Trade Liberalisation, Intra-industry Trade and Adjustment Costs

by

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Dedicated to Professor Peter Drysdale

Declaration

This dissertation was written while I was studying at the Australia–Japan Research Centre, the Australian National University. The opinions expressed are my own, unless otherwise indicated.

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Abstract

This study examines relative adjustment costs associated with resource relocation under inter-industry trade and intra-industry trade patterns in the face of trade liberalisation.

Adjustment costs arise as a result of greater import penetration leading to a contraction in domestic production. The hypothesis that adjustment costs under intra-industry trade are lower than adjustment costs under inter-industry trade is supported theoretically. Firstly, in a specific-factor model, there are lower adjustment costs associated with intra-industry trade because of both labour market segmentation and price differentials. Secondly, the linkage between foreign direct investment and IIT through intra-firm trade reduces the costs of dislocation and unemployment and lessens the need for government assistance to smooth the transition process. Thirdly, it is possible for both factors to gain from trade liberalisation under intra-industry trade, and therefore, there is a greater willingness to adjust.

Previous empirical studies of adjustment costs are subject to one or both two limitations in measuring adjustment costs: lack of dynamic features and indirect measurement.

The hypothesis that adjustment costs associated with intra-industry trade specialisation are lower than those under inter-industry trade is also supported by empirical evidence. Based on the dynamic adjustment costs model, intra-industry factor adjustment is found to be associated with industries with high levels of intra-industry trade. Measured in terms of six adjustment cost indicators, labour adjustment costs associated with an industry with a high degree of intra-industry trade specialisation are found to be lower than those associated with an inter-industry trade specialisation. Assessment of the linkage between foreign direct investment and intra-industry trade both theoretically and empirically also provides support for the central hypothesis.

The policy implications of trade liberalisation depend on the determinants of the growth of intra-industry trade. The main theoretical framework which is generally believed to be applicable to trade among developed countries is also found to be applicable to trade in the APEC region with developed, newly industrialising and developing economies. APEC economies have experienced and are experiencing painful stuctural adjustment from regional trade liberalisation compared with European economies, since their levels of intra-industry trade in total trade are still low. There are challenges and opportunities for the further growth of intra-industry trade so that adjustment costs associated with further trade liberalisation may be lower for APEC economies in the future.

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1 Trade Liberalisation, Intra-industry Trade and Adjustment Costs: The Issues

World trade is 'managed' by a vast array of interventions. These range from customs manipulation to open quantitative restrictions and tariff measures. But these trade distortions are being liberalised through GATT negotiation and by other processes. The basis of the movement towards trade liberalisation is that there are substantial gains to be made from the dismantling of trade protection, entailing the removal of both production and consumption inefficiencies for economies.

The theory of trade policy encompasses a new range of interests as a result of changes to the trading environment in the last two decades. The relationship between trade liberalisation and intra-industry trade is one such important issue. Many have argued that trade liberalisation will lead to increased international trade, with growth of intra-industry trade relative to inter-industry trade (Balassa 1967; Pagoulatos and Sorensen 1975; Lundberg and Gavelin 1986; Greenaway 1987; Ray 1987; Chen 1994). Some economists (Cox and Harris 1985; Rodrik 1988; and Richardson 1989) suggest that the gains from trade liberalisation are more significant if imperfect competition and scale economies prevail than is the case when an economy operates under perfect competition: Even though the easy presumption of gains from trade liberalisation in a perfectly competitive environment vanishes under imperfect competition, empirical research to date has generated a replacement presumption: as a rule, trade liberalisation leads to gains, which may be two or three times larger than those estimated under perfect competition (Richardson 1989).

Although it is widely believed that there are gains from trade liberalisation, there is continuing and substantial resistance to it. One possible explanation is that the gains from trade liberalisation are recognised to be a long-term benefit. This could be for 'simple' static reasons: every tariff reduction leads to a new and more efficient allocation of resources. But in the short term, affected firms in an industry must make adjustments to trade liberalisation. The process of industry adjustment inevitably incurs costs for both labour and capital. The short-term dynamic adjustment process may be accompanied by costs such as the closure or decline of firms leading to some labour and capital being unemployed. The results of an increase in the unemployment rate include social problems and private losses. These negative side effects may outweigh the gains from trade liberalisation in the short term, giving rise to severe difficulties in achieving trade liberalisation and even economic development.[1] Another possible explanation is that the gains from trade liberalisation are recognised as net gains which are generated on the basis of the well-known theory of 'gains from trade' coupled with Pareto-efficient income redistribution. The central thrust of this theory is that although trade liberalisation yields gains to social welfare in the aggregate, it generates significant costs to certain workers and producers. According to the Pareto principle, those harmed by changes in trade policies can be compensated. In practice, the compensation of losers is conducted by means of income redistribution via government programs which provide supplementary assistance to displaced workers in designated industries. Such measures include supplementary unemployment benefit programs like long-term early retirement

[1] Baldwin et al. (1979) estimate the impact of a 50 per cent multilateral tariff reduction on US trade, employment, capital utilisation and economic welfare. In the aggregate, the calculated gains from trade liberalisation dwarf the measured adjustment costs by a ratio of almost 20 to 1.

benefits. In the United States, there is the Trade Adjustment Assistance program, and in other industrial countries, supplementary aid packages are provided to selected groups of displaced workers.

Effective compensation, however, is problematic when the information costs of identifying winners and losers are large. Implementation issues associated with programs of this type generally stem from a lack of information whereby to identify the adjustment costs of heterogenous workers (Brander and Spencer 1994; Feenstra and Lewis 1994). Benefits should vary across workers according to the adjustment costs they face, but the fact is that policy makers are unable to calculate the costs. The eligibility criterion often adopted by governments for adjustment assistance programs is the displaced worker's former sector of employment. The rationale for this by policy makers is that a sectoral benefits approach coincides roughly with the sectoral pattern of adjustment costs (Gray 1996).

Some labour economists (Kruse 1987 and Kletzer 1995) claim that trade-displaced workers may have more difficulty in making labour market adjustments, but the source of the difficulty is their own disadvantage, not the characteristics of the industry from which they have been displaced. Others (Kletzer 1992; Summer 1986; Houseman 1988; Grando 1983; and Jacobson 1993) recognise the existence of marked sectoral effects on adjustment costs such as efficiency wages and unions. Industry trade specialisation in terms of inter- versus intra-industry trade is an important sector-specific effect in determining the gains from trade liberalisation. Thus the level of intra-industry trade specialisation may to some extent have an effect on adjustment costs.

The central hypothesis

It has been an article of faith in commenting on European integration that successful economic integration within European economies can be attributed to some extent to the larger share of intra-industry trade between economies (Greenaway and Hine 1991) since it is believed that the adjustment costs associated with intra-industry trade specialisation are lower than those associated with inter-industry trade specialisation. Despite a lack of theoretical analysis, this argument has been investigated empirically by many economists (Balassa 1966; Adler 1970; Rayment 1976; Lundberg 1986). The results from these studies are quite weak, as the relative adjustment costs under inter- versus intra-industry trade are examined very intuitively. Hence, there is merit in analysing the adjustment costs under different trade patterns both theoretically and empirically in a more rigorous way.

World economies are becoming more and more integrated. While European economic integration is widening and deepening, trade liberalisation is also on the agenda of APEC economies. Whether APEC economies will experience similar ease in their adjustment to trade liberalisation depends very much not only on the nature and characteristics of the economies within this region, but also on relative adjustment costs under different trade patterns. Hence, the study of relative adjustment costs under different trade patterns has important policy implications for trade liberalisation of Asia Pacific economies.

From these perspectives, this study seeks to formulate and test the central hypothesis that adjustment costs under intra-industry trade specialisation are lower than those under inter-industry trade specialisation.

An analytical framework

A common theme in studies of structural adjustment is that structural change refers to the longer term and more fundamental changes that occur in the production patterns, employment, output and size of industries and firms. Structural change occurs as a result of longer term pressures, such as the emergence of new sources of import competition. Structural adjustment refers to the ways in which firms attempt to accommodate these changes. According to adjustment costs theory, firms suffer short-run output loss as they adjust their stocks of quasi-fixed inputs over time. In considering the costs arising from the adjustment process of fixed factors, firms will form an optimal adjustment of all factors of production in a given time period. Given the nature of this adjustment process, use of the dynamic adjustment costs model is proposed and applied in this study. The theory of optimal adjustment of all factors of production provides a basis for the study of adjustment costs resulting from resource reallocation. The problem of the theoretical adjustment costs model is, therefore, defined as the maximisation of the current value of profits over an infinite time domain by a price-taking firm, subject to a net change in quasi-fixed factors.

There are many approaches that can be followed to generate functional forms for factor demand functions in solving the problem outlined above. Epstein (1981) establishes a duality between the value function and the production function and applies the envelope theorem to the value function to generate optimal solutions to quasi-fixed input, variable input and output supply.

The adjustment cost approach is thought to be more appropriate because it allows for the imperfect adjustment of resources in response to changes in external forces. These slow-to-adjust factors are called quasi-fixed inputs. Their level and rate of change are determined by exogenous factors. Quasi-fixed inputs are also choice variables which affect production in both the short and long run (Huang et al. 1995).

The empirical model derived this theoretical model can not only account for the relationship among multiple outputs, inputs, and exogenous shifters, but it also allows for the imperfect adjustment of resources in response to changes in external forces. Therefore, relative adjustment costs can be measured in this framework empirically as the relative effectiveness in reallocating quasi-fixed factors when there is a change in external conditions, such as trade liberalisation. The adjustment coefficients of quasi-fixed factors can be provided as a measure of adjustment speed (or the extent of inter- or intra-industry factor adjustment) while the eigen values of the adjustment matrix provide a check on the stability of the adjustment process of quasi-fixed factors.

In most previous studies, the adjustment costs under different trade patterns are addresssed not only intuitively but also statically. By using a dynamic adjustment costs model, the analysis of adjustment costs from factor relocation is undoubtedly a better starting point.

Methodology

One of the most important features of this study is the way in which it measures the association between two factors. Weiss (1968) has defined association between two factors as follows: 'Two qualities are associated when the distribution of values of the one differs for different values of the other'. At the same time, Weiss has identified four alternative ways of examining association. One way of examining association is to hypothesise what the data would look like if there were no association and then calculate the presence of association to the extent that the observed data depart from this. The second involves examining sub-group differences. The third approach entails forming all possible comparisons of one member of the population with another. In these comparisons, we decide whether the two qualities under study occur together or not. The fourth way of measuring association involves examining the extent to which increments in one factor occur together with increments in the other. A relationship is often specified in terms of an increase or decrease of a certain number of units in the one variable producing an increase or decrease of a related number of units of the other. Under these circumstances, it is more correct to refer to that relationship as a correlation rather than an association. The important measures of correlation are summarised by Kalirajan (1998) as: Pearson's product moment correlation coefficient; Spearman's rank correlation coefficient; and Kendall's rank order correlation coefficient. When examining one group of data, if the aim is to examine whether there is any difference in behaviour in the two matched pairs under two different circumstances, Wilcoxen's test is the most appropriate. The method to be applied depends on the nature of the association of the two factors.

The above-mentioned methods are often referred as non-stochastic measures. A more rigorous and stochastic measure of a relationship between two factors is well-specified econometric modelling, in which one variable is treated as an explained variable and the other is an explanatory variable. Under this kind of econometric modelling, the relationship between two variables can be tested not only in direction but also in magnitude and significance levels. For this reason, econometric modelling is used in this study to examine factor adjustment coefficients and the level of intra-industry trade (Chapter 4); and labour adjustment costs indicators and the level of intra-industry trade (Chapter 5).

Although the stochastic method is used where possible to address the relationship between the two variables throughout the study, non-stochastic tests are useful in some cases, for example when there is not enough information to construct a well-specified econometric model. In Chapter 6, the relationship between foreign direct investment (FDI) and the level of intra-industry trade (IIT) is examined using Spearman's rank correlation coefficients test.

Structure of the study

A review of existing studies identifies the theoretical nature and the direction of empirical analysis of adjustment costs under different trade patterns following trade liberalisation (Chapter 2).

Trade liberalisation results in price changes in the affected markets, but if agents fail to respond quickly to these changes, or if any price change is resisted, an adjustment problem is said to exist. In theory, an adjustment problem is a short- to medium-run phenomenon, depending on the nature of the market. When using a specific-factor model, an adjustment problem arises when there is some degree of factor specificity, and the resulting wage (price) inflexibility leads to sticky or incomplete adjustment and/or adjustment friction arises as a result of market segmentation, for example, when the labour market is segmented occupationally and/or geographically. The adjustment costs arising from the adjustment process are therefore defined as greater import penetration leading to a contraction in domestic production. Resources are displaced from domestic production and may become temporarily unemployed. The redeployment of resources will be costly for those involved in terms of temporary loss of earnings, and the expense of relocation, job search and retraining.

By definition, inter-industry trade is international trade among different industry categories, and intra-industry trade is international trade within the same industry category. By further investigating theoretical explanations for inter- and intra-industry trade together with the nature of the adjustment process from the specific-factor model, it is argued that following trade liberalisation, adjustment costs under intra-industry trade are lower than those under inter-industry trade. Other factors which affect adjustment costs under different trade patterns are also discussed, including the ways in which FDI is linked to intra-industry trade thereby smoothing the adjustment process and the differences in factor gains under different trade patterns.

Previous studies on the measurement of adjustment costs are subject to some limitations. A more appropriate analytical framework—the dynamic adjustment costs model—for an empirical study of adjustment costs under different trade patterns is recognised in Chapter 2 and formally introduced in Chapter 3. Epstein (1981) applies the familiar principles of duality and the envelope theorem to the value function, and generates optimal solutions to quasi-fixed input and variable input and output supply. As Epstein's dynamic adjustment costs model is based on the assumption that firms are price-takers, the justification for the use of this model under economies of scale and imperfect competition is discussed.

In Chapter 4, the dynamic adjustment costs model is used to examine relative factor adjustment under different trade patterns. The hypothesis that intra-industry factor adjustment will be associated with an industry characterised by high levels of intra-industry trade is tested in this chapter. The test for this hypothesis is designed in three steps. Firstly, the optimal solutions for factor demand and output supply are derived with the production function in the dynamic adjustment costs model assigned a quadratic form. Secondly, using data in quasi-fixed input demand equations, adjustment coefficients are estimated. Thirdly, the relationship between the adjustment coefficients of labour and capital and the level of intra-industry trade is examined.

Chapter 5 tests actual adjustment costs under inter- versus intra-industry trade patterns, as measured by several adjustment cost indicators including average unemployment duration and the rate of re-employment in the same industry, using displaced workers' data from the United States. Linear probability and logit model estimations are applied to test the hypothesis that adjustment costs are lower for industries with intra-industry trade specialisation.

Foreign direct investment (FDI) is closely related to intra-industry trade (IIT) through intra-firm trade. This is examined and tested in Chapter 6, using panel data of FDI and IIT for the United States in and between APEC and European economies. The correlation between FDI and IIT is estimated. A positive correlation tends to support the view that foreign direct investment, mainly channelled through multinationals, helps to reduce adjustment costs following trade liberalisation.

In order to draw policy implications for future trade liberalisation from the results of this study, the determinants of intra-industry trade need to be examined. Most of the existing empirical analyses of the determinants of intra-industry trade are concentrated on developed economies. In Chapter 7, the determinants of intra-industry trade are examined among APEC with developed, newly industrialising and developing economies.

The final chapter summarises the findings and policy implications of the study and discusses the study's shortcomings. Directions for future study are also identified.

2 Adjustment Costs under Inter- versus Intra-Industry Trade: A Theoretical Analysis

Introduction

This chapter analyses relative adjustment costs in the context of resource relocation associated with inter- versus intra-industry trade.

In neoclassical welfare economics, adjustment is represented by an instantaneous jump from one point to another on the production possibility frontier and no cost of adjustment is explicitly recognised. However, movement from one point to another on the production possibility frontier conceals a great deal of economic activity. In particular, in a world in which when there are market imperfections, there are private and social costs associated with the process of adjustment. This gives rise to questions about the nature of the relative adjustment costs in the course of resource reallocation associated with different trade and production structures.

Some studies have touched upon this issue. Where intra-industry trade is prevalent, firms bear the cost of retraining labour when rationalisation takes place. In contrast, where inter-industry trade is prevalent, adjustment entails considerable public assistance to help labour retrain and relocate on an inter-industry and inter-region basis (MacCharles 1987). Moreover, Greenaway and Hine (1991) argue that since industries are frequently geographically concentrated, intra-industry specialisation requires less inter-regional mobility of capital and labour than would otherwise be the case. The aim of this chapter is to clarify the idea of adjustment costs and to provide a systematic theoretical analysis and to shed some light on how to proceed with empirical analysis by surveying existing studies. I aim to establish a theoretical framework for exploring the adjustment implications of trade liberalisation under different trade patterns and to advance the central hypothesis that adjustment costs under intra-industry trade specialisation are lower than adjustment costs under inter-industry trade specialisation.

This chapter is organised as follows: section 2 specifies the nature of adjustment by adopting a specific model from international trade theory. A survey of the literature to compare the main determinants of inter- versus intra-industry trade is conducted in section 3. In section 4, based on the framework set out in section 2 and the discussion in section 3, the implications for adjustment are drawn out for inter- and intra-industry trade patterns. Other factors that influence the adjustment process are addressed in section 5. Section 6 reviews existing empirical studies relating to adjustment costs and intra-industry trade. Finally, section 7 offers some concluding remarks.

