TRAD_COMM, CONSHR(m,r) * INCPAR(m,r)
                * ALPHA(m,r))) + (ALPHA(i,r)
                - sum(m,TRAD_COMM, CONSHR(m,r) * ALPHA(m,r))) ;

COEFFICIENT (all,i,TRAD_COMM)(all,k,TRAD_COMM)(all,r,REG)           EP(i,k,r)
! the uncompensated cross-price elasticity of household demand for good i with respect
  to the kth price in region r ! ;

FORMULA (all,i,TRAD_COMM)(all,k,TRAD_COMM)(all,r,REG)
        EP(i,k,r) = 0 ;
```

```
FORMULA (all,i,TRAD_COMM)(all,k,TRAD_COMM)(all,r,REG)
        EP(i,k,r) =  (APE(i,k,r) - EY(i,r)) * CONSHR(k,r) ;

! Next, declare a small coefficient used to prevent singularity problems arising from zero
  trade flows !

COEFFICIENT                                                                          TINY
# Arbitrary small number # ;

FORMULA
        TINY = 0.000001 ;

!------------------------------------------------------------------!
!                      Checking The Base Data                      !
!------------------------------------------------------------------!

COEFFICIENT (all,j,PROD_COMM)(all,r,REG)                                   PROFITS(j,r)
! profits in j of r. This should equal zero. ! ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
        PROFITS(j,r) = VOA(j,r) - sum(i,DEMD_COMM, VFA(i,j,r));

COEFFICIENT (all,s,REG)                                                       SURPLUS(s)
! Economic surplus in region s. This should equal zero. Note: We first compute net
  income from endowments and then income from various taxes. At the end we deduct
  private and government expenditures and net savings ! ;

FORMULA (all,r,REG)
        SURPLUS(r) = sum(i,ENDW_COMM, VOA(i,r)) - VDEP(r)
                + sum(i,NSAV_COMM,VOM(i,r) - VOA(i,r))
                + sum(j,PROD_COMM,sum(i,ENDW_COMM, VFA(i,j,r) - VFM(i,j,r)))
                + sum(i,TRAD_COMM,VIPA(i,r) - VIPM(i,r))
                + sum(i,TRAD_COMM,VDPA(i,r) - VDPM(i,r))
                + sum(i,TRAD_COMM,VIGA(i,r) - VIGM(i,r))
                + sum(i,TRAD_COMM,VDGA(i,r) - VDGM(i,r))
                + sum(j,PROD_COMM,sum(i,TRAD_COMM, VIFA(i,j,r)
                - VIFM(i,j,r))) + sum(j,PROD_COMM,
                            sum(i,TRAD_COMM, VDFA(i,j,r) - VDFM(i,j,r)))
                + sum(i,TRAD_COMM,sum(s,REG,VXWD(i,r,s) - VXMD(i,r,s)))
                + sum(i,TRAD_COMM,sum(s,REG,VIMS(i,s,r) - VIWS(i,s,r)))
                - sum(i,TRAD_COMM, VPA(i,r)+ VGA(i,r)) - SAVE(r) ;

DISPLAY PROFITS ;

DISPLAY SURPLUS ;
```

```
!-------------------------------------------------------!
!                    THE EQUATIONS                      !
!-------------------------------------------------------!

!-------------------------------------------------------!
!              Market Clearing Conditions               !
!-------------------------------------------------------!
```

```
EQUATION                                            MKTCLTRD
! This equation assures market clearing in the traded goods markets. !
    (all,i,TRAD_COMM)(all,r,REG)
    VOM(i,r) * qo(i,r) = VDM(i,r) * qds(i,r) + VST(i,r) * qst(i,r)
        + sum(s,REG, VXMD(i,r,s) * qxs(i,r,s)) + VOM(i,r) * tradslack(i,r) ;

EQUATION                                            MKTCLIMP
! this equation assures market clearing for the tradeable commodities entering each
  region. !
    (all,i,TRAD_COMM)(all,r,REG)
    qim(i,r) = sum(j,PROD_COMM, SHRIFM(i,j,r) * qfm(i,j,r))
        + SHRIPM(i,r) * qpm(i,r) + SHRIGM(i,r) * qgm(i,r) ;

EQUATION                                            MKTCLDOM
! this equation assures market clearing for domestic output. !
    (all,i,TRAD_COMM)(all,r,REG)
    qds(i,r) = sum(j,PROD_COMM, SHRDFM(i,j,r) * qfd(i,j,r))
        + SHRDPM(i,r) * qpd(i,r) + SHRDGM(i,r) * qgd(i,r) ;

EQUATION                                            MKTCLENDWM
! In each of the regions, this equation assures market clearing in the markets for
  endowment goods which are perfectly mobile among uses. !
    (all,i,ENDWM_COMM)(all,r,REG)
    VOM(i,r) * qo(i,r) = sum(j,PROD_COMM, VFM(i,j,r) * qfe(i,j,r))
        + VOM(i,r) * endwslack(i,r) ;

EQUATION                                            MKTCLENDWS
! In each of the regions, this equation assures market clearing in the markets for
  endowment goods which are imperfectly mobile among uses. !
    (all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG)
    qoes(i,j,r) = qfe(i,j,r);

EQUATION                                            PRIVATEEXP
! This equation computes private household expenditure as household income less
  savings less government expenditures. !
    (all,r,REG)
    PRIVEXP(r) * yp(r) = INCOME(r) * y(r)
        - SAVE(r) * [ psave + qsave(r) ]
        - sum(i,TRAD_COMM, VGA(i,r) * [pg(i,r) + qg(i,r)]) ;
```

EQUATION REGIONALINCOME

! This equation computes regional income as the sum of primary factor payments and tax receipts. !