The nature of adjustment problems

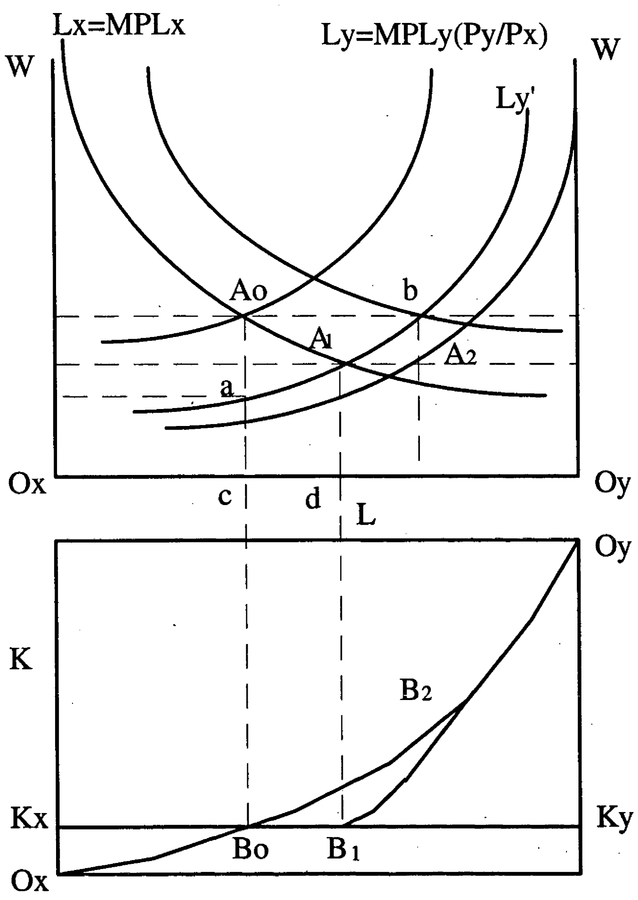
Adjustment problems arise when agents in a market fail to respond quickly to a price change, and as a result, the market in question fails to clear. Often adjustment problems are associated with market imperfections which frustrate the adjustment process. At the same time, adjustment problems are a short- to medium-run issue; in the long run, agents can always respond fully to price changes.

Greenaway and Milner (1986) made an important contribution to the discussion of adjustment costs using a specific factor model. Following their work and that of Jones (1971) and Neary (1978; 1982 and especially 1985), the nature of adjustment problems is discussed in both the short and medium run. In this study, production is assumed to be a function of two primary factors—labour and capital. The analysis here is confined to these factors.

Suppose there are two sectors, X and Y, and two factors, labour and capital. Suppose also that only one of the factors, labour, is assumed to be mobile in the short run, whereas the other, capital, is sector-specific in the short run, but adjusts slowly over time.

In Figure 2.1, the upper part describes the well-known specific-factors model. It can be used to demonstrate short-run equilibrium in a way that is both simple to understand and reasonably plausible. The lower part of Figure 2.1 is an Edgeworth-Bowley box, whose dimensions correspond to a country's factor endowments. Labour is measured along the horizontal axis of the box. Putting the two parts together, we can trace both the short-run and long-run consequences of any exogenous shocks.

Figure 2.1 The nature of adjustment problems



Source: Adapted from Greenaway and Milner (1986).

It is assumed that each sector uses a single factor, labour, in common with other sectors. But capital including plant and equipment, non-traded resources and entrepreneurial and managerial skills, is specific to each sector. Industry *X* produces exportables, industry *Y* produces import substitutes and *X* is assumed arbitrarily to be the relatively labour-intensive sector. The initial equilibrium is indicated by points A_0 and B_0 in the upper and lower parts of the figure, respectively. The economy produces two goods, *X* and *Y*, under perfectly competitive conditions in both commodity and factor markets, using fixed supplies of the two factors, labour and capital, and subject to constant returns to scale. In the long run, both factors are completely mobile between sectors, and in the short run, capital goods are fixed. However, there are diminishing returns to labour in each sector, because of the fixity of capital goods. Hence, entrepreneurs in each sector maximise profits by increasing employment until the value of the marginal product of labour equals the wage rate. The initial wage rate and labour force allocation is determined by the intersection of the two marginal products of the labour schedules at A_0 in the upper part of Figure 2.1. The location of these schedules depends on the initial commodity prices, and on the initial allocation of capital to each sector, with the latter represented by distances $O_x K_X$ and $O_y K_y$ in the lower part of the figure. Point A_0 in the upper part corresponds to point B_0 in the lower part, and the latter lies on the contract curve, indicating that the initial equilibrium is one in which both labour and capital are allocated in such a way that they receive the same return in each sector.

Consider now the effects of a fall in the relative price of *Y*. Without loss of generality, we choose good *X* as the numeraire, which implies that price changes do not affect the location of the L_x curve and the vertical axis measures the wage rate in terms of good *X*. The reduction in the price of good *Y* therefore leads to an equiproportionate downward shift in that sector's labour demand schedule from L_y to L_y'. The new short-run equilibrium is at point A_1 and B_1 in the upper and lower parts of Figure 2.1: restoration of labour market equilibrium requires a fall in the wage rate in terms of *X*, leading sector *X* to expand its output and employment and sector *Y* to contract.

The question now is how the economy actually moves from the initial equilibrium represented by point A_0 to the new short-run equilibrium represented by point A_1. For a variety of reasons, adjustment may take time to occur. One possibility is that wages may be flexible within sectors but, in the short run, wages may be independent of each other. This could occur if there were constraints on occupational mobility between the sectors, or if the sectors were geographically concentrated and there were constraints on moving from one region to another. In this sort of segmented labour market, sector *X* is insulated from the shock in the very short run, whereas the wage in sector *Y* falls by the full amount of the price change from A_0c to ac. Over time, the resulting disparity in wages between sectors provides an incentive for labour in *Y* to retrain or relocate in order to gain employment in *X*. Hence, the production points in the two sectors move along the L_x and L_y schedules until the new equilibrium at A_1 is attained and the wage differential is eliminated.

Another possibility is that the same type of labour is employed in *X* and *Y* and the two industries draw from the same pool of labour, but real wages are sticky downwards. In this case the fall in the relative price of *Y* results in a temporary equilibrium at b. The impact of a fall in the price of *Y* is therefore that sector *Y* lays off workers that sector *X* has no incentive to hire. Over time, the excess supply of labour causes the real wage to fall and both sectors adjust their labour demand schedules towards b. Naturally, the process of adjustment in an actual economy is likely to combine elements of both these extreme mechanisms, with both sectors exhibiting a combination of unemployment and sluggish wage change throughout the adjustment period.

In a competitive economy, adjustment takes place because any exogenous shock changes the incentives to factor owners and entrepreneurs. However, it is not only suppliers of labour services who face such incentives: owners of capital face them too. In the short run, the move from A_0 to A_1 in the upper part of Figure 2.1 corresponds to a move in the lower part from B_0 to B_1 because of the specificity of capital. Clearly this cannot be a new long-run equilibrium, since it lies off the contract curve. In economic terms, the fall in the real wage facing producers in sector *X* increases the return to capital in that sector, whereas the rise in the wage rate relative to the price of good *Y* lowers the return to capital there. Hence there is now an incentive for capital to move out of sector *Y* into sector *X*.

As capital reallocates, both curves in the upper part shift rightward. In the lower part, the economy moves along a path from B_1 towards a new long-run equilibrium at point B_2. The adjustment of labour towards long-run equilibrium can be divided into the two adjustment scenarios described above. The adjustment of capital depends very much on the ability of the expanding sector to absorb the existing capital which is released from the sectors which have contracted.

This is a relatively simple framework for clarifying the nature of adjustment problems, and it incorporates a variety of restrictive assumptions. In the present context it is useful because it permits us to identify not only how factors of production adjust to a long-run equilibrium in response to a change in relative prices, but also suggests possible reasons why adjustment to a change in relative prices may be protracted; either because there is wage inflexibility in a downward direction and/or because the labour market is segmented or the ability of the expanding sector to absorb existing labour and capital released from contracted sectors is limited.

Adjustment problems can arise from many areas of an economy facing trade liberalisation. At the national level, there are problems of structural unemployment and public assistance. When international trade is liberalised, some industries may expand and some may contract in the wake of international competition. The adjustment costs arising from the adjustment process in this context therefore can be regarded as a result of greater import penetration leading to a contraction in domestic production. Resources are displaced from domestic production and may become temporarily unemployed. The redeployment of resources will be costly for those involved in terms of temporary loss of earnings, relocation, job search and retraining expenses.

Determinants of inter- versus intra-industry trade

In order to compare the adjustment costs arising from the adjustment process which is described in the previous section, it is necessarily to identify determinants for different trade patterns. The distinguishing feature of inter- and intra-industry trade is that intra-industry trade is defined as international trade occurring within the same industry categories whereas inter-industry trade is international trade occurring in different industry categories.

The standard theory of inter-industry trade relates the pattern of trade (which country will export which goods) to comparative advantage (international differences in relative opportunity costs), and then tries to explain comparative advantage in terms of differences in technologies, factor supplies and so on.

The theory of comparative advantage is simple: if two countries engage in trade, each will have incentives to increase production, and reduce consumption, of goods in which they have the lower relative marginal cost prior to trade. Thus we may conjecture that in free trade equilibrium, each country will export such goods.

In principle, under autarky, the differences in relative marginal costs between countries can arise from differences in any of the underlying exogenous entities in the equilibrium of each: consumer tastes, production technologies or factor supplies. For the first—difference in consumer tastes—means that other things being equal, a country will import goods for which domestic consumers have stronger preferences than foreign consumers.[1] The second aspect—differences in production technology—is at the heart of Ricardo's model in which a single input illustrates in a simple way how comparative advantage matters for trade. A modification of the Ricardo–Viner model is very instructive in that it embodies both differences in technology and differences in factor endowments as determinants of inter-industry trade.

Differences in factor endowments have proved to be the most widely analysed explanation of comparative advantage, as it can yield the greatest variety of testable propositions. The idea is that in each country, the factor which is relatively abundant will be used relatively more intensively in production and also will be cheaper. Therefore we should expect a country to have a comparative advantage in goods that are relatively intensive in the use of those factors that are in relatively abundant

[1] This observations is rather trivial. With imperfect competition and product diversity, however, consumer tastes may have a more important effect on trade.

supply. This is the central proposition of the Heckscher–Ohlin model. Such propositions are simple and plausible in the light of elementary economic intuition, but their justification rests on several assumptions such as the well-defined notions of factor intensity and factor abundance and the assumption of perfect competition.

Intra-industry trade (IIT), which accounts for a substantial proportion of total trade, is an important economic phenomenon observed by economists (Verdoorn 1960; Balassa 1966; Grubel 1967), and a huge literature has been developed to document and to seek a satisfactory explanation for it. Theoretical explanations of intra-industry trade involve consideration of factors such as relative factor endowments, product differentiation, economies of scale, monopolistic competition or oligopolistic behaviour, and there are many possible models proposed in the literature. They can be grouped under three headings.

Neo-Heckscher–Ohlin model

The first group of models explains intra-industry trade along vertically differentiated products (where varieties differ in their quality) based on the Neo-Heckscher–Ohlin framework. The production function is specified as a combination of basic factors such as capital and labour in a way that is consistent with constant returns to scale and perfect competition, and the pattern of vertical intra-industry trade is driven by relative factor endowments.

One well-known model of this type was developed by Falvey (1981). Based on differences in factor endowments, this model suggests that intra-industry trade occurs along vertically differentiated products giving reciprocal demand for both high and low qualities of a product between two countries. Unlike the standard Heckscher–Ohlin model, in this model capital is assumed to be industry-specific and one of the industries produces a differentiated product which is referred to as of different quality or vertically differentiated. These 'qualities' are distinguished by the capital–labour ratio: higher quality products require more capital-intensive techniques of production. Falvey shows that a capital-rich country will export higher quality differentiated products and a labour-rich country will export lower quality differentiated products and labour-intensive products.

An alternative explanation for intra-industry trade within the Heckscher–Ohlin framework extends the basic Heckscher-Ohlin model to take account of the human capital embodied in skilled labour. Assuming that higher quality versions of a good involve a larger proportion of skilled labour (and thus human capital) in their production then, according to the standard Heckscher–Ohlin prediction, countries that are well endowed with human capital will export goods intensive in that factor.

There are also some simple explanations of intra-industry trade which can be regarded as conforming to the inter-industry trade model. For example intra-industry trade could occur between countries with a common border. Because of low transportation costs in the parts of the country adjacent to the border, it is sometimes cheaper to trade products across the border than to transport the product within the country. Hence the geographical characteristics of countries are to some extent a determinant of the costs of production and transport and therefore of intra-industry trade.

Monopolistic competition model

Spence (1976), Dixit and Stiglitz (1977), Krugman (1979) and Lancaster (1980) have explained intra-industry trade based on horizontally differentiated products (where varieties differ in their characteristics) under monopolistic competition, scale economies in production and diverse consumer tastes. The main idea of these models is that if the number of varieties enters directly into the utility function (desire for variety) and economies of scale limit the number of variety of goods produced, then IIT may indeed take place and, by increasing the number of varieties, have positive welfare effects.

<u>Neo-Chamberlinian models</u>

Neo-Chamberlinian models are based on a model suggested by Krugman. It is assumed that consumers derive utility by simultaneously consuming a number of varieties of a given product with consumers' consumption of more varieties yielding higher utility. It is also assumed that each country has only one industry which produces a range of differentiated products, so that international trade can occur between countries with identical costs. All goods have the same cost curve, and labour is the only factor of production to produce any variety.

The effect of opening two identical economies to free trade is that the number of varieties produced in each country is fewer under free trade than under autarky. But the total number available to consumers is higher than under autarky. It is clear that intra-industry trade occurs with different varieties being produced in each country.

This model provides an explanation for intra-industry trade which is not based on differences in factor endowment. Two economies produce differentiated products and trade to take advantage of the larger market.

Dixit and Norman, (1980) develop a two-country model to explain intra-industry trade. Two types of good enter into the utility functions: a numeraire good that represents the goods produced in perfectly competitive industries and under conditions of constant returns to scale; and goods produced in a monopolistically competitive industry, which are assumed to be differentiated and perfectly symmetrical, and subject to economies of scale. The potential range of varieties produced is assumed to be very large and hence the entry conditions for the industry determine the number of differentiated products to be produced.

The conventional theory of comparative advantage determines the net exchange for the numeraire goods. Two factors are important in determining intra-industry trade: the share of world income in each country and the share in world production of differentiated products in each country.

Trade in differentiated products is at its highest level when each of these two factors is nearly half, that is, the closer the two countries are in size, and if each has no clear comparative advantage among industries, then intra-industry trade is the predominant pattern of trade.

Venables (1984) extended the Krugman model to take account of the production of a homogeneous good under constant costs, in addition to the production of a differentiated commodity. There are various possible equilibria including that identified by Krugman, so this is a more general class of model.

Lawrence and Spiller extend the basic model to include two factors of production which are used to make a capital-intensive horizontally differentiated product and a labour-intensive homogeneous product. They assume that firms entering the differentiated good sector face an initial capital outlay and that the two countries face initially different factor endowments. Their predictions are along the lines of the standard Heckscher–Ohlin and the Falvey models: the number of goods produced and the scale of production of the differentiated good increases in the capital-abundant country. In the labour-abundant country the number of varieties produced falls while production of the homogeneous goods increases.

Neo-Hotelling models

This type of trade model was firstly proposed by Lancaster. The basic idea is as follows. Products are horizontally differentiated by the set of characteristics. All consumers prefer certain characteristics, but as the products available are limited, consumers are forced to consume the good which better suits their preferences.

Consumers are assumed to be identical in all respects except for different preferences in characteristics, and they benefit from diverse varieties because they can obtain goods closer to their ideal characteristics.

On the production side of this model, all goods are assumed to have the same cost function. Suppose that each producer chooses price and product characteristics, taking other firms' values of these variables as given. Given that all goods in the product spectrum are produced with the same technology, and the distribution of consumers' ideal characteristics is uniform along the spectrum, the resulting Nash equilibrium involves product varieties equally spaced along the line, each selling at the same price so that output and consumption of all varieties are also identical.

With the opening of the two identical economies to free trade, if the number of available products is unchanged, but the number of consumers is doubled, therefore demand for the typical varieties is doubled. Now existing firms will earn positive profits, so encouraging the entry of new firms to this industry until equilibrium is reached, where firms earn zero profit. At this equilibrium, firms are producing a higher output at a lower price than under autarky, the number of varieties available is greater than under autarky and fewer varieties are produced in each economy. As a consequence, intra-industry trade takes place.

One extension Lancaster made to his model was to allow for initial differences in factor endowment between the two countries, hence providing a Heckscher–Ohlin framework under the assumption of a relatively capital-intensive manufacturing sector and a relatively labour-intensive agricultural sector. Intra-industry trade occurs as well as inter-industry trade because each variety of manufactured good is only produced in one country.

Oligopolistic models

This group of oligopolistic models considers the strategic interdependence between firms in the industry. A major difference between models is the form of conjecture assumed to influence a firm's decisions.

Brander and Krugman (1983), using Cournot type conjectures, developed a model which explains intra-industry trade in a homogeneous commodity which is often referred to as the two-way trade or 'cross-hauling' effect. This can occur because each producer seeks to maximise his own profit by selling to both markets, assuming no change in the sales of the other producer. This model assumes two countries which are identical in all aspects. There is one producer of the goods in each country and each faces the same production costs. The domestic demand function for the good is the same in both countries. This symmetry assumed in the model means that in equilibrium, each firm will produce the same output and will sell half its output on the domestic market and export the other half.

The extension of this model by incorporating transportation costs is referred to as the reciprocal dumping model. It is assumed that only a proportion g ($0<g<1$) of each unit of exports may be sold in the export market and a proportion of exports is 'absorbed' by across border fee charges. This increases the marginal cost of production for the export market above that of the home market.

By introducing transportation costs to the profit function for each of the producers, intra-industry trade will still occur under the Cournot strategic assumption as long as transportation costs are not too high.

Given the symmetry assumed in the model, the same price will be obtained in both markets and each producer will receive a higher price for sales in the home market than from sales in the export market net of transport costs. This led Brander and Krugman to describe such intra-industry trade as reciprocal dumping.

Natural oligopoly and trade in vertically differentiated models have been developed by Shaked and Sutton (1982; 1983; 1984). This class of models explains intra-industry trade along the lines of vertical differentiated products. They assume that there are fixed costs for firms entering the industry, and average variable costs are assumed to be constant or to increase slowly with improvements in the quality of goods.