```
(all,r,REG)
INCOME(r) * y(r) = sum(i,ENDW_COMM, VOA(i,r) * [ps(i,r) + qo(i,r)])
        - VDEP(r) * [pcgds(r) + kb(r)] + sum(i,NSAV_COMM, {VOM(i,r)
        * [pm(i,r) + qo(i,r)]} - {VOA(i,r) * [ps(i,r) + qo(i,r)]})
        + sum(i,ENDWM_COMM,sum(j,PROD_COMM,{VFA(i,j,r)
        * [pfe(i,j,r) + qfe(i,j,r)]} - {VFM(i,j,r) * [pm(i,r) + qfe(i,j,r)]}))
        + sum(i,ENDWS_COMM,sum(j,PROD_COMM,{VFA(i,j,r)
        * [pfe(i,j,r) + qfe(i,j,r)]} - {VFM(i,j,r) * [pmes(i,j,r) + qfe(i,j,r)]}))
        + sum(j,PROD_COMM, sum(i,TRAD_COMM,{VIFA(i,j,r)
        * [pfm(i,j,r) + qfm(i,j,r)]} - {VIFM(i,j,r) * [pim(i,r) + qfm(i,j,r)]}))
        + sum(j,PROD_COMM, sum(i,TRAD_COMM,{VDFA(i,j,r)
        * [pfd(i,j,r) + qfd(i,j,r)]} - {VDFM(i,j,r) * [pm(i,r) + qfd(i,j,r)]}))
        + sum(i,TRAD_COMM,{VIPA(i,r) * [ppm(i,r) + qpm(i,r)]}
        - {VIPM(i,r) * [pim(i,r) + qpm(i,r)]})
        + sum(i,TRAD_COMM,{VDPA(i,r) * [ppd(i,r)+ qpd(i,r)]}
        - {VDPM(i,r) * [pm(i,r) + qpd(i,r)]})
        + sum(i,TRAD_COMM,{VIGA(i,r) * [pgm(i,r) + qgm(i,r)]}
        - {VIGM(i,r) * [pim(i,r) + qgm(i,r)]})
        + sum(i,TRAD_COMM,{VDGA(i,r) * [pgd(i,r) + qgd(i,r)]}
        - {VDGM(i,r) * [pm(i,r) + qgd(i,r)]})
        + sum(i,TRAD_COMM,sum(s,REG,{VXWD(i,r,s)
        * [pfob(i,r,s) + qxs(i,r,s)]} - {VXMD(i,r,s) * [pm(i,r) + qxs(i,r,s)]}))
        + sum(i,TRAD_COMM,sum(s,REG,{VIMS(i,s,r)
        * [pms(i,s,r) + qxs(i,s,r)]} - {VIWS(i,s,r) * [pcif(i,s,r) + qxs(i,s,r)]}))
        + INCOME(r) * incomeslack(r);
```

EQUATION KEND

! Ending capital stock equals beginning stock plus net investment. !

```
(all, r, REG)
ke(r) = INVKERATIO(r) * qcgds(r) + [1.0 - INVKERATIO(r)] * kb(r) ;
```

EQUATION WALRAS_S

! This is an extra equation which simply computes change in supply in the omitted market. !

```
walras_sup = globalcgds ;
```

EQUATION WALRAS_D

! This is an extra equation which simply computes change in demand in the omitted market. !

```
GLOBINV * walras_dem = sum(r,REG, SAVE(r) * qsave(r)) ;
```

EQUATION WALRAS

! This equation checks Walras Law. The value of the endogenous slack variable should be zero. !

```
walras_sup = walras_dem + walraslack ;
```

EQUATION SUPPLYPRICES
! This equation links pre- and post-tax supply prices for all industries. This captures the effect of output taxes. TO(i,r) < 1 in the case of a tax. !

```
(all,i,NSAV_COMM)(all,r,REG)
ps(i,r) = to(i,r) + pm(i,r) ;
```

EQUATION MPFACTPRICE
! This equation links domestic and firm demand prices. It holds for Mobile endowment goods and captures the effect of taxation of firms' usage of primary factors. !

```
(all,i,ENDWM_COMM)(all,j,PROD_COMM)(all,r,REG)
pfe(i,j,r) = tf(i,j,r) + pm(i,r) ;
```

EQUATION SPFACTPRICE
! This equation links domestic and firm demand prices. It holds for Sluggish endowment goods and captures the effect of taxation of firms' usage of primary factors. !

```
(all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG)
pfe(i,j,r) = tf(i,j,r) + pmes(i,j,r) ;
```

EQUATION PHHDPRICE
! This equation links domestic market and private household prices.It holds only for domestic goods and it captures the effect of commodity taxation of private households.!

```
(all,i,TRAD_COMM)(all,r,REG)
ppd(i,r) = tpd(i,r) + pm(i,r)  ;
```

EQUATION GHHDPRICE
! This equation links domestic market and government household prices. It holds only for domestic goods and it captures the effect of commodity taxation of government households. !

```
(all,i,TRAD_COMM)(all,r,REG)
pgd(i,r) = tgd(i,r) + pm(i,r)  ;
```

EQUATION DMNDDPRICE
! This equation links domestic market and firm prices. It holds only for domestic goods and it captures the effect of commodity taxation of firms. !

```
(all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
pfd(i,j,r) = tfd(i,j,r) + pm(i,r)  ;
```

EQUATION PHHIPRICES
! This equation links domestic market and private household prices. It holds only for imports and it captures the effect of commodity taxation of private households. !

```
(all,i,TRAD_COMM)(all,r,REG)
ppm(i,r) = tpm(i,r) + pim(i,r)  ;
```

EQUATION GHHIPRICES
! This equation links domestic market and government household prices. It holds only for imports and it captures the effect of commodity taxation of government households. !

```
(all,i,TRAD_COMM)(all,r,REG)
pgm(i,r) = tgm(i,r) + pim(i,r)  ;
```

```
EQUATION                                                        DMNDIPRICES
! This equation links domestic market and firm prices. It holds only for imported goods
  and it captures the effect of commodity taxation of firms. !
        (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
        pfm(i,j,r) = tfm(i,j,r) + pim(i,r) ;

EQUATION                                                        MKTPRICES
! This equation links domestic and world prices. It includes a source-generic import
  levy. !
        (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        pms(i,r,s) = ftm(s) + tm(i,s) + tms(i,r,s) + pcif(i,r,s) ;

EQUATION                                                        PRICETGT
! This equation defines the target price ratio to be attained via the variable levy. !
        (all,i,TRAD_COMM)(all,s,REG)
        pr(i,s) = pm(i,s) - pim(i,s) ;

EQUATION                                                        EXPRICES
! This equation links agent's and world prices. In addition to tx we have ts which
  embodies both production taxes (all s) and export taxes (r not equal to s). !
        (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        pfob(i,r,s) = pm(i,r) - tx(i,r) - txs(i,r,s) ;


!----------------------------------------------------------!
!                  Composite Imports Nest                  !
!----------------------------------------------------------!