All consumers are assumed to have the same tastes, hence there will be common ranking of commodities according to their perceived quality. But income across consumers is assumed to be different with high-quality commodities consumed by high-income consumers. In equilibrium, the number of firms in an industry depends on the range of income distribution, consumers' tastes and the average variable costs of different qualities. If there is a narrow distribution of income and no variation in average variable costs on the basis of quality, a 'natural oligopoly' tends to emerge.

The simple version of the models assumes that there are only two firms operating in the market. The firm with lower fixed costs will produce a low-quality variety at which the marginal revenue from changing the quality of its product is equal to the marginal cost of changing its variety; for the same reason, the firm with higher fixed costs will produce a high-quality variety.

Free trade between these two identical countries results in there being only one producer of each of the two qualities of good in each country, with each producer supplying both markets. As a result intra-industry trade occurs.

These theoretical models have several implications for intra-industry trade. Firstly, similarities in production structure are necessary for the presence of horizontal intra-industry trade. Secondly, diversity of consumer preferences and similarity of taste play an important role in determining horizontal intra-industry trade; geographical characteristics to some extent determine both the horizontal and vertical intra-industry trade. Thirdly, similarities in factor endowment are one of the characteristics explaining horizontally differentiated intra-industry trade whereas comparative advantage based on differences in factor endowment are one of the characteristics explaining vertically differentiated intra-industry trade.

Adjustment implications under different trade patterns

Adjustment costs arising from domestic resource relocation are taken to mean all private and social costs resulting from the intersectoral relocation of capital and labour from one pattern of specialisation to another. Adjustment costs are made up of the costs of retraining and re-educating employees, social problems resulting from increased unemployment and the utility loss of being unemployed, among other costs. Physical capital is frequently industry-specific for technology reasons, and even if this is not the case, no perfect market for second hand physical capital exists. Thus, adjustment costs include the costs of obsolete physical capital which has to be depreciated.

The specific-factors model discussed in section 2 of this chapter served to highlight the implications of labour (factor) market segmentation for market clearing. The extent to which the market is segmented depends on the degree of occupational and geographical mobility between sectors.

As discussed in section 3 of this chapter, in the theoretical explanation of the nature of the development of inter-industry trade and intra-industry trade, both the occupational and geographical segmentation of factor markets are less significant for intra-industry trade than for inter-industry trade.

According to Balassa (1966) the theoretical concept of intra-industry trade is defined as the simultaneous export and import of products which are close substitutes in production and end use. In turn, the costs of reallocating capital and labour are expected to be small if exports and imports are close substitutes in production (Lundberg and Hansson 1986). The package of skills acquired during employment in the import substitute sector can be redeployed with minimal retraining in the export sector. In the extreme case, where adjustment takes place within the firm, workers could simply be transferred from one production line to another. By contrast, if factor mixes are very different between sectors, transferability would not be possible without complete retraining.

In theoretical models, intra-industry trade is classified as trade in horizontally and vertically differentiated products. Therefore, the adjustment cost implications are predicted to be different. Even when a simultaneous expansion of imports and exports occurs in the same 'industry', both product mixes and factor mixes may alter. Specialisation in products which are vertically differentiated provides a concrete example. In this case the capital–labour ratio alters in the process of specialisation. More importantly, however, the skill requirements may alter with the process of specialisation.

In sum, in the case of intra-industry trade in completely homogeneous products, technologies and skill requirements for exports and imports are equal and no structural adjustment is necessary. If exports and imports are horizontally differentiated, adjustment costs are still small because basically there is no need for essentially different technologies and skills to be applied. In the case of intra-industry trade in vertically differentiated products (differentiated in quality), there are two possible adjustment costs implications. When a change of product quality is not likely to require a fundamentally different production technology, intra-industry trade in vertically differentiated products will imply fewer adjustment costs than inter-industry trade. When vertically differentiated products are produced using different technologies, intra-industry trade will imply the same adjustment costs as inter-industry trade.

More generally, taking intra-industry trade as a whole, there is a possibility that adjustment from import-competing activities to export production can be managed in the same industry. In general, intra-industry adjustment is smoother because structural unemployment can be avoided and existing skilled labour and physical capital can be re-employed more effectively.[2]

Another issue we should comment upon in this section is geographical mobility of labour. It can be argued that adjustment is likely to be smoother in an intra-industry trade setting because the expanding and contracting activities are more likely to be based in a given region than is the case with inter-industry trade. When industries are contracting, individuals may not only be required to retrain but also to relocate geographically. The greater the geographical resistance to mobility, the more protracted the adjustment. As with the issue of occupational mobility, the argument has a certain plausibility. After all, industries usually are geographically concentrated for particular reasons. Transportation costs may be one such reason. More importantly, the closer countries are geographically, the more similar the culture tends to be and therefore the more similar consumers' tastes are. As noted in section 3 of this chapter, similarity in consumers' tastes plays a significant role in generating intra-industry trade. So if simultaneous expansion and contraction does occur within an industry and within an area/region, intra-industry specialisation requires less inter-regional mobility of capital and labour.

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[2] Although there have been some attempts to separate vertical and horizontal intra-industry trade from total intra-industry trade, this is a task fraught with tremendous difficulties. Taking intra-industry trade as one measure (a mix of vertical and horizontal intra-industry trade), the above hypothesis may be weakened to some extent as the adjustment implications are different for vertical and horizontal intra-industry trade.

As discussed in section 2 of this chapter, there is another scenario for adjustment to short-run equilibrium which is the stickiness of wage rates. Attention has been paid to the explanation of why there may be a downward inflexibility of money wages, even when this might be inconsistent with expectations being formed 'rationally'. One source of inflexibility which has received emphatic support is the existence of labour market institutions. In particular, the role of labour unions, implicit and explicit long-term labour contracts, and transaction costs of hiring and firing labour, have all been stressed. One possible justification for greater ease of adjustment in sectors engaged in intra-industry trade is therefore that those labour market institutions which frustrate wage adjustments are less pervasive and less influential in industries where intra-industry trade is relatively high and less important where intra-industry trade dominates. This, however, is a somewhat more difficult case to support.

One possible scenario has been suggested by Greenaway and Milner (1986). If the differential between the pre-trade expansion wage and the post-trade expansion wage is relatively small then the transitional period from the pre-trade to the post-trade equilibrium can be expected to be relatively short. This follows because with a smaller differential there may be a greater willingness and/or a greater ability to move from one sector to another. And, in turn, this is consistent with fewer distributional changes pursuant upon the opening of trade and, by implication, greater ease of adjustment. This model relies very much upon a 'greater willingness' to adjust notion; the smaller the required change in factor prices, the greater the likelihood that consumption gains will compensate for income losses, and therefore the more acceptable the change to agents in the import substitution sector.

Many studies have been conducted on the factor price differential of opening up to trade under a range of assumptions. What Krugman (1981) had in mind is that the similarity in initial factor endowments between the two trading economies is responsible for narrow factor price differentials. A study of factor price differentials under inter- versus intra-industry trade was conducted by Chen (1995). By reviewing a set of papers and using the factor price equalisation theorem Chen shows that when economies have 'similar environments',[3] factor prices tend to be closer. However, similar environments, as discussed in section 3 of this chapter, necessarily generate horizontal intra-industry trade in contrast to inter-industry trade, which occurs among countries with comparative advantages.

In summary, IIT adjustment is less costly than adjustment under inter-industry trade, because factor mixes tend to be more similar within industries than between industries, by definition. Secondly, to the extent that industries are geographically concentrated, factors in production are less likely to involve relocation if there is intra-industry trade creation than when trade creation is inter-industry. Thirdly, with respect to price adjustment, under intra-industry trade, the factor price gap before and after trade liberalisation is smaller than under inter-industry trade. Accordingly, the adjustment response to price change will be more rapid. Thus, it seems reasonable to conclude that the adjustment costs associated with domestic resource relocation should be lower when trade is intra-industry than inter-industry.

[3] This is regarded in theoretical models as the similarity in consumers' tastes and similarities in production technology and factor endowments etc.

Other factors

In addition to the theoretical determinants of inter- vs intra-industry trade which provide the basic grounds for drawing their adjustment implications under different trade patterns, other factors may contribute to the contrast between adjustment costs under different trade patterns.

FDI and IIT

First of all, it has been noted on both theoretical and empirical grounds that IIT is closely related to foreign direct investment (FDI) through intra-firm trade.

FDI is the exercise of control over decision making in an enterprise located in one country by investors located in another. Although such investments may be made by individuals or partnerships, most FDI is undertaken by enterprises, and the larger part by multinational enterprises (MNEs).[4]

Multinational enterprises are essentially those that own or control production facilities in more than one country (Sodersten and Reed 1994). Obviously, MNEs can only come into existence in the presence of FDI. Nowadays the importance of MNEs lies in their role as the major providers of FDI.

FDI is more than merely a capital flow; its function includes the exercise of control over business operations. A significant body of literature seeks to explain why MNEs

[4] MNEs are also referred to as multinational firms (MNFs), multinational companies (MNCs) and transnational enterprises.

choose FDI in the first place rather than expanding production and increasing exports in their home countries. The central element of FDI is that it consists of a package of capital, knowledge and skill. This suggests that FDI is industry-specific and is related closely to the characteristics of the industries in which it takes place.

Industry-specific investments take two important forms: horizontal and vertical integration. Horizontal integration is conducted in the form of opening new subsidiaries by large corporations. It is often carried out when one or several existing firms are acquired by a large international rival. Faced with an imperfect external market, such as intermediate inputs and technology, there are time lags, uncertainty, and high investment expenditure in the development of new processes and products. Firms therefore may choose to internalise these externalities by using backward or forward integration in the production process which is the basis of the vertical integration.

As noted above, MNEs can make available to their subsidiaries significant advantages through their control of management expertise and knowledge about new products and production technologies. This knowledge and management expertise flows on an intra-firm basis and therefore provides foreign subsidiaries with advantages over their counterparts, especially the smaller ones, in host countries. MNEs also have more flexibility in rationalising production through access to the products of affiliates and the marketing channels of parents. As a result, the subsidiaries are better able to reduce costs and gain access to export markets and this creates international intra-firm and intra-industry trade and resource relocation.

FDI and IIT are linked because multinationals engage in international specialisation by establishing plants as specialist suppliers of components to affiliates. The specialisation of production activities across nations allows MNEs to overcome the problems of small-scale production and diversity of activities that would exist if the plants were producing for the domestic market alone. At the same time, subsidiaries owned by multinationals in host countries are more efficient and competitive than their domestic counterparts. Therefore, much of the host country's international trade takes the form of intra-firm trade as MNEs trade products and components among themselves on a two-way basis. MNEs, through their ability to specialise internationally, create benefits by facilitating freer trade than would otherwise be available to the country in which the investment occurs. MNEs give their subsidiaries access to world markets which provides them with opportunities to specialise and increase production scales and exports (because of their relative competitiveness over the host country's suppliers). They also give subsidiaries access to efficiently produced components and minor product lines that would otherwise have to be produced at a higher cost either by local suppliers or through internal production by the subsidiaries themselves. The flexibility to carry out rationalisation strategies creates two-way flows of products and components between affiliates. This results in a strong relationship between the number of MNEs in a country and the level of IIT. For host countries, the result of having high levels of FDI is increased cross-trade on an international basis as both exports and imports increase with rationalisation.

Some evidence from the literature is that IIT and direct foreign investment are related through intra-firm trade flows. As an illustration of this phenomenon, some estimates have put the level of intra-firm trade at 70 to 80 per cent of Canada's total trade.

These studies also indicate that about 80 per cent of the exports of Canadian subsidiaries go to affiliates, with over 80 per cent of them being materials and components meant for further processing by the receiving affiliates. A study by Bonturi and Fukasaku (1993) concludes that trade of the intra-industry type in manufactured goods among developed countries often takes the form of intra-firm trade. A well documented example of intra-industry, intra-firm trade is the US–Canada–Mexico automobile trade, where cross-border trade of automotive parts and assembled cars within North America is conducted between parent firms and their affiliates.

Another example of such trade is trade in manufacturing among Asia Pacific economies, which has seen a rapid increase in intra-industry trade as a proportion of total trade over the last decade. This can be primarily attributed to the globalisation of corporate activities by US and Japanese firms and more recently by firms from Asian newly industralising economies (NIEs). This involves assembly production based on imported parts and components in different countries in East and Southeast Asia, and the establishment of these corporate networks has been associated with FDI by the United States, Japan and more recently, the Asian NIEs (Fukasaku 1992).

There are two aspects to be taken into account when considering the adjustment implications on the basis of the above discussion. The first point is that it is argued that much intra-industry trade is in parts and components rather than trade in final goods, which are horizontally or vertically differentiated. And this IIT through intra-firm trade is partly due to the fact that subsidiaries owned by multinationals in the host country are more efficient and competitive than the host country's counterparts.

Therefore they are likely to be more competitive in the face of increased import competition (such as from trade liberalisation). However, as the traded components from subsidiaries and host country suppliers are produced in the same 'industry' and rely upon similar skills, transferring labour from contracting to expanding activities may be easier than otherwise. This phenomenon was noted by Adler (1970), in his study of specialisation patterns in the European steel industry. Furthermore, without FDI in the first place the host country's counterparts would undertake more inter-industry adjustment in the face of increased import competition.

A further point here is adapted from MacCharles (1987). He argues that under IIT, firms will undertake the costs of retraining labour as rationalisation takes place.[5] But under inter-industry trade, considerable public assistance is required to retrain and relocate labour. As a result, resource relocation under IIT is quicker and smoother, thereby considerably reducing the costs of dislocation and unemployment and lessening the need for government assistance to smooth the transition process.

Factors gains from trade

Another important factor, as Krugman (1981) has shown, is that it is possible for all factors to gain from trade in an IIT setting, thus alleviating adjustment pressures.

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[5] Two facts form the basis for this view. Firstly, MNEs' rationalisation will internalise retraining costs, as profit maximising firms can simply add retraining costs to total costs thereby reducing their taxable income. The second fact is that the reason MNEs expand their activities across nations in the first place is because they have an advantage in a package of knowledge including research and development (R&D). From that perspective, MNEs have a greater ability to internalise retraining costs than other firms.

Krugman shows that under certain conditions, both factors can gain from trade. The distribution problems arising from trade will be less serious if this is the case.

To verify whether factors gain from trade, utility needs to be specified in a way which depends on the variables of the model. Individuals are supposed to receive a wage w and have the utility

$$U = \ln(\sum_{i=1}^{N_1} C_{1,i}^{\theta})^{1/\theta} + \ln(\sum_{j=1}^{N_2} C_{2,j}^{\theta})^{1/\theta}, \quad 0 \prec \theta \prec 1 \tag{2.1}$$

where $C_{1,i}$ is consumption of the ith product of industry 1; $C_{2,j}$ is consumption of the jth product of industry 2; and N_1 and N_2 are the numbers of potential products in each industry.[6]

It follows that individuals will then spend $w/2$ on the products of each industry and divide their expenditure equally among the products within an industry. There are two kinds of welfare effects of trade. First, there is a distribution effect as factor prices are equalised. As can easily be verified, labour's real wage remains the same in terms of the products of its own industry while rising or falling in terms of the other industry's products, depending on whether the factor is abundant or scarce. The second effect comes from the increase in the size of the market, which makes a greater variety of products available. This increases everyone's utility.

[6] This utility function has several useful properties. First, it ensures that half of income will always be spent on industry 1's products. Second, if the number of products in each industry is large, it implies that every producer faces a demand curve with elasticity $1/(1-\theta)$. Finally, it explains the problem of gains and losses from trade in a particularly simple way.

The result is that the abundant factor must be made better off as both effects work in its favour. For the utility of the scarce factor, it appears that when $\theta \prec 0.5$, both factors gain from trade when products are sufficiently differentiated; if $\theta \succ 0.5$, both factors gain from trade when countries have sufficiently similar factor endowments.

We have already seen that there tends to be a one-to-one relationship between similarity of factor endowments and intra-industry trade. Thus one can conclude that there is lower income distribution effect in an intra-industry trade setting than for inter-industry trade. Subsequently, this less troublesome income distribution effect will work to reduce the pressure of the adjustment process thereby smoothing the process of resource reallocation.

Test of adjustment costs

In existing studies, the adjustment implications are generally examined in the context of looking at the relationship between trade liberalisation and intra-industry trade. Basically they can be classified into five groups.

Case study approach

The adjustment implications under different trade patterns in this approach are examined by means of the changes in trade patterns following trade liberalisation.

Adler (1970), in an study of adjustment within a specific sector following trade liberalisation, examines changes in steel production and trade across the original six members of the European Community following the creation of the European Coal and Steel Community (ECSC) in 1952. This agreement created a free market for steel products within the European Community. As Adler notes, a prognosis of the effects of the agreement founded on the traditional Vinerian approach to customs union theory would suggest sectoral specialisation in accordance with comparative advantage in the member states. Fears of such inter-industry specialisation, with the German steel industry dominating the entire market, created anxieties regarding possible adjustment problems, in particular on the part of the French and Italians. What Adler demonstrates, however, is that at least by 1966, rather than inter-industry specialisation occurring, a substantial increase in intra-industry specialisation trade had taken place. Instead of one country dominating, as had been widely anticipated, specialisation in different steel products in different countries resulted in ten product lines examined, of which country specialisation was apparent in six.

Greenaway and Hine (1991) and Fukorora (1990) present a similar analysis of adjustment in the Japanese textile and clothing industry which followed trade expansion with a number of East Asian trade partners. The analysis demonstrates that, although significant changes have occurred in the industry, adjustment was relatively smooth. Fukorora offers evidence to support the thesis that this is largely attributable to the fact that the trade expansion was intra- rather than inter-industry trade in nature.

Like the approach above, this approach examines the adjustment costs under inter- versus intra-industry trade by testing the relationship between intra-industry trade and tariff protection. A negative relationship between these two would imply lower adjustment costs associated with intra-industry trade and vice versa.

As Greenaway and Hine (1991) point out, adjustment pressures can give rise to political pressure for protection.[7] This provides a further source of indirect evidence on adjustment costs: if adjustment costs are lower in sectors which are intensive in IIT, we would expect to see less pressure for protection and/or less resistance to liberalisation in those sectors. A number of analysts have investigated the relationship between protection (typically measured by tariffs) and IIT. Pagoulatos and Sorensen (1975), Lundberg and Gavelin (1986) and Ray (1987) all provide evidence which suggests that IIT and tariff protection are negatively correlated. Against this, a recent study of the United Kingdom by Greenaway and Milner (1990) provides mixed evidence. The results, however, are generally supportive of the view that recorded protection tends to be lower in IIT-intensive sectors.

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[7] Empirical evidence on this tendency has been provided by Cheh (1974). He examined inter-industry variation in reductions in norminal tariff and non-tariff rates negotiated by the United States at the Kennedy Round, and found that 50 per cent may be accounted for by variables that proxy labour adjustment costs. He concluded that trade policy, as manifest in the Kennedy Round reductions, aims to reduce short-run labor adjustment costs.

The marginal intra-industry trade (MIIT) approach

One group of papers uses marginal growth of IIT in total trade as the implicit measure of adjustment costs in the face of trade liberalisation. The basis of this approach is that following trade liberalisation, if there is a greater increase in the amount of intra-industry trade, then lower adjustment costs are implied. The major difference between this approach and two approaches discussed above is the method used to measure intra-industry trade.

Milner (1988) discusses some of the weighting problems associated with the use of the standard Grubel–Lloyd (G-L) index of IIT: the use of each industry's gross trade in the denominator of the index means that the ranking of the industries according to the G–L index may be poorly correlated with one based on the absolute amounts of IIT in each industry. Trade resistance variables, such as trade barriers or transport costs, are more likely to affect the absolute amounts, rather than the shares of IIT (see Greenaway and Milner 1986; Kol 1988). The distinction between the share and amount of IIT becomes particularly relevant in the case of any empirical investigation into the adjustment implications of IIT. Given the initiatives to foster greater regional economic integration (for example in the EU and North America), the focus of research is increasingly on the effect of greater integration on intra-industry trade and specialisation at the margin. In turn, an increase in intra-industry trade or specialisation may involve different adjustment processes (employment and production changes) from those associated with increases in inter-industry trade and specialisation. For the purpose of empirical research into these results it would seem more appropriate to measure changes in the amount, rather than in the share, of IIT.

From this perspective, in addition to using the Grubel–Lloyd index of IIT, Hamilton and Kniest (1991) employ a new index measuring the share of IIT in new trade flows. This new measure, the index of marginal intra-industry trade (MIIT), has been devised to overcome a conceptual problem encountered in comparing Grubel–Lloyd IIT indexes over different time periods. Then the relative adjustment costs are examined by assessing at the relationship between trade liberalisation and this new MIIT.[8]

Following this work, Greenaway, Hine, Milner and Elliott (1994) demonstrate some potential limitations of the H–K MIIT index and illustrate the extent of the potential biases involved using United Kingdom trade data for the chemicals sector over the period 1979–85. Their work also suggests some alternative measures of marginal intra-industry trade, or specialisation, that may be used to investigate adjustment issues in trade expansion.

Brulhart (1994) argues that adjustment, being a dynamic phenomenon, is not directly related to the ('static') amount or proportion of matched two-way trade in one particular year. Neither is the absolute change in the 'static' levels of IIT between different periods in direct relation to the costs of adjustment due to increased trade. The nature of adjustment, in so far as it is affected by international trading patterns, directly depends on the structure of change in trade flows. In light of this idea, he

[8] In their examination of the impact of trade liberalisation following CER on the nature of trans-Tasman trade, they confirm that there is no support for the proposition that trade liberalisation encourages intra-industry trade, by examining the MIIT indexes. A further study of structural adjustment and IIT provides some evidence, albeit not very strong, that trade liberalisation has induced more structural adjustment in industries characterised by inter-industry rather than intra-industry trade.

points out that neither the H–K index nor the GHME measure provides any information on the structure of change in trading patterns. Therefore he proposes a 'Grubel–Lloyd style' measure of MIIT. The main appeal of this index lies in the fact that it reveals the structure of the change in import and export flows, and at the same time it is defined in all cases and shares all the familiar statistical properties of the G–L index.

Menon (1996) takes this further. He finds that even Brulhart's measure can overestimate the extent of MIIT and underestimate the extent of the adjustment cost. He asserts that his trade-weighted average of the percentage point contribution of dynamic intra-industry trade to the percentage growth in total trade in a sector overcomes this limitation.

CGE approach

Computable General Equilibrium techniques have been one of the most important empirical methods used to investigate the impact of policy shocks on trade flows. They have been also used by some economists to address the adjustment costs issue by means of comparing trade effects under perfect and imperfect competition assumptions.

Greenaway and Hine (1991) adapt a table from Richardson's 1988 paper to summarise the work undertaken on imperfect competition and international trade. However, there are some difficulties in interpreting the information in the table. Harris (1984) and Cox and Harris (1985) carry out some studies on the theoretical structure and empirical implementation of general equilibrium evaluation of the impact of unilateral and multilateral trade liberalisation in Canada. These studies are primarily concerned with the implications for gains from trade. They also offer some comments on the adjustment issue.

In these studies, inter- and intra-industry adjustment is explicitly modelled, with intra-sectoral adjustment dominating. For example Cox and Harris (1985) find that in both the unilateral and multilateral liberalisation scenarios, imports and exports expand in all sectors. Moreover, in both cases intra-sectoral resource reallocation dominates inter-sectoral reallocation. For example, in the multilateral liberalisation case only 6 per cent of the labour force is reallocated intersectorally. This suggests to the authors that ‘the adjustment costs of adopting a free trade policy may not be large’ (p. 140). The simulations appear therefore to provide strong support for the view that adjustment to trade expansion may be smoother in an economy where a significant degree of intra-industry specialisation is evident.

However, in these studies it is also clear that trade expansion need not result in increased IIT between industrialised countries. It depends very much on market structure. Thus, in those cases where minimum efficient size is large relative to the total market, significant inter-industry adjustments can occur with large numbers of firms exiting sectors.

Factor intensity approach

The above methods aim to draw out adjustment implications within a framework of analysing the relationship between trade liberalisation and intra-industry trade, so that the adjustment costs under different trade patterns are examined indirectly. A more direct method to examine the adjustment costs that has so far been devised is to calculate the factor similarities between and within industry groups.

One of the best known papers on intra-industry trade is Finger (1975). Finger purports to show that the variability in capital–labour ratios within SITC 3-digit 'industries' is greater than the variability of those ratios between 3-digit groups. Rayment (1976) offers similar evidence for the UK SIC. Lundberg and Hansson (1986) reinforce this result by pointing to product heterogeneity at the third digit of the Swedish Industrial Classification.

The question of similarity of factor requirements between and within industries as conventionally defined is of course an empirical issue. Evidence on this question was discussed in connection with the categorical aggregation problem. There is some evidence to suggest that variability in capital–labour ratios may be greater within than between industry groups, as proxied by the third digit of certain classifications (the SITC in the case of Rayment's 1976 study); although some evidence to the contrary can also be cited (Lundberg and Hanssen 1986). The problem with this evidence is that capital–labour ratios can be computed in a variety of ways and any given measure can also be interpreted in various ways.

An accurate and comprehensive measure of adjustment costs should in theory simultaneously incorporate the following two important features. First, any measure of adjustment costs should have dynamic characteristics, since adjustment is a dynamic process. Second, it should be a direct measure rather than one that merely draws implications from other relationships. The danger in this kind of analysis is not only that the results might be biased but they can also be totally misleading. The above-mentioned methods of measuring adjustment costs in existing studies are less satisfactory. For example, the MIIT measure captures the dynamic aspect to some extent, but it measures adjustment costs indirectly. The CGE model offers a labour reallocation index but it does not capture its dynamic nature. The other three measures have no dynamic features and do not measure the adjustment costs directly.

The comprehensive dynamic factor demand model derived by Epstein (1981) offers advantages both in respect of dealing with dynamic features and direct examination of resource reallocation. Based on the adjustment cost theory that firms suffer short-run output loss as they adjust their stocks of quasi-fixed inputs over time, the model provides imperfect adjustment of resources in response to changes in external conditions. However, this model is derived under the conventional assumption of perfect competition and constant returns to scale. It is therefore necessary to derive or make a justification for the use of a factor demand model incorporating imperfect competition and economies of scale for the study of adjustment costs.

Conclusions

This chapter reviewed several strands in the literature with the aim of establishing a theoretical framework for the comparison of adjustment costs under different trade patterns, namely inter- vs intra-industry trade. There are four main results.

First, a specific-factor trade model can be used to examine the nature of adjustment. Trade liberalisation results in price changes in the affected markets, but if agents fail to respond quickly to these changes, or if any price change is resisted, an adjustment problem is said to exist. In theory an adjustment problem is a short- to medium-run phenomenon, depending on the nature of the market. Generally adjustment problems arise when there is some degree of factor specificity, and the resulting wage (price) inflexibility leads to sticky or incomplete adjustment. In turn, this inflexibility is generally attributable to differences in the input requirements of the expanding and contracting sectors. If factor ratios differ, for example between exportable and importable sectors, the relative price adjustments following any liberalisation shock are significant and, consequently, resistance to liberalisation is greater. Even where factor ratios are similar in terms of capital–labour requirements, adjustment friction can arise as a result of market segmentation. For example, the labour market is segmented occupationally and geographically. Often this leads to a mismatch between the 'requirements' of expanding sectors and the provisions of contracting sectors.

Secondly, the determinants of inter- and intra-industry trade have been distinguished. As an empirical phenomenon, inter-industry trade is defined as international trade among different industry categories, while intra-industry trade is defined as international trade within the same industry category. The reason inter-industry trade occurs is well explained by the conventional framework: under an assumption of perfect competition a country will specialise in and export goods whose production is intensive in factors with which the country is well endowed. In the case of intra-industry trade, however, vertical intra-industry trade is explained under the conventional framework, but horizontal intra-industry trade is explained by similarity in consumers' tastes on the demand side and similarity in factor endowments on the production side. Imperfect competition and economies of scale are also major determinants.

Thirdly, a comparison of adjustment costs between inter-industry trade and intra-industry trade has been made according to the nature of adjustment, as analysed in section 2. First, since under the intra-industry pattern of trade, the market is less segmented both occupationally and geographically, the reallocation of resources is relatively easy. With price adjustment under the intra-industry trade pattern, the factor price gap before and after trade liberalisation is smaller than under the inter-industry trade pattern, so the adjustment response to price change will be quicker. Second, when intra-industry trade is closely related to FDI, rationalisation by multinational firms will internalise labour retraining costs, thereby smoothing the adjustment process. Furthermore, as argued, it is possible for both factors to gain from trade liberalisation under intra-industry trade. Consequently, it is easier for both parties to manage the adjustment.

Current empirical studies relating to adjustment costs were reviewed. They can be classified into five groups: the case study approach; the econometric approach; the

CGE approach; the factor intensity approach; and the MIIT approach. All these approaches are subject to one or both of the following limitations in measuring adjustment costs: lack of dynamic features and indirect measurement. The dynamic factor demand model, which is constructed under conventional assumptions is recognised as a more appropriate analytical framework to the empirical study of adjustment costs under different trade patterns, but only if its use under the condition of imperfect competition and economies of scale can be justified. The elaboration of the model is set out in the following chapter.

3 Dynamic Adjustment Costs Model: An Analytical Framework

Introduction

This chapter introduces the dynamic adjustment costs model, also known as the dynamic factor demand system.

As shown in Chapter 2, there are five main approaches in the literature to adjustment costs analysis under different trade patterns. They are the case study approach, the intensity approach, the CGE modelling approach, the political economy approach and the MIIT approach. Among them the case study, political economy and MIIT approaches take basically the same line: adjustment costs are implicitly addressed through the relationship between trade liberalisation and intra-industry trade. The CGE modelling approach merely says that under imperfect competition, trade liberalisation gives rise to greater intra-industry resource allocation than would occur under perfect competition. The intensity approach examines the variations of factor intensities between and within industry groups. Each of these has two shortcomings. First, adjustment costs are not explicitly examined—only a few implications can be drawn from relationships between other variables. Secondly, factor adjustment is a dynamic process by nature, so an appropriate analysis must in some way incoporate this characteristic. With the exception of the MIIT approach, all the other approaches are essentially 'static'.

The adjustment cost approach is thought to be more appropriate because it allows for the imperfect adjustment of resources in response to changes to external forces. These slow-to-adjust factors are called quasi-fixed inputs. Their levels and rate of change are determined by exogenous factors. Quasi-fixed inputs are also choice variables which affect production in both the short and long run. Adjustment cost theory suggests that firms suffer short-run output loss as they adjust their stocks of quasi-fixed inputs over time.

Relative adjustment costs can be measured in this framework as the relative effectiveness in reallocating quasi-fixed factors when there is a change in external conditions, such as trade liberalisation. The adjustment coefficients of quasi-fixed factors can be provided as a measure of adustment speed (or the extent of inter- or intra-industry factor adjustment) while the eigen values of the adjustment matrix provide a check on the stability of the adjustment process of quasi-fixed factors.

After discussing the theory of adjustment costs in section 2 and the development of the adjustment costs model in section 3, in section 4 I present Epstein's (1981) work on the establishment of a theory of duality between production and value functions for the adjustment costs model of the firm and the derivation of optimal solutions. Some justifications for applying this model under conditions of economies of scale and imperfect competition are discussed in section 5.

Adjustment costs theory

Following Gravelle and Rees (1987), the theory of adjustment costs is simple in nature.

To demonstrate the nature of the problem, a two-input model is adopted here. Suppose X_1 is a variable input: it can be varied at will by the firm. X_2 on the other hand takes time to vary (it is a quasi-fixed input). It is assumed to take one period to make available an increment of X_2, for example the flow of services from a machine or some type of skilled labour. Hence, the firm can decide in the 'present' time period (period 0), to use any level of X_1 in production and is in a position to implement that decision. But a decision taken at the 'present' time period to increase the amount of X_2 by ΔX_2 will result in that increment becoming available for use in production only in the next time period (period 1). X_2 is a constrained input into production in the present period. The amount of X_2 used in production in the present period cannot be increased beyond the amount available at the start of this period. On the other hand, the firm may or may not be able to reduce the amount of X_2 it uses in period 0.[1]

The distinction between fixed and variable inputs has a crucial implication for the firm's decision-making. The firm at the start of period 0 must make two types of decision. First, given the desired output level for period 0, it must choose an actual

[1] For example, if the input is divisible, the firm will be able to use less than the maximum amount unless there is some contractual limitation. Since contracts usually stipulate the amount of an input to be paid for rather than the amount to be used, divisibility usually implies the possibility of using an input below capacity. For example, a firm may hire labour on a monthly contract, and be unable to increase or reduce the number of workers to whom it must pay a guaranteed weekly wage within that period, but it may if it chooses use less than the maximum possible number of man-hours.

level of X_1 for period 0, given that maximum X_2 is fixed in production in period 0. Second, given the planned or desired output level for period 1, the firm must formulate a plan specifying the desired levels of X_1 and X_2 to be used in period 1. If the desired amount of X_2 in period 1 in the plan differs from the level of X_2 held by the firm at the start of period 0, the firm will change the amount of X_2, so that it is available at the start of period 1. Thus the choices implemented by the firm in period 0 are on the variable input levels actually used in period 0, and the change on the fixed input available for the next period.

Firms are supposed to find their desired levels of X_1 and X_2 to maximise production profit of producing the planned period 1 output. It is assumed that it was impossible to change X_2 within period 0 but that X_1 was freely variable. Adjustment costs, in general terms, are those costs which arise solely from a change in the level of use of an input. For example if a firm wishes to hire more labour, it may have to advertise for new workers. This advertising cost is an adjustment cost: it is incurred solely because the firm wishes to hire more labour. In general, firms must shop around, search, and collect information. Moreover, changes in input quantities have to be planned and organised. This absorbs resources and hence imposes adjustment costs.

If actual input levels differ from desired profit maximising levels, the firm will gain from changes in input levels. But these changes in themselves involve adjustment costs. Therefore, the firm needs to find an optimal rate of adjustment. Theoretically, this optimal rate of adjustment can be obtained by balancing the benefits (reduced production costs) against the adjustment costs of the changes. The firm will not in general adjust fully within the period because there are positive marginal costs of adjustment. Hence, in this situation, the adjustment cost in terms of opportunity cost from the firms' point of view is one of output forgone.

The nature of the adjustment theory discussed above is that, in considering the costs arising from an adjustment process involving fixed factors to produce an output level which maximises long-run equilibrium profit, firms seek an optimal rate of adjustment for factors of production within a time period instead of adjusting fully. In other words, since there are costs associated with adjusting fixed factors in production, profit maximising firms will choose to adjust a fraction of fixed factors within a time period.

Development of adjustment costs model

The development of adjustment costs models is well reviewed by Epstein (1981), and is briefly summarised below.

Static profit maximisation

The large body of empirical studies of factor demand systems is based on the assumption of instantaneous adjustment by firms to prevailing prices. A factor demand system under this assumption can be derived from the theory of static profit maximisation. An exhaustive set of integrability conditions can be applied to guide the specification of functional forms and generate a meaningful hypothesis for testing.

Empirical studies of this type can be found in Christensen, Jorgensen and Lau (1973), Berndt and Christensen (1973), Fuss and McFadden (1978).

Dynamic factor demand models

The first dynamic factor demand analysis is highly empirical in nature. Jorgenson (1965) appends an ad hoc lag structure to a theory of static profit maximisation to generate an investment demand function. Thereafter, Lucas (1967), Treadyway (1969; 1971) and Mortensen (1973) provide a consistent dynamic theoretical framework for the determination of all inputs and outputs. Following from these studies, Schramm (1970), Nadiri and Rosen (1969) and Brechling (1975) develop econometric factor demand models by maintaining a flexible accelerator adjustment with constant adjustment coefficients.

There are some problems with econometric factor demand models. Adjustment costs theory implies that the flexible accelerator is generally optimal only locally in the neighbourhood of the steady state and the adjustment coefficients generally depend on exogenous variables (see Treadyway 1974). The studies mentioned above also fail to relate the hypothesised adjustment matrices to the specified technologies satisfactorily.