EQUATION                                                        DPRICEIMP
! Price for aggregate imports. !
        (all,i,TRAD_COMM)(all,s,REG)
        pim(i,s) = sum(k,REG, MSHRS(i,k,s) * pms(i,k,s));

EQUATION                                                        IMPORTDEMAND
! Regional demand for disaggregated imported commodities by source. !
        (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
        qxs(i,r,s) = qim(i,s) - ESUBM(i) * [pms(i,r,s) - pim(i,s)];

!----------------------------------------------------------!
!             Behavioral Equations for Firms               !
!----------------------------------------------------------!

!----------------------------------------------------------!
!              Composite intermediates nest                !
!----------------------------------------------------------!

EQUATION                                                        ICOMPRICE
! Industry price for composite commodities. !
        (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
        pf(i,j,r) = FMSHR(i,j,r)*pfm(i,j,r) + [1 - FMSHR(i,j,r)]*pfd(i,j,r) ;
```

```
EQUATION                                                          INDIMP
! Industry j demands for composite import i. !
        (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG)
        qfm(i,j,s) = qf(i,j,s)
                - ESUBD(i) * [pfm(i,j,s) - pf(i,j,s)];

EQUATION                                                          INDDOM
! Industry j demands for domestic good i. !
        (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG)
        qfd(i,j,s) = qf(i,j,s) - ESUBD(i) * [pfd(i,j,s) - pf(i,j,s)];

!---------------------------------------------------------------!
!                       Value-added nest                        !
!---------------------------------------------------------------!

EQUATION                                                          VAPRICE
! (Effective) price of primary factor composite in each sector/region. !
        (all,j,PROD_COMM)(all,r,REG)
        pva(j,r) = SUM{k, ENDW_COMM, SVA(k,j,r) * pfe(k,j,r)} ;

VARIABLE (all, i, ENDW_COMM)(all, j, PROD_COMM)(all, r, REG)     bfe(i,j,r)
        # factor i intensifying technological change # ;

COEFFICIENT (all, j, PROD_COMM)(all, r, REG)                      VLD(j,r)
        # demand value of labour employment # ;
FORMULA (all, j, PROD_COMM)(all, r, REG)
        VLD(j,r) = SUM{i, LABR_COMM, VFA(i,j,r)} ;

COEFFICIENT (all, i, LABR_COMM)(all, j, PROD_COMM)(all, r, REG)
                                                            SHLABrit(i,j,r)
        # share of labour type i in demand value of employment # ;
FORMULA (all, i, LABR_COMM)(all, j, PROD_COMM)(all, r, REG)
        SHLABrit(i,j,r) = VFA(i,j,r)/VLD(j,r) ;

COEFFICIENT (integer) (all, i, ENDW_COMM)                         ISLAB(i) ;
FORMULA (all, i, ENDW_COMM)
        ISLAB(i) = 0 ;
FORMULA (all, i, LABR_COMM)
        ISLAB(i) = 1 ;

EQUATION                                                          ENDWDEMAND
! Demands for endowment commodities. !
        (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
        qfe(i,j,r) = qva(j,r) + IF(ISLAB(i) = 1,
                bfe(i,j,r) - SUM{i0, LABR_COMM, SHLABrit(i0,j,r) * bfe(i0,j,r)})
                - pfe(i,j,r) + pva(j,r);
```

```
!-----------------------------------------------------------!
!                    Total output nest                      !
!-----------------------------------------------------------!
```

EQUATION VADEMAND
! Sector demands for primary factor composite. !
(all,j,PROD_COMM)(all,r,REG)
qva(j,r) + ava(j,r) = qo(j,r) - ao(j,r);

EQUATION VATECH
! factor-augmenting technological change !
(all,j,PROD_COMM)(all,r,REG)
ava(j,r) = favari(j,r) + favar(r);

EQUATION INTDEMAND
! Industry demands for intermediate inputs, including cgds. !
(all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)
qf(i,j,r) + af(i,j,r) = qo(j,r) - ao(j,r) ;

```
!-----------------------------------------------------------!
!               The Zero Profits Equations                  !
!-----------------------------------------------------------!
```

EQUATION ZEROPROFITS
! Industry zero pure profits condition. This condition permits us to determine the endogenous output level for each of the non-endowment sectors. The level of activity in the endowment sectors is exogenously determined. !
(all,j,PROD_COMM)(all,r,REG)
VOA(j,r) * [ps(j,r) + ao(j,r)] =
sum(i,ENDW_COMM, VFA(i,j,r) * [pfe(i,j,r) + bfe(i,j,r) - ava(j,r)])
+ sum(i,TRAD_COMM, VFA(i,j,r) * [pf(i,j,r) - af(i,j,r)])
+ VOA(j,r) * profitslack(j,r);

```
!-----------------------------------------------------------!
!            The Household Behavior Equations               !
!-----------------------------------------------------------!

!-----------------------------------------------------------!
!                    Aggregate utility                      !
!-----------------------------------------------------------!
```

EQUATION UTILITY
! computation of per capita regional utility. !
(all,r,REG)
INCOME(r) * u(r) = PRIVEXP(r) * up(r)
+ GOVEXP(r) * [ug(r) - pop(r)] + SAVE(r) * [qsave(r) - pop(r)] ;

```
!--------------------------------------------------------------!
!                     Regional savings                         !
!--------------------------------------------------------------!
```

EQUATION SAVINGS
! regional demand for savings -- generated from aggregate Cobb-Douglas utility function where the pop(r) terms again cancel. !
(all,r,REG)
qsave(r) = y(r) - psave + saveslack(r) ;

```
!--------------------------------------------------------------!
!                  Government purchases                        !
!--------------------------------------------------------------!
```

EQUATION GOVERTU
! Computation of per capita utility from regional government consumption. In some closures this index of gov't activity may be fixed, in which case govslack is endogenized. In this case the mix of regional expenditures changes and the aggregate utility index no longer applies. !
(all,r,REG)
ug(r) = y(r) - pgov(r) + govslack(r) ;

```
!--------------------------------------------------------------!
!               Demand for composite goods                     !
!--------------------------------------------------------------!
```

EQUATION GPRICEINDEX
! definition of price index for aggregate gov't purchases. !
(all,r,REG)
pgov(r) = sum(i,TRAD_COMM, [VGA(i,r)/GOVEXP(r)] * pg(i,r)) ;

EQUATION GOVDMNDS
! Government household demands for composite commodities. Note that the pop(r) argument in per capita income and that in per capita consumption cancel due to homotheticity. !
(all,i,TRAD_COMM)(all,r,REG)
qg(i,r) = ug(r) - [pg(i,r) - pgov(r)] ;

```
!--------------------------------------------------------------!
!                  Composite tradeables                        !
!--------------------------------------------------------------!
```

EQUATION GCOMPRICE
! Government household price for composite commodities (HT#42). !
(all,i,TRAD_COMM)(all,s,REG)
pg(i,s) = GMSHR(i,s) * pgm(i,s) + [1 - GMSHR(i,s)] * pgd(i,s) ;

EQUATION GHHLDAGRIMP
! Government household demand for aggregate imports (HT#43). !
(all,i,TRAD_COMM)(all,s,REG)
qgm(i,s) = qg(i,s) + ESUBD(i) * [pg(i,s) - pgm(i,s)] ;

```
EQUATION                                                    GHHLDDOM
! Government household demand for domestic goods (HT#44). !
        (all,i,TRAD_COMM)(all,s,REG)
        qgd(i,s) = qg(i,s) + ESUBD(i) * (pg(i,s) - pgd(i,s)) ;

!-----------------------------------------------------------!
!                 Private household demands                 !
!-----------------------------------------------------------!

EQUATION                                                    PRIVATEU
! This equation determines private consumption utility for a representative household in
  region r, based on the per capita private expenditure function (HT#45). !
        (all,r,REG)
        yp(r) = sum(i,TRAD_COMM, (CONSHR(i,r) * pp(i,r)))
                + sum(i,TRAD_COMM, (CONSHR(i,r) * INCPAR(i,r))) * up(r)
                + pop(r) ;

!-----------------------------------------------------------!
!                    Composite demands                      !
!-----------------------------------------------------------!

EQUATION                                                    PRIVDMNDS
! Private household demands for composite commodities. Demand system is on a per
  capita basis.  Here, yp(r) - pop(r) is % change in per capita income (HT#46). !
        (all,i,TRAD_COMM)(all,r,REG)
        qp(i,r) = sum(k,TRAD_COMM,EP(i,k,r) * pp(k,r)) + EY(i,r) * [ yp(r) - pop(r) ]
                + pop(r) ;

!-----------------------------------------------------------!
!                  Composite tradeables                     !
!-----------------------------------------------------------!

EQUATION                                                    PCOMPRICE
! Private household price for composite commodities (HT#47). !
        (all,i,TRAD_COMM)(all,s,REG)
        pp(i,s) = PMSHR(i,s) * ppm(i,s) + [1 - PMSHR(i,s)] * ppd(i,s) ;

EQUATION                                                    PHHLDDOM
! Private household demand for domestic goods (HT#48). !
        (all,i,TRAD_COMM)(all,s,REG)
        qpd(i,s) = qp(i,s) + ESUBD(i) * [pp(i,s) - ppd(i,s)] ;

EQUATION                                                    PHHLDAGRIMP
! Private household demand for aggregate imports (HT#49). !
        (all,i,TRAD_COMM)(all,s,REG)
        qpm(i,s) = qp(i,s) + ESUBD(i) * [pp(i,s) - ppm(i,s)] ;
```

```
!-----------------------------------------------------------!
!                 Sluggish Primary Factors                  !
!-----------------------------------------------------------!
```

EQUATION ENDW_PRICE
! This equation generates the composite price for sluggish endowments (HT#50). !
(all,i,ENDWS_COMM)(all,r,REG)
pm(i,r) = sum(k,PROD_COMM, REVSHR(i,k,r) * pmes(i,k,r)) ;

EQUATION ENDW_SUPPLY
! This equation distributes the sluggish endowments across sectors (HT#51). !
(all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG)
qoes(i,j,r) = qo(i,r) + endwslack(i,r) + ETRAE(i) * [pm(i,r) - pmes(i,j,r)] ;

```
!-----------------------------------------------------------!
!             Capital Stock and Rate of Return              !
!-----------------------------------------------------------!
```

EQUATION KAPSVCES
! This equation defines a variable for capital services, for convenience (There is really only one capital services item). !
(all,r,REG)
ksvces(r) = sum(h,ENDWC_COMM, [VOA(h,r) /
sum(k,ENDWC_COMM, VOA(k,r))] * qo(h,r)) ;

EQUATION KAPRENTAL
! This equation defines a variable for capital rental rate. !
(all,r,REG)
rental(r) = sum(h,ENDWC_COMM, [VOA(h,r) /
sum(k,ENDWC_COMM, VOA(k,r))] * ps(h,r)) ;

EQUATION CAPGOODS
! This equation defines a variable for gross investment, for convenience (There is really only one capital goods item). !
(all,r,REG)
qcgds(r) = sum(h,CGDS_COMM, [VOA(h,r) / REGINV(r)] * qo(h,r))
+ cgdslack(r) ;

EQUATION PRCGOODS
! This equation defines the price of cgds for convenience. !
(all,r,REG)
pcgds(r) = sum(h,CGDS_COMM, [VOA(h,r) / REGINV(r)] * ps(h,r)) ;

EQUATION KBEGINNING
! This equation associates any change in capital services during the period with a change in capital stock. Full capacity utilization is assumed. !
(all,r,REG)
kb(r) = ksvces(r) ;

EQUATION RORCURRENT
! This generates the current rate of return on capital in region r. !
(all, r, REG)
rorc(r) = GRNETRATIO(r) * [rental(r) - pcgds(r)] ;

EQUATION ROREXPECTED
! Expected rate of return depends on the current return and investment. !
(all, r, REG)
rore(r) = rorc(r) - RORFLEX(r) * [ke(r) - kb(r)] ;

! The following equations hold for the world as a whole !

EQUATION PRICGDS
! This equation generates a price index for the aggregate global cgds composite. !
psave = sum(r,REG, [NETINV(r) / GLOBINV] * pcgds(r)) ;

! Suggestions for use:
-- to control relativities between rates of return, exogenize:
-- frore,
-- fglobalcgds;
-- to control national composition of net investment, exogenize:
-- frorg,
-- fqcgds. !

VARIABLE frorg
global shift in expected rate of return # ;

fglobalcgds
global shift in investment # ;

(all, r, REG) frore(r)
region-specific shift in expected rate of return #;

(all, r, REG) fqcgds(r)
region-specific shift in investment #;

EQUATION EQUIL_ROR
international equilibration of expected rates of return
(all, r, REG)
rore(r) = frorg + frore(r);

EQUATION ALLOC_INV
international allocation of investment
(all, r, REG)
[REGINV(r)/NETINV(r)] * qcgds(r) - [VDEP(r)/NETINV(r)] * kb(r) =
fglobalcgds + fqcgds(r) ;