Berndt, Fuss and Waverman (1977) have estimated a model that is fully consistent with the adjustment cost theory. But there are three limitations to this approach. First, the approach is practical only when there is a single quasi-fixed factor in production, or at most two. Second, the flexible accelerator is the only adjustment mechanism that can be followed to generate testable hypotheses from this approach. Thirdly, they assume that firms expect current prices to persist indefinitely.

Epstein (1981) describes a practical procedure for generating a large class of functional forms for dynamic factor demand functions that can be used to test and apply the adjustment cost theory of the firm. The procedure developed in this approach is applicable to any number of quasi-fixed stocks and is capable of generating a richer class of dynamic adjustment mechanisms. However, the assumption of static expectations, common in the adjustment cost literature, is maintained.

The adjustment costs model

The theory of optimal adjustment of all factors of production provides a basis for the study of adjustment costs resulting from resource reallocation.

The basic assumption of the adjustment cost model is that at any point in time $t = 0$ (or base period), a price-taking firm solves the following infinite horizon problem:

$$J(K_0, p, w, r) \equiv \max_{L \geq 0, I \geq 0} \int_0^\infty e^{-rt}[F(L, K, I) - w^\tau L - p^\tau K]dt \tag{3.1}$$

subject to

$$\dot{K} = I - \delta K, \quad K(0) = K_0 > 0, \qquad (K(t), p, w,) \in \Theta \qquad \text{for all } t$$

where $F(L, K, I)$ is a production function giving the maximum amount of the scalar output y that can be produced from the perfectly variable factor $L \in \overline{\Omega}^m$ and the quasi-fixed factor $K \in \Omega^n$, called capital stock or skilled labour, given that gross investment I is taking place.

$w \in \Omega^m$ and $p \in \Omega^n$ are the rental prices corresponding to L and K, respectively, normalised with respect to the output price. The prices denote actual market prices at $t = 0$, which are expected to persist indefinitely. As the base period changes and new market prices are observed, the firm revises its expectations and its previous plans; thus only the $t = 0$ part of the plan corresponding to (3.1) is carried out in general.

$r \succ 0$ is the real rate of discount. δ is a diagonal $n \times n$ matrix made up of the depreciation rates δ_i of the *ith* stock, $i = 1, \cdots, n$. K_0 is the initial vector of capital stocks. The constraint $I \geq 0$ is used to assume that investment is completely irreversible.

J is the profit function for the specific intertemporal technology defined in (3.1). In other words, J is the value of the problem (3.1), assuming that a solution exists. $\Theta \subset \Omega^{2n+m}$ is a bounded and open set which will be taken below to be the domain of the value function J.

Many approaches can be followed to generate functional forms for factor demand functions in solving (3.1). Epstein establishes a duality between J and F. This duality is local. A local duality suffices for empirical purposes since interest is generally centred on a neighbourhood of prices and quantities defined by the data.

There are some additional assumptions:

- The same real rate of discount is used by the firm in all base periods to discount future profits. Thus γ is a constant and may be suppressed as an argument of J.
- The duality to be established is between functions $F(L, K, I)$ and $J(K, p, w)$.
- The domain of definition of F is restricted to a bounded open set $\Theta \subset \Omega^{2n+m}$ and this gives an implicit constraint in (3.1).
- Interior solutions, $(I, L) > 0$, are assumed.[2]

Some final notations:

$\Phi(K) \equiv \{(L, I) | (L, K, I) \in \Phi\}$, $\Theta(K) \equiv \{(p, w) | (K, p, w) \in \Theta\}$. Under this notation, for each $K \in \Omega^n$ it is assumed that $\Phi(K)$ is empty if and only if $\Theta(K)$ is empty.

$\dot{K}^*(K_0, p, w)$, $L^*(K_0, p, w,)$ and $y^*(K_0, p, w)$ are denoted as the optimal solutions in (3.1) at $t = 0$. They are also called policy functions (Arrow and Kurz 1970).

$\lambda^*(K_0, p, w)$ denotes the optimal current value shadow price at $t = 0$.

The following regularity conditions, valid throughout Φ, are imposed on the technology:

Condition T1: F maps Φ into $\overline{\Omega}^1$; F, F_L and F_I are once continuously differentiable.

Condition T2: F_L, $F_K > 0$, $F_I < 0$.

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[2] This is not restrictive if the empirical work is based on aggregate data.

Condition T3: F is strongly concave in (L, I).

Condition T4: For each $(K_0, p, w) \in \Theta$, a unique solution exists for (3.1), in the sense of the convergent integral; the policy functions $\dot{K}^*$, L* and y* are continuously differentiable on Θ.

Condition T5: $\lambda^*_p\ (K, p, w)$ is non-singular for each $(K, p, w) \in \Theta$.

Condition T6: For each $(L', K_0, I') \in \Phi$, there exists $(K_0, p', w') \in \Theta$ such that (L', I') is optimal in (3.1) at $t = 0$ given initial stock K_0 and prices p', and w'.

Condition T7: For each $(K_0, p, w) \in \Theta$, the problem (3.1) has a unique steady-state capital stock $\overline{K}(p, w) \in \Theta$ that is globally stable, which means optimal paths converge to $\overline{K}(p, w)$ regardless of their starting point K_0.

The specification of the above regularity conditions is for the purpose of empirical application.

T1—T3 are self-explanatory and fairly standard. T1 simply says that F is a real-valued function that assumes the value $-\infty$ for those vectors (L, K, I) that are technologically infeasible.

T2 asserts that the marginal product of variable factors and quasi-fixed factors are positive. $F_I < 0$ reflects the adjustment costs associated with gross investment.

F is strongly concave if the appropriate Hessian is negative definite throughout Φ. If $\Phi(K)$ is not a convex set, F will be concave in (L, I) for each K should be taken to mean that the appropriate Hessian is negative semi-definite throughout $\Phi(K)$ for each K.

T4 asserts the existence of well-defined and differentiable solutions associated with (3.1).

The non-singularity of λ^*_p aims to reduce the considerable complexity in the derivation. In fact non-singularity cannot be refuted empirically since it is a sufficient condition for the functional relationship $\lambda = \lambda^*(K, p, w)$ to be locally invertible in p, for given K and w.

T6 ensures that there is one-to-one relationship between factor prices and corresponding factors. In fact points (L', K_0, I'), which violate T6, would never be observed empirically.

T7 assumes the uniqueness and global stability of the steady state.[3]

Suppose that F satisfies Condition T and let J be defined by (3.1). Then it is well known (Arrow and Kurz 1970: 33–35) that J satisfies the Hamilton–Jacobi equation[4] which takes the form

[3] These have been investigated by Lau (1976).
[4] This is described as $-V_t = \max_v H = H^0$, where V is the value function of the maximisation problem and the function H is known as the Hamiltonian.

$$rJ(K,p,w) = \max_{(L,I)\in\Phi(K)}\{F(L,K,I) - w^{\tau}L - p^{\tau}K + J_K(K,p,w)(I-\delta K)\},$$
$$(K,p,w)\in\Theta. \tag{3.2}$$

Moreover, the maximising values of L and I when $K = K_0$ are precisely the demands that are optimal in (3.1) at $t = 0$.

The significance of (3.2) in establishing the duality between J and F is that static optimisation problems may be applied. The following problem, the 'inverse' of (3.2) will be important below:

$$F^*(L,K,I) = \min_{(p,w)\in\Theta(K)}\{rJ(K,p,w) + w^{\tau}L + p^{\tau}K - J_K(k,p,w)(I-\delta K),$$
$$(K,p,w)\in\Phi. \tag{3.3}$$

Problem (3.3) can be interpreted as defining a production function F^* given a function J that satisfies appropriate regularity conditions. The properties (V) that characterise value functions $J(K,p,w)$ are set out below.

Condition V1: J is a real-valued, bounded-from-below function defined on Θ; J and J_K are twice continuously differentiable.

Condition V2: (I) $(\delta + r)J_K^{\tau}(K,p,w) + p - J_{KK}(\tilde{I}(K,p,w) - \delta K) > 0$,

(II) $J_K^{\tau}(K,p,w) > 0$.

Condition V3: For each $(K,p,w)\in\Theta$, $\tilde{y}\geq 0$; for each K such that $\Theta(K)$ is non-empty, $(\tilde{L}(K,\cdot,\cdot),\ K,\ \tilde{I}(K,\cdot,\cdot))$ maps $\Theta(K)$ onto $\Phi(K)$.

Condition V4: The dynamic system $\dot{K} = \tilde{I}(K, p, w) - \delta K$, $K(0) = K_0$, $(K_0, p, w) \in \Theta$,

defines a profile $K(t)$ such that $(K(t), p, w) \in \Theta$ for all t and

$K(t) \to \overline{K}(p, w) \in \Theta$, a globally stable steady state.

Condition V5: J_{pK} is non-singular.

Condition V6: For $(K, p', w') \in \Theta$, the minimum in (3.3) is attained at (p', w') if

$(I, L) = (\tilde{I}(K, p', w'), \;\; \tilde{L}(K, p', w'))$.

Condition V7: The matrix $\begin{bmatrix} \tilde{L}_w & \tilde{L}_p \\ \tilde{I}_w & \tilde{I}_p \end{bmatrix}$ is non-singular for $(K, p, w) \in \Theta$.

According to V1, J is real valued function; V2 (I) and (II) are dual to $F_K > 0$ and $F_I < 0$, respectively. V3 is dual to $F \geq 0$ and T6. V6 is dual to T6. V4, V5 and V7 roughly correspond to T7, T5 and T3, respectively.

The important condition V6 could have been expressed in the following equivalent manner: V6'—given $(K, p'w') \in \Theta$ there exists $(I', L') \in \Phi(K)$ such that (p', w') is optimal in (3.3) given (L', K', I'). Alternatively, V6 may be viewed as requiring that the first order conditions be sufficient for a global (over $\Theta(K)$) minimum in (3.3), which is clearly a curvature restriction of sorts.

Following from that, Theorem 1 is therefore delivered. It establishes a duality between production and value functions.

Theorem 1: (a) Let F satisfy conditions (T) and define J by (3.1). Then J satisfies conditions (V). If further J is used to define F^* by (3.3), then $F^* = F$.

(b) Let J satisfy conditions (V) and define F by (3.3). Then F satisfies conditions (T). If further F is used to define J^* by (3.1), then $J^* = J$.

Proof of Theorem 1.

(a) Let F satisfy (T) and show that J defined by (3.1) satisfy (V).

There are a number of conditions in V1. Firstly, J is well defined on Θ by T4 as T4 ensures the existence of well-defined solutions for (3.1). Secondly, the boundedness of F in Φ and (K_0, p, w) in Θ implies that J is bounded below over Θ. Thirdly, it is well known that $J_K(K, p, w) = \lambda^*(K, p, w)$, the unique and twice continuously differentiable shadow price. Therefore, J_K has the required differentiability. Since *T1* gives the differentiability of F and *T4* gives the differentiability of K, L and y, if we apply the envelope theorem to equation (3.3), the required differentiability of J is established.

V2 (I) follows from T2 and the envelope theorem is applied to (3.2). For V2 (II), if $J_K \leq 0$ at some (K, p, w), then the maximum in (3.2) would not be attained over $I > 0$, contradicting T4. V3 is implied by $F \geq 0$ and T6. T4 and T7 yield V4. V5 is simply a restatement of T5.

Let $(K, p', w') \in \Theta$ and according to T6, $I^*(K, p', w') \equiv \dot{K}^*(K, p', w') + \delta K$ and $L^*(K, p', w')$ are optimal in solving (3.2), given $(p, w) = (p', w')$. By the inverse nature of problems (3.2) and (3.3), it follows that (p', w') is optimal in (3.3) given $(I, L) = (I^*(K, p', w'), \quad L^*(K, p', w'))$. But the first order conditions for an optimum in (3.3) yield precisely that $I^* = \tilde{I}$ and $L^* = \tilde{L}$ evaluated at (K, p', w'). Henceforth there is no need to distinguish between (I^*, L^*) and $(\tilde{I}, \tilde{L})$. Similarly, $\tilde{y} \equiv rJ + w^{\tau}\tilde{L} + p^{\tau}K - J_K(\tilde{I} - \delta K) = y^*$, where the equality follows from (3.3).

V7 can be proved as follows: $\tilde{L}$ and $\tilde{I}$ (or equivalently L^* and I^*) satisfy

$$F_L^{\tau}(\tilde{L}, K, \tilde{I}) = w, \quad F_I^{\tau}(\tilde{L}, K, \tilde{I}) = -\lambda^*(K, p, w) \tag{3.4}$$

Applying the Implicit Function Theorem to differentiate (3.4) with respect to *L* and *I*, respectively, yields the following relationships:

$$\begin{bmatrix} F_{LL} & F_{LI} \\ F_{IL} & F_{II} \end{bmatrix} \times \begin{bmatrix} \tilde{L}_w & \tilde{L}_p \\ \tilde{I}_w & \tilde{I}_p \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -\lambda^*_w & -\lambda^*_p \end{bmatrix} \qquad \Leftrightarrow \qquad AB = C$$

A is non-singular from the strong concavity of F in L and I, and C is non-singular from the non-singularity of λ^*_p, therefore the matrix B is non-singular.

Now use J to define F^* by (3.3). It must be shown that $F = F^*$ over their common domain. By V3, it is enough to prove that $F = F^*$ for all arguments of the form

$(L^*(K,p,w), K, I^*(K,p,w))$, $(K,p,w) \in \Theta$. As in the proof above that J satisfies V6, so that

$$F^*(L^*(K,p,w),K,I^*(K,p,w)) = rJ(K,p,w) + w^\tau L^*(K,p,w) + p^\tau K - J_K(I^*(K,p,w) - \delta K) = y^*(K,p,w) = F(L^*(K,p,w),K,I^*(K,p,w)).$$

(b) Let J satisfy (V), define F by (3.3) and show that F satisfies (T).

F is firstly well defined by V6 and V3. The required differentiability of F and T2 can be verified by the Implicit Function Theorem. From the above, the functions p^* and w^* satisfying

$$(p,w) = (p^*(L,K,I),\, w^*(L,K,I)) \text{ iff } (L,I) = (\tilde{L}(K,p,w), \tilde{I}(K,p,w)) \tag{3.6}$$

are (locally) well defined and continuously differentiable. By V6 the minimum in (3.3) is attained at $(p^*(L,K,I), w^*(L,K,I))$. The once continuous differentiability of F now follows directly from (3.3). Apply (3.5), V2 and the envelope theorem to (3.3) to obtain

$$\begin{aligned} F_K^\tau(L,K,I) &= (r+\delta)J_K^\tau(K,p^*,w^*) + p^* - J_{KK}(I-\delta K) > 0,\\ F_I^\tau(L,K,I) &= -J_K^\tau(K,p^*,w^*) < 0,\\ F_L^\tau(L,K,I) &= w^* > 0. \end{aligned} \tag{3.6}$$

(3.6) and the differentiability of J_K and (p^*, w^*) yields the continuous differentiability of F_I and F_L.

where $\dot{K} = I - \delta K$ for any feasible path $K(t)$ and J is bounded below on Θ.

The above formula shows that $J(K_0, p', w')$ is bounded above the value of any feasible program. This result is attained (uniquely) by the particular program defined by setting $(L, I) = (\tilde{L}(K, p', w'), \tilde{I}(K, p', w'))$. Therefore, the original inequalities become equalities. And further it can be shown that

$$\int_0^T [F(\tilde{L}, \tilde{K}, \tilde{I}) - w'^{\tau} \tilde{L} - p'^{\tau} \tilde{K}] e^{-rt} dt = J(K_0, p', w') - e^{-rT} J(\tilde{K}(T), p', w')$$

where $\tilde{K}(t)$ denotes the profile defined by $\dot{K} = \tilde{I}(K, p', w') - \delta K, \quad K(0) = K_0$. By the stability of the steady state (V4),

$\tilde{K}(T) \rightarrow K(p', w')$ as $T \rightarrow \infty$.

Therefore $e^{-rT} J(\tilde{K}(T), p' w') \rightarrow 0$

and $\int_0^\infty [F(\tilde{L}, \tilde{K}, \tilde{I}) - w'^{\tau} \tilde{L} - p'^{\tau} \tilde{K}] e^{-rt} dt = J(K_0, p', w')$.

J defines the value of programs corresponding to F. And $\lambda^* = J_K$, $\dot{K}^* = \tilde{I} - \delta K$, $L^* = \tilde{L}$ and $y^* = \tilde{y}$. The required differentiability of λ^* and the policy functions follow from (3.3) and the differentiability of J (V1).

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T5 restates V5. For T6, let $(L', K_0, I') \in \Phi$ and let $(p', w') \in \Theta(K_0)$ be optimal in (3.3). That this price vector makes (L', I') optimal in (3.1) at $t = 0$ was shown in the proof of T4. T7 restates V4.

Now use F to define J^* via (1). It was shown above in the above proof of T4 that $J^* = J$.

Theorem 2: Let F satisfy (T) and let J be the dual value function. The policy functions are given by $\dot{K}^* = \tilde{I} - \delta K$, $L^* = \tilde{L}$ and $y^* = \tilde{y}$.

Theorem 2 is the analogue of Hotelling's Lemma. It is proved in the context of proving Theorem 1, mainly through the proof of the duality between V6 and T6. Therefore, if we apply the first order conditions for an optimum in (3.3), the following formulas which will be shown to describe optimal behaviour in (3.1) will be generated:

$$\begin{aligned}
\tilde{I}(K,p,w) &= J_{pK}^{-1}(K,p,w)(rJ_p^{\tau} + K) + \delta K, \\
\tilde{L}(K,p,w) &= -rJ_w^{\tau}(K,p,w) + J_{wK}(\tilde{I} - \delta K), \\
\tilde{y}(K,p,w) &= rJ + w^{\tau}\tilde{L} - p^{\tau}K - J_K(\tilde{I} - \delta K) \\
&= r[J - J_w w - J_p p] - [J_K - w^{\tau}J_{wK} - p^{\tau}J_{pK}](\tilde{I} - \delta K).
\end{aligned} \tag{3.8}$$

The above development shows that if the production technology F is well specified by conditions (T), the value function J will be characterised by conditions (V). Further, the value function J can be used to define F and vice versa. Thereafter, the factor demand and output supply which describes the behaviour optimal to (3.1) can be generated.