```
EQUATION                                                        RORGLOBAL
# average expected rate of return #
      GLOBINV*rorg = sum(r, REG, REGINV(r)*rore(r)) ;

EQUATION                                                        GLOBALINV
# quantity index for net investment #
      GLOBINV*globalcgds =
            sum(r, REG, REGINV(r)*qcgds(r)) - SUM(r, REG, VDEP(r)*kb(r)) ;

!-------------------------------------------------------!
!           The Composite Transport Services            !
!-------------------------------------------------------!

EQUATION                                                           PTRANS
! This equation generates a price index for transportation services based on zero profits.
  (NOTE Sales to international transportation are not subject to export tax. This is why
  we base the costs to the transport sector on market prices of the goods sold to
  international transportation). !
      VT * pt = sum(i,TRAD_COMM, sum(r,REG, VST(i,r) * pm(i,r))) ;

EQUATION                                                        TRANSVCES
! This equation generates the demand for regional supply of global transportation
  services. It reflects a unitary elasticity of substitution between transportation services
  inputs from different regions. !
      (all,i,TRAD_COMM)(all,r,REG)
      qst(i,r) = qt + [pt - pm(i,r)] ;

EQUATION                                                           QTRANS
! This equation computes the global demand for international transportation services
  (i.e., variable qt). It reflects the fact that the demand for services along any particular
  route is proportional to the quantity of merchandise shipped [i.e., variable qxs(i,r,s)]. !
      VT * qt = sum(i,TRAD_COMM, sum(r,REG,
            sum(s,REG, VTWR(i,r,s) * [qxs(i,r,s) - atr(i,r,s)] ))) ;

EQUATION                                                           FOBCIF
! This equation links fob and cif prices for good i shipped from region r to s. !
      (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)
      pcif(i,r,s) = FOBSHR(i,r,s) * pfob(i,r,s) + TRNSHR(i,r,s) * [pt - atr(i,r,s)];

!-------------------------------------------------------!
!                 Regional Terms of Trade               !
!-------------------------------------------------------!

EQUATION                                                       REGSUPRICE
! This equation estimates the change in the index of prices received for tradeable
  products produced in r. !
      (all,r,REG)
      VWLDSALES(r) * psw(r) = sum(i,TRAD_COMM, sum(s,REG, VXWD(i,r,s)
            * pfob(i,r,s)) + VST(i,r) * pm(i,r)) + NETINV(r) * pcgds(r) ;
```

```
EQUATION                                                    REGDEMPRICE
! This equation estimates the change in the index of prices paid for tradeable products
 used in r. !
        (all,r,REG)
        VWLDSALES(r) * pdw(r) = sum(i,TRAD_COMM, sum(k,REG, VIWS(i,k,r)
                * pcif(i,k,r))) + SAVE(r) * psave ;

EQUATION                                                    EXPORTS
! computes the change in volume of exports of commodity i from r !
        (all,i,TRAD_COMM)(all,r,REG)
        [VXW(i,r) + TINY] * qex(i,r) =
                sum{s,REG, VXWD(i,r,s) * qxs(i,r,s)} + TINY * qexreg(r) ;

EQUATION                                                    P_EX
! computes the change in price index of exports of commodity i from r !
        (all,i,TRAD_COMM)(all,r,REG)
        [VXW(i,r) + TINY] * pex(i,r) =
                sum{s,REG, VXWD(i,r,s) * pfob(i,r,s)}  + TINY * pexreg(r) ;

!-------------------------------------------------------------!
!       Quantity Indexes for Aggregate Trade Figures          !
!-------------------------------------------------------------!

EQUATION                                                    REGEX_v
! computes % change in value of merchandise exports, by region !
        (all,r,REG)
        VXWREG(r) * vexreg(r) =
                sum(i,TRAD_COMM, VXW(i,r) * [pex(i,r)+qex(i,r)]) ;

EQUATION                                                    REGIM_sv
! computes % change in value of merchandise imports, by region !
        (all,s,REG)
        VIWREG(s) * vimreg(s) =
                sum(i,TRAD_COMM, VIW(i,s) * [pim(i,s)+qim(i,s)]) ;

EQUATION                                                    COMEX_v
! computes % change in value of merchandise exports, by commodity !
        (all,i,TRAD_COMM)
        [VXWCOM(i)  + TINY] * vexcom(i) =
                sum{r,REG, VXW(i,r) * [pex(i,r) + qex(i,r)]} + TINY * vexwld ;

EQUATION                                                    REGIM_iv
! computes % change in value of merchandise imports, by commodity !
        (all,i,TRAD_COMM)
        [VIWCOM(i) + TINY] * vimcom(i) =
                sum{s,REG, VIW(i,s) * [pim(i,s)+qim(i,s)]} + TINY * vexwld ;
```

```
EQUATION                                                    WLDTRD_v
! computes % change in value of global merchandise exports !
        VXWLD * vexwld =
                sum(i,TRAD_COMM, VXWCOM(i) * [pexcom(i)+qexcom(i)]) ;

EQUATION                                                    REGEX_p
! computes % change in price index of merchandise exports, by region !
        (all,r,REG)
        VXWREG(r) * pexreg(r) = sum(i,TRAD_COMM, VXW(i,r) * pex(i,r)) ;

EQUATION                                                    REGIM_sp
! computes % change in price index of merchandise imports, by region !
        (all,s,REG)
        VIWREG(s) * pimreg(s) = sum(i,TRAD_COMM, VIW(i,s) * pim(i,s)) ;