Adjustment costs model under imperfect competition and scale economies[5]

A theory of duality between the production and value function has been established above for the adjustment cost model of the firm. In the context of proving this, an analogue of Hotelling's Lemma was proved. In doing so, some formulas which describe optimal behaviour in (3.1) were derived. But it should be noted that the assumption maintained here is that firms are price takers. Under standard economic theory, firms are price takers only when economies are in a state of perfect competition. Now the question is whether the use of this model can be justified when there are scale economies and imperfect competition.[6]

Before answering the above question, let us look at the types of economy of scale and the types of competition that are relevant.[7]

There are generally two types of economy of scale: those internal to the firm and those external to the firm but internal to the industry.

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[5] It is not inconsistent with Epstein's model in incorporating economies of scale. The key assumption in Epstein's model is that of price-taking.

[6] It is surprising that in existing studies this problem has never been explained or investigated. Some empirical studies apply this framework to a highly aggregated industry analysis. For example, Epstein and Denny (1979) applied a similar model to the aggregate US manufacturing sector.

[7] These theories are well established. Discussion in this section is drawn from Gravelle and Rees (1987), Helpman (1984) and Maddala and Miller (1989).

Economies of scale or diseconomies of scale which are internal to the firm can be represented by a firm's production function of the form $x = F(v)$,where v is a vector of factor inputs and x is output.

Assume λ is a scalar, then if $\lambda F(v) > F(\lambda v)$, we say there are increasing returns to scale or economies of scale; if $\lambda F(v) = F(\lambda v)$, there are constant returns to scale; when $\lambda F(v) < F(\lambda v)$, there are diminishing returns to scale or diseconomies of scale.

Economies or diseconomies of scale which are external to the firm but internal to the industry are usually represented by a production function in the form $x = F(v; X)$, where x is the output level of the single firm, v is its vector of inputs and X is industrial output. The production function is assumed to be quasi-concave and positively linear homogeous in v. This means that from the point of view of a single firm which considers the industry's output level as invariant to its decisions, the production process exhibits constant returns to scale. Explanations of external economies of scale which are external to the firm but internal to the industry rest on the argument that a larger industry is better placed to take advantage of within-industry specialisation, as well as conglomeration, indivisibilities and public intermediate inputs.

Broadly speaking, there are three types of assumption about firms' behaviour. The first behavioural assumption is that firms behave in a purely competitive fashion. That is, firms take prices of inputs and output as given, and choose the input–output combination that maximises profits. As a result, firms end up with marginal cost pricing. This pricing procedure is viable if the resulting profits are non-negative, which means that perceived marginal costs exceed perceived average costs—there are no economies of scale.

The second behavioural assumption that has been employed is that of price competition, associated with the name of Bertrand. Under this assumption a firm takes the prices charged by its competitors as given and chooses a price for its product so as to maximise profits.

The third assumption in this broad categorisation of firms behaviour is that of quantity competition, associated with the name of Cournot. Under this assumption, a firm takes the quantities of the sale by its competitors as given. In other words, it assumes that changes in its own sales will not affect the sales of its competitors. It then calculates the response of the price to changes in its sales and it chooses a profit-maximising level of sales.

If the process of production is characterised by global economies of scale, the competitive assumption is inappropriate. But when the economies (or diseconomies) of scale are external to the firm but internal to the industry, the single firm operates under perceived constant returns to scale. Firms are still price takers.

If the economies of scale are internal to the firm, then the competitive assumption no longer holds. Oligopolistic competition in the form of the Cournot or Bertrand model will result. Oligopoly is characterised by a small number of sellers who are well aware of their interdependence. The product can be homogeous or differentiated. In this context Bertrand price competition is examined in more detail.

Assume that there is free access to technology, free entry (and exit) into the industry, and price competition. If an entering firm conjectures that by charging the market price it can get any market share it desires, that by charging a higher price it will get zero market share, and by charging a lower price it will capture the entire market, then in the resulting equilibrium there will be a single firm in the industry and it will charge the possible lowest price. The Bertrand model is based on the assumption that each firm believes that its competitor will maintain its current price. Firms therefore successively undercut each other's price until a competitive outcome is reached. A practical way to think about the Bertrand model is as a model of competitive bidding. Each firm submits a sealed bid stating the price at which it will serve all customers; the bids are opened and the lowest bidder gets the customers. Once the bidder is aware of the bids, the next step for this firm is simply to sell or produce the amount at which its profit is maximised at this bidding price. In this regard, the firm can be loosely regarded as a 'price taker'.

If there are decreasing returns to scale, free entry and free access to the technology lead to an infinite number of firms which operate at an infinitesimal level. The industry's implicit production function exhibits constant returns to scale and perfect competition will prevail.

An extreme form of the case arises when the market for a commodity is supplied by a single monopolist. A firm with monopoly power, which faces a downward sloping demand curve, maximises profits by equating marginal costs to marginal revenue. The structure of the marginal revenue function depends on the nature of demand.

Nonetheless, at the equilibrium, the monopolist is a 'price maker' rather than a price taker.

Monopolistic competition is characterised by a large number of firms producing differentiated products. The firms behave independently, and non-price competition is prevalent under the condition that there are no barriers to entry or exit.

In summary, in the presence of economies of scale and imperfect competition, the use of the adjustment costs model can still be justified with respect to the price-taking assumption of firms. If the economies of scale are external to the firm but internal to the industry, firms are still price takers. When the economies of scale are internal to firms, but they are assumed to follow price competition, the price taking assumption can be loosely maintained.

Conclusion

The existing studies of adjustment costs under different trade patterns are constrained by one or both of the following shortcomings: indirect measurement and lack of dynamic characteristics. Thus, a dynamic adjustment costs model is necessary to the present analysis.

Based on earlier development of the adjusment costs model, Epstein (1981) has shown that by applying the familiar principles of duality and the envelope theorem to the value function, one can generate optimal solutions to quasi-fixed input and variable input and output supply.

As the whole story of Epstein's dynamic adjustment costs model is based on the price-taking assumption of firms, it is necessary to discuss the justification for the use of this model under economies of scale and imperfect competition. The result emerges is that when economies of scale are external to firms and internal to the industry, the price-taking assumption of firms is maintained. When economies of scale are internal to firms, only when firms follow price competition, can the 'price-taking' assumption be loosely attained. As discussed in Chapter 2, the theoretical explanation of inter-industry trade is based on the conventional framework of perfect competition and constant returns to scale. But horizontal intra-industry trade involves product differentiation, economies of scale and monoplistic competition and oligopolistic behaviour, while vertical intra-industry trade is still explained under conditions of perfect competition and constant returns to scale. This justification is very significant for the empirical analysis that follows.

This model provides the theoretical foundation of the empirical analysis that follows. As will be shown in the next chapter, this model not only can account for the relationship among multiple outputs, inputs, and exogenous shifters, but also allows for the imperfect adjustment of resources in response to changes in external forces. In Chapter 4, this model is applied to an empirical analysis of the costs of resource adjustment under different trade patterns.

4 Factor Adjustment and Intra-industry Trade: An Application of the Adjustment Costs Model

Introduction

There are theoretical reasons for believing that the adjustment costs associated with factor adjustments under intra-industry trade are lower than those under inter-industry trade. This idea is initially supported by a specific-factor model analysis. Where there are specific factors of production, the relative adjustment of labour depends on how the market is occupationally and geographically segmented (or concentrated). The nature of the determinants of intra-industry trade and inter-industry trade suggests that under intra-industry trade specialisation, firms within an industry are likely to be more geographically concentrated and the labour in that industry is likely to be less occupationally segmented. An implication is that intra-industry trade specialisation will be associated with lower factor adjustment costs as trade patterns change since much of the adjustment takes place within each industry.

Yet there is no comprehensive empirical evidence to support the hypothesis that factor adjustment under intra-industry trade specialisation predominantly occurs within industries rather than between industries. The aim of this chapter therefore, is to test this hypothesis using a dynamic factor demand system.

Functional forms of adjustment cost models

The theoretical basis for an adjustment costs model was introduced in Chapter 3. In order to test the core hypothesis in the thesis using this adjustment costs model, the form of the value function must be specified. Before doing this, the model of adjustment costs is summarised briefly.

Theoretical model

When facing adjustment problems with a set of quasi-fixed inputs (K), firms are assumed to select an optimal level of variable inputs (L), and an investment rate (I), for their quasi-fixed inputs. They make these choices to maximise the value (V) of their production over an infinite time domain (t), given output prices (p), variable input prices (w) and rental prices (q) of quasi-fixed inputs.

This maximisation problem can be written as

$$V(p,w,q,K) = Max_{(Y,L,I)} \int_0^\infty e^{-rt}[p'Y - w'L - q'K]dt \tag{4.1}$$

s.t.:

$\dot{K} = I - \delta K,$

$K(0) = K_0 > 0$, and

$Y = f(K,L,I)$

where r is the discount rate, $\dot{K}$ is the net investment in quasi-fixed inputs, $K(0) = K_0$ is the stock of investment at the base year, and δ is a diagonal matrix with positive depreciation rates on the diagonal investment stocks. Earnings are measured as the difference between sales revenue and the costs of purchasing variable inputs and renting quasi-fixed inputs. The function $f(\cdot)$ is a multi-product production function, twice continuously differentiable, which satisfies $f(\cdot) > 0$, $f_K(\cdot) > 0$, and $f_I(\cdot) < 0$ if $I > 0$, $f_I(\cdot) > 0$ if $I < 0$, and is strictly concave in K and I (Epstein 1981). The relationship $f_I < 0$ reflects the adjustment costs associated with gross investment I, and is measured in terms of foregone output.

Given the regularity conditions on $f(\cdot)$ and static price expectations, the value function in Equation (4.1) satisfies the following Hamilton–Jacobi equation:

$$rV(p,w,q,K,I) = Max_I\left[\pi *(p,w,q,K,I) - q'K + V'_K(p,w,q,K)(I - \delta K)\right] \qquad (4.2)$$

where $\pi *$ is variable profit and represents the optimum solution for profit maximisation in the short run, and V_k represents a vector of shadow prices associated with quasi-fixed stocks. Equation (4.2) indicates that producers can increase their earnings by accumulating net profit from production and by new investment in the quasi-fixed inputs with a marginal value of V_K. By the duality relationship which exists between V and $\pi *$, the value function V is expected to satisfy the following properties: V and V_K are twice continuously differentiable; V is homogeneous of degree zero in prices, non-decreasing in p, and K, non-increasing in w and q, convex in prices (p, w, and q), and concave in inputs (L and K).

By applying duality principles summarised in Chapter 3 and the envelope theorem to (4.2), the following equations can be generated:

$$\begin{aligned} \dot{K}^* &= V_{kq}^{-1}(rV_q + K) \\ L^* &= -rV_w + V_{kw}^{'}\dot{K} \\ Y^* &= rV_p - V_{kp}^{'}\dot{K} \end{aligned} \tag{4.3}$$

where the lower case subscripts are used to designate derivatives.

These equations indicate that the optimal solutions for the quasi-fixed inputs, variable inputs and output supply are functions of p, w, q and K.

The above system provides a useful representation of the determination of quasi-fixed input demand. In this study, the theory of optimal adjustment of all factors of production provides a basis for the study of adjustment costs resulting from resource relocation.

Empirical model

For the purpose of the empirical estimation of the dynamic factor demand response system of equation (4.3) above, an explicit functional form of the value function *V(.)* must be specified. Epstein (1981) proposed a number of functional forms for the value function which are useful in empirical studies. One of them, the normalised quadratic value function, has been used frequently in empirical work (Vasavada and

Chambers 1986; Vasavada and Ball 1988; Huang, Rosegrant and Rozelle 1995). Following Huang et al., the specification that is used in this study is as follows:

The form of the value function can be expressed as

$$V(p,w,q,K) = a_0 + [a_1,a_2,a_3,a_4][p,w,q,K]' + \frac{1}{2}[p\ w\ q\ K]\begin{vmatrix} A & F' & G' & H' \\ F & B & L' & N' \\ G & L & C & R^{-1\prime} \\ H & N & R^{-1} & D \end{vmatrix}\begin{bmatrix} p \\ w \\ q \\ K \end{bmatrix} \quad (4.4)$$

where, V, p, w, q, and K, are as defined in the theoretical model, and $a_0,\cdots,a_5$ and A,F,G,H,B,L,N,C,R,D are parameter matrices with the appropriate dimensions.

Following the steps outlined in the theoretical model derivation, the empirical formulation of the dynamic factor demand equations (corresponding to the optimal solutions in equation (4.3)) has the following form:

$$\dot{K}_t = rRa_3 + (rU + R)K_{t-1} + rRGp_{t-1} + rRLw_t + rRCq_t + e_{12t}$$

$$L_t = -ra_2 - rF'p_{t-1} - rBw_t - rL'q_t - N'K_t{}^* + e_{3t} \quad (4.5)$$

where $K^* = rK_{t-1} - \dot{K}$ and U is an identity matrix. All matrices and vectors have the appropriate dimensions.

In this study, each industry employs two primary factors—capital and labour—and both are treated as quasi-fixed inputs as a fraction of labour is skilled. Therefore only the first equation of the above factor demand system is required for empirical analysis.

Measuring intra-industry trade

There are two major issues in empirical studies involving intra-industry trade: defining an industry and measuring the extent of intra-industry trade within such industries.

Two main criteria have been used to define an industry. Two different products are the output of a single industry either if it is relatively easy to substitute one for the other in the production process or if consumers put them to essentially the same use. The choice between these two criteria depends on the use to which the data generated by the criteria is put.

Economists studying intra-industry trade often use data from published statistics on trade in various recognised 'categories'. The most commonly used classification is the Standard International Trade Classification (SITC). There are 10 sections at the 1-digit level, 63 2-digit groups, and so on.

The level of IIT depends crucially on the level of aggregation. If IIT is measured at a very detailed classification, there might be very little intra-industry trade. On the other hand, if IIT is measured at very high level of aggregation, much trade will be intra-industry trade. Such problems have led some economists such as Finger (1975) to suggest that intra-industry trade is merely a 'statistical artefact'. Although relatively little effort has been devoted to measurement problems, they are of absolutely vital significance to the entire subject. The standard documentary work often reports IIT at the 3-digit level of aggregation. Efforts have been made to find a more constructive way to take some account of the bias due to the aggregation level or even to establish a more appropriate trade classification.

The first measure of the extent of intra-industry trade was proposed by Balassa in 1966. The most widely used measure is the Grubel–Lloyd index, which is a simple modification of the Balassa measure. The problem with the Grubel–Lloyd index is associated with biases created by trade imbalances at the multilateral level (Grubel and Lloyd 1975). Some economists have attempted to correct this, but a widely acceptable method of correction has yet to be found. As argued by Helpman (1987), attempts to modify the Grubel–Lloyd index to correct for trade imbalance bias are inappropriate since the nature of the bias is not known. In particular, we do not know whether the imbalance is caused by homogeneous or differentiated products and whether the trade structure is in equilibrium or not. This explains why in general, bilateral IIT is more interesting than overall IIT.[1]

Following Grubel and Lloyd (1975), the individual industry IIT index between countries i and j for product k in year t is given by

[1] There are, of course, many methodological questions which have been raised in the literature about calculation of intra-industry trade indexes. Fontagn and Freudenberg (1997) etc, for example, provide an excellent review of the aggregation issue in their work on European trade.

$$IIT_{ij,k}^{t} = [1 - \frac{\left|X_{ij,k}^{t} - M_{ij,k}^{t}\right|}{(X_{ij,k}^{t} + M_{ij,k}^{t})}] * 100 \qquad (4.6)$$

X and M are exports and imports of product k in year t between two countries respectively.

The aggregate IIT index is calculated as

$$IIT_{ij}^{t} = [1 - \frac{\sum_{k}\left|X_{ij,k}^{t} - M_{ij,k}^{t}\right|}{\sum_{k}(X_{ij,k}^{t} + M_{ij,k}^{t})}] * 100 \qquad (4.7)$$

This is a weighted average of the individual industry indices, where the weights are the share of the industry in total trade.

Factor adjustment in various industries

Before testing the central hypothesis relating factor adjustment and IIT across industries, as foreshadowed in the first section, it is necessary to derive factor adjustment for various industries by applying the adjustment costs model.

Justification for the use of the adjustment costs model

An industry's output can be produced under either constant returns to scale or economies of scale, and firms may form prices under perfect competition, monopolistic competition or oligopolistic behaviour. Firms may engage in trade in either inter- or intra-industry trade. Under these circumstances, it is necessary to discuss the justification for the use of the adjustment costs model first.

Whether the use of the adjustment costs model can be justified depends on whether the price-taking assumption, which is the key assumption of the adjustment costs model, can be attained. As discussed in Chapter 3, the assumption that firms are price takers holds not only under perfect competition but also under conditions with economies of scale and imperfect competition. When economies of scale are external to firms and internal to the industry, the price-taking assumption of firms is maintained. When economies of scale are internal to firms, only when firms follow price competition can the price-taking assumption be loosely maintained.

Inter-industry trade is explained in theory under a framework of constant returns to scale and perfect competition, and vertical intra-industry trade has essentially the same implication. Firms pricing under these circumstances are simply acting as price-takers.

For horizontal intra-industry trade, economies of scale, monopolistic competition and oligopolistic behaviour explain why trade takes place. In the presence of economies of scale and oligopolistic behaviour of firms, these explanations of horizontal IIT lie in their incorporation of two assumptions: (a) that there exist sectors with product differentiation and there exists in every country a demand for a wide spectrum of varieties; and (b) that each variety of a differentiated product is produced with internal economies of scale. Two assumptions have been used to model the demand for varieties. One approach, based on Dixit and Stigliz (1977), assumes that a representative consumer likes to consume a large number of varieties. An alternative approach, taken by Lancaster (1979), assumes that a consumer prefers a product whose characteristics are close to his or her ideal. In both cases it is assumed that firms engage in price competition. Thus the price-taking assumption is also attained under these circumstances.

Theoretically, horizontal intra-industry trade can also take place under the condition of monopolistic competition. According to Maddala and Miller (1989), the monopolistic competition model was received very enthusiastically in the 1930s, but later attracted much criticism. One criticism concerns problems associated with the product differentiation assumption. Downward-sloping demand curves are derived from the assumption of product heterogeneity. This is inconsistent with the assumption that either cost curves or demand conditions are the same for all firms. Long-run equilibrium in which firms earn normal profit is logically incompatible with this assumption. If a firm is providing a unique product and making super-normal profits as a consequence, other firms can erode these profits simply by providing the same product, rather than some differentiated product.

Another problem created by the introduction of product heterogeneity is that it is difficult to define an industry or 'competing group'. For example, tea, coffee, soft drinks, beer, wine and liquor could form a chain of competing products. Under models of perfect competition or monopoly, these would be considered as different homogeneous products. Under monopolistic competition, it is not clear where to draw the line.

Finally, differentiated products are not necessarily produced by different firms. For instance, the fact that there are different brands of soaps and detergents does not mean that the market is monopolistically competitive. Different brands may be produced by a single firm, which has more than half of the market in soaps and detergents. This represents an oligopoly of multi-product firms.

Nevertheless, on the one hand we have observed that monopolies rarely exist in reality; on the other hand, there is no firm support for monopolistic competition in theory. Thus it is reasonable to rule out the case that horizontal intra-industry trade takes place under monopolistic competition.

Thus, firms' pricing behaviour is limited to either perfect competition or price competition for both inter- and intra-industry trade specialisations, making the price-taking assumption of the adjustment costs model justified.

Further, intra-industry trade is a fraction of an industry's total trade and a large proportion may be vertical intra-industry trade.[2] This fact may add more weight statistically to the justification of the use of the adjustment costs model under the condition that firms engage in both inter- and intra-industry trade.

[2] A recent study by Greenaway, Hine and Milner (1994) reveals that, on average, more than two-thirds of the United Kingdom's total trade is in the form of vertical intra-industry trade.

Test equations

To facilitate testing of the adjustment costs hypothesis, the quasi-fixed input equations are linearised. For a two-factor system, the linearised first equation of (4.5) can be written as follows:

$$\begin{aligned}\hat{K}_t &= \alpha_0 + \alpha_1 K_{t-1} + \alpha_2 L_{t-1} + \alpha_3 p_{t-1} + \alpha_4 w_t + \alpha_5 r_t + \varepsilon_1 \\ \hat{L}_t &= \beta_0 + \beta_1 K_{t-1} + \beta_2 L_{t-1} + \beta_3 p_{t-1} + \beta_4 w_t + \beta_5 r_t + \varepsilon_2\end{aligned} \tag{4.8}$$

in which, $\hat{K}_t$ and $\hat{L}_t$ represent the change of capital and labour employment levels in the current time period, respectively; K_{t-1} and L_{t-1} are the capital and labour employment levels in the previous time period; p_{t-1} is the output price in the previous time period; w_t and r_t are the current wage rate and rental price for labour and capital, respectively.

$M = \begin{vmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{vmatrix}$ is called an adjustment matrix. The direction and magnitude of the particular factor adjustment can be obtained from the sign and value of α_1 and β_2.

The dynamic nature of the model here is reflected as the changes of current labour or capital employment levels depending on labour and capital employment levels in the previous period.

As shown in the above test equation of quasi-fixed input demand, the data needed in this study are time-series data for total employed persons, the value of capital stock, output prices, wage rates and returns to capital. These data are available only from the OECD's International Sectoral Database at a subdivision level of manufacturing industry, classified according to International Standard Industrial Classification (ISIC) as shown in Table 4.1. Only three economies—the United States, Canada and Germany—have the information necessary to construct the above measures.

Table 4.1 Industry classification code for ISIC manufacturing

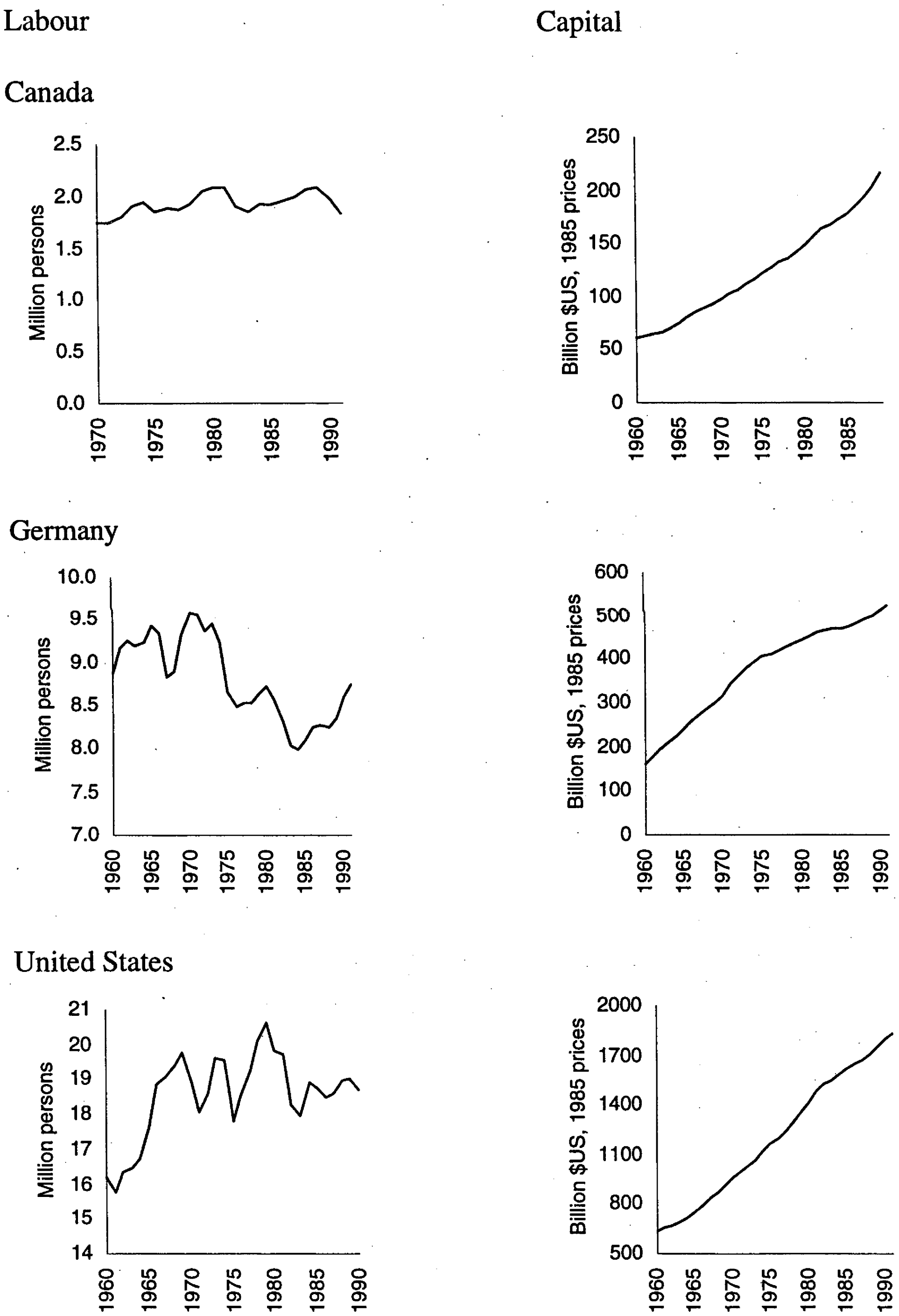
ISIC code	description
3	Manufacturing
31	Food, beverages and tobacco
32	Textiles
33	Wood and products
34	Paper, printing and publishing
35	Chemicals
36	Non-metallic minerals products
37	Basic metal products
38	Machinery and equipment
39	Other manufactured products

Source: United Nations of Industrial Development Organisation (UNIDO) in International Economics DataBank, Australian National University.

Output price indices are obtained as a GDP deflator at 1985 prices for each industry. Gross domestic product is expressed in market prices, except for Canada, where it is given at factor cost.

The value of capital stock available in this database is gross capital stock in 1985 prices and measured in US dollars. The return to capital is derived as the ratio of gross operating surplus to gross capital stock. The level of labour employment is measured as the number of employees. The wage rate is first calculated as the value of compensation of employees at current prices divided by the number of employees, then converted to a wage rate index in 1985 prices.

Figure 4.1 Changes in labour and capital over time



Source: The International Sectoral Database, 1993 at Statistics Directorate, OECD.

All the above data are available from 1970 to 1989 for Canada, from 1960 to 1987 for the United States, and from 1970 to 1990 for Germany.

Figure 4.1 shows changes in the level of labour and capital over time for total manufacturing for Canada, Germany and the United States. For all these economies, changes in the level of employment of labour fluctuate markedly, with increasing trends for Canada and the United States, and a decreasing trend for Germany. The changes in the level of capital all increase over time but fluctuate less than labour. There may be slight differences in changes in the employment of labour and capital at a disaggregated level, but they should show the same trends. Negative signs for labour adjustment coefficients are expected, with some positive and some negative signs for capital adjustment coefficients.

Empirical results

Given price changes over time, the labour and capital adjustment coefficients can be derived using the two-equation system in equation (4.8). An iterative, seemingly unrelated regression procedure is used for the estimations.

Two sets of hypotheses can be tested before the formal analysis. In the formulation suggested by Epstein (1981), if the coefficients, M11 and M22 are 1 or -1, and the rate of movement towards equilibrium of one quasi-fixed input does not rely on the adjustment rate of the other (i.e. M12=M21=0), complete and independent adjustment to the optimal point in capital and labour is made in a single period, and adjustment costs are minimal. If the hypothesis that M11 and M22 are equal to 1 or -1 is rejected, that would mean that, on average, only a fraction of equilibrium factor adjustment is made in a single period. If the independent adjustment hypothesis (M12=M21=0) is rejected, it means that the adjustment paths are not independent. In other words, after a change in output prices makes the original levels of labour and capital less than optimal, the movement of labour towards its new long-run equilibrium level is affected by the adjustment of capital stock (and vice versa).

Table 4.2 Quasi-fixity of inputs and dependent adjustment test

H0: No adjustment costs & independent adjustment	F Value		
	United States	Canada	Germany
Labour: (M11=-1 & M12=0)			
3	52.58	22.97	40.52
31	13.31	1.94	9.97
32	13.96	4.86	17.88
33	3.68	7.82	3.92
34	33.17	4.39	25.38
35	126.07	3.71	16.87
36	44.02	18.02	15.44
37	36.51	8.15	8.69
38	33.59	8.18	16.48
39	29.22	0.16	5.65
Capital (M22=-1 or 1 & M21=0)			
3	561.91	7.28	125.54
31	61.18	78.06	45.75
32	448.07	29.75	36.58
33	545.64	27.41	70.34
34	369.80	13.62	16.61
35	334.62	7.38	40.41
36	392.80	36.65	45.57
37	422.27	44.23	90.43
38	287.58	55.403	111.34
39	291.72	77.24	18.86
DF	2/21	2/13	2/14
1% critical value	5.78	6.70	6.51
5% critical value	3.47	3.81	3.74

Source: Author's calculation.

Table 4.2 shows that the hypothesis of no adjustment costs and independent adjustment is rejected for most industries for the three economies at both 1 per cent and 5 per cent significance levels. The high F-statistics in the tests of quasi-fixity of capital by itself and labour by itself and the joint test of the two quasi-fixed inputs point to the importance of accounting or dynamic adjustment costs in the analysis.

The adjustment coefficients (M) for labour and capital for each industry are calculated by applying the data constructed above to equation (4.8). As the model is written in the form of first differences, the Eigen values of the adjustment matrix provide a check on the stability of the adjustment process of capital and labour. Their absolute values, as calculated, are less than unity. Therefore the quasi-fixed demand system is stable. The results are shown in Table 4.3.

Table 4.3 Adjustment coefficients from dynamic adjustment analysis

Labour adjustment coefficients

Industry code	United States	t-ratio	Canada	t-ratio	Germany	t-ratio
3	-0.22334	-1.87	-0.27955	-2.64	-0.14225	-1.35
31	-0.37185	-3.12	-0.92302	-5.65	-0.17388	-1.12
32	-0.48328	-3.11	-0.62938	-4.58	-0.39492	-3.02
33	-0.59581	-3.36	-0.70465	-4.82	-0.50539	-3.41
34	-0.01501	-0.12	-0.88760	-5.91	-0.14964	-0.74
35	-0.16365	-0.96	-0.48179	-2.92	0.02063	0.15
36	-0.47410	-3.26	-1.01610	-6.19	-0.43351	-4.72
37	-0.58103	-5.44	-0.80051	-4.32	-0.36043	-2.24
38	-0.18442	-1.43	-0.63471	-3.64	-0.24313	-0.89
39	-0.63918	-2.93	-0.92067	-6.30	-0.34815	-1.77

Capital adjustment coefficients

Industry code	United States	t-ratio	Canada	t-ratio	Germany	t-ratio
3	0.04134	1.35	0.14425	0.76	-0.13384	-2.81
31	0.15610	2.31	0.17769	3.26	-0.28331	-4.43
32	0.09182	2.73	0.23681	2.66	-0.23446	-2.68
33	0.19997	8.68	-0.07629	-0.63	-0.17758	-3.01
34	0.03349	0.91	0.20821	1.58	0.09596	0.45
35	-0.01271	-0.15	-0.45260	-2.99	-0.16200	-2.06
36	0.06969	1.95	0.25669	2.58	-0.20479	-3.39
37	0.05745	1.74	-0.17589	-1.77	-0.27930	-5.86
38	-0.08525	-1.95	0.12723	1.66	-0.16233	-1.63
39	0.26153	3.90	0.10945	1.84	-0.07798	-0.53

Note: All the coefficients are significant at least at the 5 per cent level with the exception of the following: industries 34 and 35 in the United States and 34, 35, 38 in Germany for labour adjustment coefficients; industries 34 and 35 in the United States, 3 and 33 in Canada and 34 and 39 in Germany for capital adjustment coefficients.
Source: Author's calculation.

To interpret these adjustment coefficients, it is necessary to clarify that the sign and value of these adjustment coefficients are the indicators of the direction and magnitude of adjustment, respectively. For example, the labour adjustment coefficients of industry 32 for the United States is -0.48328 which means that, on average over the sample time period, 48 per cent of labour adjustment decisions are carried out annually in the US textile industry. In other words, after changes in price, the full adjustment for labour to the long-run equilibrium value takes on average about two years. Fractional adjustments in the labour and capital markets keep producers from making instantaneous adjustments (within one year) to long-run equilibrium.

Factor adjustment and intra-industry trade

After testing the adjustment coefficients, the next step is to examine how the adjustment coefficients vary across industries with respect to the extent of the level of intra-industry trade for these industries. This leads to a test of the central hypothesis of this chapter, namely the higher the level of intra-industry trade in an industry, the greater the intra-industry factor adjustment.

Model specification

There are several ways of looking at the relationship between labour and capital adjustment coefficients and the level of IIT across industries. One way, and possibly the most appropriate way under the circumstances, is to set up an econometric model to estimate the determinants of adjustment coefficients with IIT as one of the explanatory variables: a cross-industry and cross-country model in which

$$\begin{aligned} &\textit{Labour adjustment coefficients} = f(IIT, \cdots) \\ &\textit{Capital adjustment coefficients} = f(IIT, \cdots) \end{aligned} \tag{4.9}$$

There are many factors that can affect labour and capital adjustment. They include whether or not an industry is highly unionised; socio-economic variables like sex, race and age composition of an industry can also affect labour adjustment. However, this study is only concerned with industry-specific factors. Two major factors are considered here: specialisation (intra-industry trade or inter-industry trade specialisation) and structural change effects. The test equations are therefore written as:

$$\begin{aligned} &L = \alpha_0 + \alpha_1 IIT + \alpha_2 GIG + \mu_1 \\ &K = \beta_0 + \beta_1 IIT + \beta_2 GIG + \mu_2 \end{aligned} \tag{4.10}$$

Where L represents labour adjustment coefficients and K represents capital adjustment coefficients. IIT and GIG denote the variables of intra-industry trade level and industry structural change.

It is expected that, expressing adjustment coefficients in absolute values, there are negative signs to the coefficients of IIT and positive signs to the coefficients of GIG.

Data

In the labour and capital adjustment coefficients estimated above, there are 10 coefficients of one variable for each country. The intra-industry trade level for each industry is calculated by using the Grubel–Lloyd index at the 4-digit ISIC level, and average IIT indices are calculated for each industry over the period 1970 to 1990 using data from the ANU's International Economic DataBank. These are set out in Table 4.4. The structural change variable is constructed as the average change in the ratio of industry GDP over total GDP over 1970 to 1989. The estimated results are shown in Table 4.5. There are negative signs associated with almost all structural changes in these industries which means that, on average, from 1970 to 1989, these industries' share of total GDP declined. This was probably associated with a sharp increase in the output of the services industry in all three countries.

Estimation

The test of the hypothesis is conducted using an Ordinary Least Square (OLS) estimation. Cross-country and cross-industry data have been applied to the above-specified a group of test equations (4.10). Originally, there were 30 observations for estimations of labour and capital adjustment determinants. Due to insignificant factor adjustment coefficients and structural changes, 24 and 23 observations were applied in the final estimation for labour and capital adjustment, respectively.

In the regression analysis, several diagnostic tests were carried out in order to ascertain the reliability of the results.