EQUATION                                                    COMEX_p
! computes % change in price index of merchandise exports, by commodity !
        (all,i,TRAD_COMM)
        [VXWCOM(i) + TINY] * pexcom(i) =
                sum{r,REG, VXW(i,r) * pex(i,r)} + TINY*pexwld ;

EQUATION                                                    REGIM_ip
! computes % change in price index of merchandise imports, by commodity !
        (all,i,TRAD_COMM)
        [VIWCOM(i) + TINY] * pimcom(i) =
                sum{s,REG, VIW(i,s) * pim(i,s)} + TINY * pexwld ;

EQUATION                                                    WLDTRD_p
! computes % change in price index of global merchandise exports !
        VXWLD * pexwld = sum(i,TRAD_COMM, VXWCOM(i) * pexcom(i)) ;

EQUATION                                                    REGEX_q
! computes % change in quantity index of merchandise exports, by region !
        (all,r,REG)
        qexreg(r) = vexreg(r) - pexreg(r) ;

EQUATION                                                    REGIM_sq
! computes % change in quantity index of merchandise imports, by region !
        (all,s,REG)
        qimreg(s) = vimreg(s) - pimreg(s) ;

EQUATION                                                    COMEX_q
! computes % change in quantity index of merchandise exports, by commodity !
        (all,i,TRAD_COMM)
        qexcom(i) = vexcom(i) - pexcom(i) ;
```

```
EQUATION                                                    REGIM_iq
! computes % change in quantity index of merchandise imports, by commodity !
        (all,i,TRAD_COMM)
        qimcom(i) = vimcom(i) - pimcom(i) ;

EQUATION                                                    WLDTRD_q
! computes % change in quantity index of global merchandise exports !
        qexwld = vexwld - pexwld ;

EQUATION                                                    EVREG
! computes regional EV !
        (all,r,REG)
        EV(r) - [INC(r)/100] * u(r) = 0 ;

EQUATION                                                    EVWLD
! computes EV for the world !
        WEV - sum(r,REG, EV(r)) = 0 ;

EQUATION                                                    PHHLDINDEX
! computes change in price index for private household expenditures !
        (all,r,REG)
        PRIVEXP(r) * ppriv(r) = sum(i,TRAD_COMM, VPA(i,r)* pp(i,r));

!-----------------------------------------------------------------!
!                         Macro Variables                         !
!-----------------------------------------------------------------!

EQUATION                                                    QDEX_HHLD_CONSN
# quantity index for household consumption #
        (all, r, REG)
        PRIVEXP(r)*qpr(r) = SUM(i, TRAD_COMM, VPA(i,r)*qp(i,r)) ;

EQUATION                                                    QDEX_GOVT
# quantity index for government consumption #
        (all, r, REG)
        GOVEXP(r)*qgr(r) = SUM(i, TRAD_COMM, VGA(i,r)*qg(i,r)) ;

EQUATION                                                    QDEX_EXP
# quantity index for exports #
        (all, r, REG)
        EXPEXP(r) * qxr(r) = SUM(s, REG, SUM(i, TRAD_COMM,
                VXWD(i,r,s) * qxs(i,r,s)))
                + SUM(i, TRAD_COMM, VST(i,r) * qst(i,r)) ;

EQUATION                                                    QDEX_IMP
# quantity index for imports #
        (all, r, REG)
        IMPEXP(r)*qmr(r) = SUM(s, REG, SUM(i, TRAD_COMM,
                VIWS(i,s,r) * qxs(i,s,r)));
```

```
EQUATION                                                        QDEX_GDP
# quantity index for GDP #
    (all, r, REG)
    GDPEXP(r)*qgdpr(r) = PRIVEXP(r)*qpr(r) + sum{h, CGDS_COMM,
        VOA(h,r) * qo(h,r)} + GOVEXP(r)*qgr(r) + EXPEXP(r)*qxr(r)
        - IMPEXP(r)*qmr(r) ;

EQUATION                                                        GOV_REG
# government consumption expenditure at agents' prices, by region #
    (all, r, REG)
    GOVEXP(r) * vgr(r) = SUM(i, TRAD_COMM, VGA(i,r) * (pg(i,r) + qg(i,r))) ;

EQUATION                                                        ABSORPTION
# domestic absorption #
    (all, r, REG)
    ABSEXP(r) * vabsr(r) = PRIVEXP(r) * yp(r) + sum{h, CGDS_COMM,
        VOA(h,r) * [ps(h,r) + qo(h,r)]} + GOVEXP(r) * vgr(r) ;

EQUATION                                                        SH_EXP_ABS
# Ratio of exports to absorption #
    (all, r, REG)
    rxar(r) = vexreg(r) - vabsr(r) ;

!-----------------------------------------------------------!
!                  The Labour Disaggregation                 !
!-----------------------------------------------------------!

VARIABLE (all, r, REG)                                          qlab(r)
# labour supply by region # ;

VARIABLE (all, r, REG)                                          plab(r)
# supply price of labour in general # ;

VARIABLE (all, r, REG)(all, i, LABR_COMM)                       bsl(i,r)
# labour transformation supply shift # ;

COEFFICIENT (all, r, REG)                                       VLS(r)
# suppliers' prices labour employment value # ;

FORMULA (all, r, REG)
    VLS(r) = SUM{i, LABR_COMM, VOA(i,r)} ;

EQUATION                                                        PRICE_SUPPL_LAB
# supply price of labour in general #
    (all, r, REG)
    VLS(r) * plab(r) = SUM{i, LABR_COMM, VOA(i,r) * ps(i,r)} ;
```

```
COEFFICIENT (all, i, LABR_COMM)(all, r, REG)                    SHLABrt(i,r)
# share of labour type i in supply value of employment # ;

FORMULA (all, i, LABR_COMM)(all, r, REG)
        SHLABrt(i,r) = VOA(i,r)/VLS(r) ;

EQUATION                                                        LAB_SUPP_TYPE
# labour supply, by type #
        (all, i, LABR_COMM)(all, r, REG)
        qo(i,r) = qlab(r) + ELTROC * [ ps(i,r) - plab(r) ] + bsl(i,r)
                - SUM { i0, LABR_COMM, SHLABrt(i0,r) * bsl(i0,r) } ;

!------------------------------------------------------------!
!                    Quantitative VERs                       !
!------------------------------------------------------------!

VARIABLE (all, i, TRAD_COMM)(all, r, REG)(all, s, REG)          rqxs(i,r,s)
#  import penetration # ;

VARIABLE (all, i, TRAD_COMM)(all, r, REG)                       qam(i,r)
# quantity index for absorption, by region and commodity # ;

COEFFICIENT (all, i, TRAD_COMM)(all, r, REG)                    VAM(i,r)
# market value of absorption # ;

FORMULA (all, i, TRAD_COMM)(all, r, REG)
        VAM(i,r) = VDM(i,r) + VIM(i,r) ;

EQUATION                                                        QUIND_ABS_RC
# quantity index for absorption, by region and commodity #
        (all, i, TRAD_COMM)(all, r, REG)
        [VAM(i,r) + 2.0 * TINY] * qam(i,r) = [VDM(i,r) + TINY] * qds(i,r)
                + [VIM(i,r) + TINY] * qim(i,r) ;

EQUATION                                                        IMP_PEN
# import penetration #
        (all, i, TRAD_COMM)(all, r, REG)(all, s, REG)
        rqxs(i,r,s) = qxs(i,r,s) - qam(i,s) ;

!------------------------------------------------------------!
!                  Real Price Variables                      !
!------------------------------------------------------------!

VARIABLE (all,i,NSAV_COMM)(all,r,REG)                           rps(i,r)
# real supply price of commodity i in region r # ;

VARIABLE (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)          rpfe(i,j,r)
# firms' real price for endowment commodity i in j of r # ;
```

EQUATION REALPS
! This is the equation to compute the real supply price of commodity i in region r !
(all,i,NSAV_COMM)(all,r,REG)
rps(i,r) = ps(i,r) - ppriv(r) ;

EQUATION REALPFE
! This is the equation to compute the real price for endowment commodity i in j of r. !
(all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
rpfe(i,j,r) = pfe(i,j,r) - ppriv(r) ;

```
!--------------------------------------------------------------!
!                     End of Tablo File                        !
!--------------------------------------------------------------!
```

Tablo Modification for the Alternative Model

! The following three sets are to replace the "ENDWC_COMM" set in the "SETS" block in the basic model. !

SET ENDWC_COMM # Capital endowment commodities # MAXIMUM SIZE 2
READ ELEMENTS FROM FILE gtapsets HEADER "H10" ;

SET UNSKIL_COMM # Unskilled commodities # MAXIMUM SIZE 2
READ ELEMENTS FROM FILE gtapsets HEADER "H12" ;

SET SKILL_COMM # Skilled commodities # MAXIMUM SIZE 2
READ ELEMENTS FROM FILE gtapsets HEADER "H13" ;

! The following four subsets are to be appended to the "Subsets" block in the basic model. !

SUBSET UNSKIL_COMM is subset of ENDW_COMM ;

SUBSET SKILL_COMM is subset of ENDW_COMM ;

SUBSET UNSKIL_COMM is subset of ENDWM_COMM ;

SUBSET SKILL_COMM is subset of ENDWM_COMM ;

! The following three blocks are to replace the "Value-added Nest" block in the basic model. !

```
!-----------------------------------------------------------!
!              Composite Capital-Labour Nest                !
!-----------------------------------------------------------!
```

VARIABLE (all,j,PROD_COMM)(all,r,REG) qfus(j,r)
demand for unskilled composite for use in j in region r # ;

VARIABLE (all,j,PROD_COMM)(all,r,REG) qfsk(j,r)
demand for skilled composite for use in j in region r # ;

VARIABLE (all,j,PROD_COMM)(all,r,REG) pfus(j,r)
price index for unskilled composite for use in j in region r # ;

VARIABLE (all,j,PROD_COMM)(all,r,REG) pfsk(j,r)
price index for skilled composite for use in j in region r # ;

COEFFICIENT (all,j,PROD_COMM)(all,r,REG) VUS(j,r)
demand value for unskilled composite # ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
VUS(j,r) = SUM{i,UNSKIL_COMM,VFA(i,j,r)} ;

```
COEFFICIENT (all,i,UNSKIL_COMM)(all,j,PROD_COMM)(all,r,REG) FSHRUS(i,j,r)
# share of type i unskilled commodity in composite demand # ;

FORMULA (all,i,UNSKIL_COMM)(all,j,PROD_COMM)(all,r,REG)
        FSHRUS(i,j,r) = VFA(i,j,r)/VUS(j,r) ;

COEFFICIENT (all,j,PROD_COMM)(all,r,REG)                          VSK(j,r)
# demand value for skilled composite # ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
        VSK(j,r) = SUM{i,SKILL_COMM,VFA(i,j,r)} ;

COEFFICIENT (all,i,SKILL_COMM)(all,j,PROD_COMM)(all,r,REG)   FSHRSK(i,j,r)
# share of type i skilled commodity in composite demand # ;

FORMULA (all,i,SKILL_COMM)(all,j,PROD_COMM)(all,r,REG)
        FSHRSK(i,j,r) = VFA(i,j,r)/VSK(j,r) ;

EQUATION UNSKILPRICE
! Industry price for unskilled composite !
        (all,j,PROD_COMM)(all,r,REG)
        pfus(j,r) = SUM{i,UNSKIL_COMM, FSHRUS(i,j,r) * pfe(i,j,r)} ;

EQUATION INDUNSKIL
! Industry demand for unskilled commodities !
        (all,i,UNSKILL_COMM)(all,j,PROD_COMM)(all,r,REG)
        qfe(i,j,r) = qfus(j,r) - ESUBUN(j) * [pfe(i,j,r) - pfus(j,r)] ;

EQUATION SKILLPRICE
! Industry price for skilled composite !
        (all,j,PROD_COMM)(all,r,REG)
        pfsk(j,r) = SUM{i,SKILL_COMM, FSHRSK(i,j,r) * pfe(i,j,r)} ;

EQUATION INDSKILL
! Industry demand for skilled commodoties !
        (all,i,SKILL_COMM)(all,j,PROD_COMM)(all,r,REG)
        qfe(i,j,r) = qfsk(j,r) - ESUBSK(j) * [pfe(i,j,r) - pfsk(j,r)] ;

!----------------------------------------------------------------!
!               Composite Skilled-Unskilled Nest                 !
!----------------------------------------------------------------!

VARIABLE (all,j,PROD_COMM)(all,r,REG)                           qfcus(j,r)
# demand for skilled-unskilled composite for use in j in region r # ;

VARIABLE (all,j,PROD_COMM)(all,r,REG)                           pfcus(j,r)
# price index for skilled-unskilled composite for use in j in r # ;
```

```
COEFFICIENT (all,j,PROD_COMM)(all,r,REG)                          SVUS(j,r)
# share of unskilled composite from mobile value added # ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
        SVUS(j,r) = VUS(j,r) / SUM{i,ENDWM_COMM, VFA(i,j,r)} ;

COEFFICIENT (all,j,PROD_COMM)(all,r,REG)                          SVSK(j,r)
# share of skilled composite from mobile value added # ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
        SVSK(j,r) = VSK(j,r) / SUM{i,ENDWM_COMM, VFA(i,j,r)} ;

EQUATION SKUNCPRICE
! Effective price of skilled-unskilled composite in each sector !
        (all,j,PROD_COMM)(all,r,REG)
        pfcus(j,r) = {SVUS(j,r) * pfus(j,r)} + {SVSK(j,r) * pfsk(j,r)} ;

EQUATION UNSKILDEMAND
! Demand for unskilled composite !
        (all,j,PROD_COMM)(all,r,REG)
        qfus(j,r) + SUM{i,UNSKIL_COMM, afe(i,j,r)} = qfcus(j,r)
          - ESUBSUC(j) * [pfus(j,r) - SUM{i,UNSKIL_COMM, afe(i,j,r)} - pfcus(j,r)] ;

EQUATION SKILLDEMAND
! Demand for skilled composite !
        (all,j,PROD_COMM)(all,r,REG)
        qfsk(j,r) + SUM{i,SKILL_COMM, afe(i,j,r)} = qfcus(j,r)
            - ESUBSUC(j) * [pfsk(j,r) - SUM{i,SKILL_COMM, afe(i,j,r)} - pfcus(j,r)] ;

!----------------------------------------------------------------------!
!                          Value-added Nest                            !
!----------------------------------------------------------------------!

COEFFICIENT (all,j,PROD_COMM)(all,r,REG)                          VSUC(j,r)
# demand value for skilled-unskilled composite # ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
        VSUC(j,r) = VSK(j,r) + VUS(j,r) ;

COEFFICIENT (all,j,PROD_COMM)(all,r,REG)                          SVSUC(j,r)
# share of skilled-unskilled composite from total value added # ;

FORMULA (all,j,PROD_COMM)(all,r,REG)
        SVSUC(j,r) = VSUC(j,r) / SUM{i,ENDW_COMM, VFA(i,j,r)} ;
```

```
EQUATION VAPRICE
! Effective price of primary factor composite in each sector !
        (all,j,PROD_COMM)(all,r,REG)
        pva(j,r) = SUM{k,ENDWS_COMM, SVA(k,j,r) * pfe(k,j,r)}
                                        + {SVSUC(j,r) * pfcus(j,r)} ;

EQUATION ENDWSDEMAND
! Demand for slugish endowment commodities !
        (all,i,ENDWS_COMM)(all,j,PROD_COMM)(all,r,REG)
        qfe(i,j,r) + afe(i,j,r) = qva(j,r) - ESUBVA(j) * [pfe(i,j,r) - afe(i,j,r) - pva(j,r)] ;

EQUATION SKUNCDEMAND
! Demand for skilled-unskilled composite !
        (all,j,PROD_COMM)(all,r,REG)
        qfcus(j,r) + SUM{i,ENDWM_COMM, afe(i,j,r)} = qva(j,r)
            - ESUBVA(j) * [pfcus(j,r) - SUM{i,ENDWM_COMM, afe(i,j,r)} - pva(j,r)] ;

! The following block support capital disaggregation. !

!-----------------------------------------------------------!
!                  Capital Disaggregation                   !
!-----------------------------------------------------------!

VARIABLE (all,i,ENDWC_COMM)(all,r,REG)                      bsc(i,r)
# Capital tranformation supply shift # ;

COEFFICIENT (all,r,REG)                                     VCS(r)
# Suppliers' prices of capital services value # ;

FORMULA (all,r,REG)
        VCS(r) = SUM{i,ENDWC_COMM,VOA(i,r)} ;

COEFFICIENT (all,i,ENDWC_COMM)(all,r,REG)                   SHRCAPrt(i,r)
# Share of capital type i in supply value of capital services # ;

FORMULA (all,i,ENDWC_COMM)(all,r,REG)
        SHRCAPrt(i,r) = VOA(i,r)/VCS(r) ;

EQUATION CAP_SUP_TYPE # Capital supply by type #
        (all,i,ENDWC_COMM)(all,r,REG)
        qo(i,r) = ksvces(r) + ELTRCAP * [ps(i,r) - rental(r)] - bsc(i,r)
                        - SUM{i0,ENDWC_COMM, SHRCAPrt(i0,r) * bsc(i0,r)} ;
```

ABBREVIATIONS AND ACRONYMS

2SLS:	Two-Stage Least Squares
3SLS:	Three-Stage Least Squares
AGE:	Applied General Equilibrium
ANU:	Australian National University
BOP:	Balance of Payment
BPS:	Badan Pusat Statistik
CDE:	Constant Difference Elasticity
CES:	Constant Elasticity of Substitution
CET:	Constant Elasticity of Transformation
CGE:	Computable General Equilibrium
CIF:	Costs, Insurance, Freight
CPI:	Consumer Price Index
EU:	European Union
FDI:	Foreign Direct Investment
FOB:	Free on Board
FPE:	Factor Price Equalisation
GDP:	Gross Domestic Product
GTAP:	Global Trade Analysis Project
HO:	Heckscher-Ohlin
HOS:	Heckscher-Ohlin-Samuelson
IEDB:	International Economic Data Bank
IMF:	International Monetary Fund

ISIC:	International Standard Industrial Classification of All Economic Activities
IV:	Instrumental Variable
NICs:	Newly Industrialising Countries
OECD:	Organisation for Economic Co-operation and Development
OLS:	Ordinary Least Squares
R&D:	Research and Development
SITC:	Standard International Trade Classification
SS:	Stolper-Samuelson
TFP:	Total Factor Productivity
Translog:	Transcedental logarithmic
UK:	United Kingdom
US:	United States
WorldScan:	World Scenario Analysis

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