Table 4.4 Intra-industry trade levels for the United States, Canada and Germany, 1970, 1980, 1990 and average (per cent)

Industry Code	70	80	90	average
United States				
3	62.32	63.01	68.45	64.59
31	44.33	55.86	57.26	52.48
32	50.44	52.71	38.05	47.07
33	54.62	69.30	70.07	64.66
34	74.48	77.62	80.20	77.43
35	63.83	55.81	69.62	63.09
36	70.42	64.62	71.11	68.72
37	76.44	69.10	61.17	68.90
38	63.28	65.16	73.14	67.19
39	51.16	67.26	37.04	51.82
Canada				
3	60.63	59.36	66.47	62.15
31	56.25	59.13	67.81	61.06
32	40.60	39.86	37.60	39.35
33	28.13	28.74	38.03	31.63
34	11.21	14.78	22.43	16.14
35	61.12	65.81	74.66	67.20
36	36.00	40.52	53.17	43.23
37	44.78	55.64	67.56	55.99
38	79.67	72.55	75.55	75.92
39	36.24	41.01	43.10	40.12
Germany				
3	59.38	65.39	72.09	65.62
31	48.62	70.09	79.12	65.94
32	79.85	71.69	71.08	74.21
33	53.66	64.43	76.46	64.85
34	47.24	59.48	64.08	56.93
35	64.26	67.26	74.90	68.81
36	73.14	84.87	85.58	81.20
37	69.88	77.62	86.67	78.06
38	51.93	59.19	68.22	59.78
39	77.70	69.77	80.91	76.13

Source: Author's calculation using UNIDO data at the International Economic DataBank, Australian National University.

Table 4.5 Average structural change for Canada, Germany and the United States, 1970–90 (per cent per year)

	Canada	Germany	United States
3	-0.2167	-0.4033	-0.3418
31	-0.0357	-0.0938	-0.0517
32	-0.0435	-0.0923	-0.0533
33	-0.0151	-0.0278	-0.0159
34	-0.0098	-0.0173	-0.0004
35	0.0111	-0.0383	-0.0053
36	-0.0157	-0.0473	-0.0154
37	-0.0275	-0.0709	-0.0677
38	-0.0694	-0.0134	-0.1255
39	-0.0110	-0.0020	-0.0064

Source: Author's calculation using data from the International Sectoral Databank, OECD.

This is, at this level of analysis, a cross-section analysis. One of the potential problems associated with cross-section analysis is hetroscedasticity, where the variances of the error term are not constant. In the presence of hetroscedasticity, the coefficients of a regression are still unbiased, but the estimation is no longer efficient. In this estimation, hetroscedasdicities for both cases are apparent. This problem is overcome by using White's hetroskedasticity-consistent covariance matrix estimation for unknown forms of heteroscedasticity. The results reported in Table 4.6 have been corrected for this problem.

As noted, this estimation is based on a very small sample. The use of OLS estimation is justified if several assumptions can be made. One assumption is that the error term must be normally distributed. In a large sample case, the central limit theorem ensures that estimators are asymptotically normal. But in a small sample case, normality can be violated. In this analysis the Jarque–Bera Asymptotic LM normality test has been applied in both cases. The results show that there are no violations to normality in either case.

Thirdly, a model specification test was applied to this estimation to ensure that there were no missing variables for the initial specified estimation models. The Ramsay misspecification test was applied and the results reveal that there were no misspecifications for this estimation.

The final regression results are presented in Table 4.6.

Table 4.6 Regression results

	L	K
IIT	0.008	-0.01
t-ratio	3.45*	-4.65*
GIG	-1.22	-0.08
t-ratio	-7.38*	-0.30
Constant	-1.08	0.63
t-ratio	-7.20*	5.14*
$\overline{R}^2$	0.50	0.29
No. of observations	24	23

Note: * significant at least at 1 per cent level.
Source: Author's estimation.

Interpretation of results

In Table 4.6, the extent of intra-industry trade specialisation has a positive and significant effect in explaining the labour adjustment coefficients. As all labour adjustment coefficients have negative signs originally, the result that intra-industry trade is associated with labour adjustment coefficients positively and significantly, can be expressed as follows: the higher the level of intra-industry trade for an industry the less the inter-industry labour adjustment. Alternatively, when faced with a price change over the relevant time period, profit-maximising firms (industries) will change their decision on labour use. In order to achieve long-run equilibrium, an industry has to reduce its labour force by a certain amount every year. Suppose over the time period concerned, an average of 1,000 employees have to be laid off. A negative adjustment coefficient merely says that on average a fraction of them are released from the industry each year. If the level of IIT and labour adjustment coefficients are positively associated across industries, higher levels of intra-industry trade for an industry are associated with a smaller fraction of labour released for that industry in each year.

The coefficient of the structural change variable is negatively and significantly related to the labour adjustment coefficients as expected. The interpretation of that coefficient is the same for intra-industry trade levels. The negative sign is due to the fact that all industries are shrinking over the time period in question. If an industry declines more sharply than others, the fraction of labour moving out of that industry is higher.

For the capital adjustment coefficients, while the coefficient of structural change variable is insignificant, the coefficient of IIT is negative and significant. As the capital adjustment coefficients are positive (some of them originally have negative signs, but in conducting the regression, an absolute value has been imposed on them), the interpretation will be exactly the same as for the labour adjustment coefficients. If an industry is more geared towards intra-industry trade specialisation than other industries, that industry's capital adjustment will be more intra-industry oriented. This seems a reasonable interpretation from an empirical point of view, but from the perspective of firms' actual operation, it is not that obvious. However, suppose a profit-maximising industry's decision is to accumulate a certain amount of capital stock over the time period concerned. If that industry has a high level of intra-industry trade specialisation, it will only need to raise a small fraction of the capital outside the industry and the bulk will be found within the industry. It may be the case that some firms within an industry simply re-employ some equipment or machinery shed by other firms within the industry. Obviously, there is also the possibility that some firms might buy capital goods produced by other firms within the industry.

In summary, if an industry is geared more towards intra-industry trade specialisation, when facing price changes, the factor adjustments are more intra-industry oriented and, it may be inferred, less costly.

Conclusion

The hypothesis that intra-industry factor adjustment is associated with industries with high levels of intra-industry trade was tested in this chapter. The test was carried out in three steps. First, the optimal solutions of factor demand and output supply were derived following the steps described in the previous chapter for the dynamic adjustment costs model when the function of production is assigned in a quadratic form. Secondly, using data obtained from the OECD's international sectoral database in the quasi-fixed input demand equations, adjustment coefficients were estimated at the subdivision level of ISIC manufacturing industries. Availability of data allowed this derivation to be employed for Canada, Germany and the United States. Thirdly, in explaining the determinants of labour and capital adjustment coefficients, two effects—a trade specialisation effect and a structural change effect—were specified in the empirical model. The results reveal strongly that if an industry has a high degree of intra-industry trade specialisation, the factor adjustments are more intra-industry oriented.

The central hypothesis of this dissertation is that in the face of trade liberalisation, the adjustment costs of factor relocation under intra-industry trade specialisation are less than those under inter-industry trade specialisation. The empirical evidence provided in this chapter provides initial support for this hypothesis. From the perspective of adjustment costs, intra-industry factor adjustment means that there are likely to be fewer costs associated with retraining and relocation of labour and that laid-off capital can be re-used more effectively. For example, workers displaced from internal labour markets tend to experience greater difficulty in finding alternative employment because of the importance of institutional and human capital factors in internal labour markets. Workers who are thrust upon external labour markets after a relatively long-term, stable employment relationship appear to have lower re-employment prospects, *ceteris paribus*, and may thus suffer greater economic losses (Gray 1996). The relative adjustment costs issue has only been addressed implicitly here. A more direct and comprehensive empirical analysis of the issue is presented in the next chapter.

5 Labour Adjustment Costs and Intra-industry Trade

Introduction

When there are price changes over time, firms re-adjust their capital and labour to produce long-run profit maximising output. In Chapter 4, it was also shown that if an industry has a high level of intra-industry trade, labour adjustment tends to take place more within that industry than is the case in other industries. But the central question remains unanswered: are the labour adjustment costs associated with intra-industry trade lower than those associated with inter-industry trade? The aim of this chapter is to answer this question.

There have been some attempts to resolve this issue.[1] But a problem common to previous studies is that relative adjustment costs under different trade patterns are examined indirectly. Moreover, labour economists hold different views about labour adjustment costs. For example, Kruse (1987) and Kletzer (1995) claim that trade-displaced workers may have more difficulty in making labour market adjustments, but the source of the difficulty is their own disadvantage, not the characteristics of the industry from which they have been displaced. Others (Kletzer 1992; Summer 1986; Houseman 1988; Grando 1983; and Jacobson 1993) recognise that industrial characteristics, such as the setting of efficiency wages of industries, affect on adjustment costs. For these reasons, the study of labour adjustment costs under inter-

[1] See Chapter 2 for a review of these studies.

versus intra-industry trade specialisation that follows not only examines adjustment costs under different trade patterns directly but also provides an assessment of sectoral effects on adjustment costs.

Approach of analysis

In theoretical terms (Chapter 2), there are several reasons why labour may take time to adjust to a price change. One is that wages may be flexible within sectors but, in the short run, changes take place independently across sectors. This can occur when there are constraints on occupational mobility between the sectors, or if the sectors are geographically concentrated and there are constraints on moving from one region to another. In this sort of segmented labour market, some sectors are insulated from a price shock in the short run, whereas wages in other sectors fall by the full amount of the price change. Workers therefore are laid off in affected sectors. Over time, the disparity in wages between sectors provides an incentive for labour to relocate until the wage differential is eliminated.

When international trade is liberalised, some industries expand and some contract in face of international competition. The costs arising from the adjustment process are a result of greater import penetration leading to a contraction in domestic production. Resources are displaced from domestic production and may become temporarily unemployed. The redeployment of resources is costly for those involved in terms of temporary loss of earnings, relocation, job search and retraining expenses.

The theoretical basis for the hypothesis of lower adjustment costs associated with intra-industry trade rests on the fact that under intra-industry trade specialisation, the labour market is less segmented both occupationally and geographically. To test this hypothesis empirically requires an approach that incorporates:

- a measure of intra-industry trade
- a measure of adjustment costs
- a model of the determinants of adjustment costs.

Intra-industry trade level can be measured using the Grubel–Lloyd index.[2] Measures of adjustment costs are proxies for the costs incurred by displaced workers including:

- Expected duration of unemployment

  Unemployment is always regarded as costly. There is both a private and a social cost. McTaggart, Findlay and Parkin (1992) argue that there are four main costs of unemployment. The most obvious costs are lost output and income that unemployed workers would have produced if they had been employed. A second cost is the permanent damage that can be done to an unemployed worker by hindering his or her career development and skill acquisition. A rise in the unemployment rate usually causes an increase in crime and social distress as people who cannot earn an income from legitimate work sometimes turn to crime or suffer social degradation. A final cost that is difficult to quantify is the loss of self-esteem that afflicts those who suffer prolonged periods of unemployment.

[2] See Chapter 4 for a discussion of the definition of, problems with and justification for the use of the index.

Duration of unemployment can be taken as a proxy of the measure of adjustment costs.

- Probability of re-employment in the same industry

Jacobson et al. (1993) argue that workers possessing skills that were especially suited to their old positions are likely to be less productive in subsequent jobs. The fit between workers' skills and the requirements of their old jobs could be the result of on-the-job investment in firm-specific human capital or costly searches resulting in particularly good matches with their old firms. The use of the probability of re-employment in the same industry as a measure of adjustment costs is based on this reasoning and the fact that re-employment in the same industry alleviates the need for displaced workers to undertake retraining with its attendant costs, and so the duration of unemployment may be shorter.

- Probability of loss of income

In theory, there are several reasons why displaced workers might experience loss of earnings beyond the period of unemployment following their job loss. Workers whose lost jobs paid wage premiums are likely to earn less if their subsequent jobs pay standard wages (Lewis 1986). It is also argued by Lazear (1981) that displaced workers' long-term earnings will be lower if, in their previous jobs, they accepted wages below their level of productivity in return for higher earnings later in their careers. Workers might have accepted such 'titled' tenure profiles in order to enhance their employers' incentives to invest in their human capital.

- Geographical movement

  If re-employment is subject to physical relocation of displaced workers, there are additional costs in the adjustment process. Although it can be argued that relocation expenses are often paid by employers to the re-employed, there are additional, unquantifiable costs to adjusting to life in a new environment.

One or all of these variables could be modelled empirically, including the level of intra-industry trade in the industry from which the worker was displaced as an explanatory variable.

Overview of data

The data used in this study—Current Population Survey, February 1996: Displaced worker, Job Tenure, and Occupational Mobility—are obtained from the United States Bureau of the Census. The data are microdata in which the unit of observation is individuals within housing units. The universe consists of all persons in the civilian non-institutional population of the United States living in households. The probability sample selected to represent the universe consists of approximately 48,000 households.

Data are provided on labour force activity for the week prior to the survey. Comprehensive data are available on the employment status, occupation, and industry of persons 14 years old and over. Displaced worker questions were asked of all persons aged 20 years or older who lost a job involuntarily within the last five years based on operating decisions of a firm, plant, or business in which the worker was employed. Job tenure and occupational mobility questions were asked of all employed persons 15 years and older. In consideration of geographical coverage, states, regions and divisions are identified in their entirety.

The file consists of 133,424 records. As the question is set out above, the group of individuals in which we are interested is displaced workers. After imposing some restrictions on the original data file (such as interview status, and that the type of person record is an adult civilian household member; and a person aged 20 and older), the new data file has 83,902 records, of whom 6,608 are displaced workers.

An examination of these displaced workers data reveals not only the pattern of displacement but also the adjustment costs incurred by displaced workers along the lines described in the previous section.

Industry and occupational patterns of displacement

The workers displaced in the early 1990s came from a wide range of industries and occupations. Herz (1991) looked at worker displacement during 1979–83 and 1985–89 and concluded that nearly 50 and 38 per cent, respectively, of displaced workers had lost factory jobs. But in the most recent period, they have been increasingly joined by workers displaced from the services sector and the wholesale and retail sectors. While the incidence of factory displacement declined (23 per cent of the total displaced), far more displacement continued to occur among factory workers than among workers in other major industry groups (see Table 5.1).

The most recent job losses are concentrated among the same group of manufacturing industries as was identified in Herz's work. Between 1993 and 1995, among the 3,830 displaced workers in the sample, 107 and 89 workers lost jobs in non-electrical and electrical machinery industries, respectively. Another 91 workers lost jobs in transportation equipment (including auto manufacturing). The non-durable goods industries account for the greatest numbers of displaced workers, including apparel with 72, printing and publishing with 80, and food processing with 64 (See Table 5.A1).

Reflecting the above industry patterns, 1,163 were displaced from technical, sales and administrative support occupations, 831 and 832 were operators, fabricators, and labourers, and managerial and professionals. Compared with Herz's earlier work, the proportion of workers displaced from managerial and professional occupations increased from 20 per cent to 21 per cent, and operators, fabricators and labourers decreased from 26 per cent to 21 per cent (see Table 5.6).

Table 5.1 Displaced workers by industry, 1993–95 (persons)

Industry	All displaced (persons)	Displaced due to plant closure or abolition of position (persons)
Agricultural wage and salary workers	57	57
Mining	44	44
Construction	429	429
Manufacturing	881	881
Durable goods	533	533
Non-durable goods	348	348
Transportation and public utilities	262	262
Wholesale and retail trade	954	954
Finance, insurance and real estate	153	153
Services	1050	1050
Professional services	958	958
Other service industries	92	92
Sub-total	3830	3830
Not in universe (-1)	2726	329
No response (-9)	52	52
Total	6608	4211

Source: *Current Population Survey, February 1996: Displaced Workers, Job Tenure, and Occupational Mobility*, United States Bureau of the Census, 1998.

Table 5.2 Geographical movements of displaced workers, 1993–95

Industry	All displaced	Moved to seek work		Moved and re-employed	
	(persons)	(persons)	(per cent)	(persons)	(per cent)
Agricultural wage and salary workers	57	4	7.0	2	50.0
Mining	44	6	13.6	4	66.7
Construction	429	33	7.7	28	84.8
Manufacturing	881	68	7.7	59	86.8
Durable goods	533	39	7.3	35	89.7
Nondurable goods	348	29	8.3	24	82.8
Transportation and public utilities	262	21	8.0	19	90.5
Wholesale and retail trade	954	72	7.5	64	88.9
Finance, insurance and real estate	153	11	7.2	11	100.0
Services	1050	108	10.3	101	93.5
Professional services	958	94	9.8	87	92.6
Other service industries	92	14	15.2	14	100.0
Sub-total	3830	323	8.4	288	89.2
Not in universe(-1)	329	0	0.0	0	0.0
No response(-9)	52	3	5.8	1	33.3
Total	4211	326	7.7	289	88.7

Note: Data refer to persons with tenure of 3 years or more who lost or left a job between January 1993 and 1995 because of plant closure or relocation, downturn in work, or the abolition of positions or shifts.
Source: See Table 5.1.

Table 5.3 Re-employment of displaced workers, 1993–95

Industry	All displaced	Re-employed		Re-employed in the same industry		Total unemployment duration	Average unemployment duration
	(persons)	(persons)	(per cent)	(persons)	(per cent)	(weeks)	(weeks)
Agricultural wage and salary workers	57	40	70.2	11	27.5	417	10.4
Mining	44	26	59.1	13	50.0	187	7.2
Construction	429	312	72.7	144	46.2	3021	9.7
Manufacturing	881	638	72.4	181	28.4	10131	15.9
Durable goods	533	402	75.4	111	27.6	6625	16.5
Non-durable goods	348	236	67.8	70	29.7	3506	14.9
Transportation and public utilities	262	189	72.1	80	42.3	2137	11.3
Wholesale and retail trade	954	716	75.1	295	41.2	7947	11.1
Finance, insurance and real estate	153	115	75.2	61	53.0	1403	12.2
Services	1050	797	75.9	350	43.9	9557	12.0
Professional services	958	733	76.5	328	44.7	8855	12.1
Other service industries	92	64	69.6	22	34.4	702	11.0
Sub-total	3830	2833	74.0	1135	40.1	34800	12.3
Not in universe (-1)	329	0	0.0	180		0	0.0
No response (-9)	52	14	26.9	7	50.0	311	22.2
Total	4211	2847	67.6	1322	46.4	35111	12.3

Note: Data refer to persons with tenure of 3 years or more who lost or left a job between January 1993 and 1995 because of plant closure or relocation, downturn in work, or the abolition of positions or shifts.
Source: See Table 5.1.

Table 5.4 Earning status of displaced workers, 1993–95

Industry	Earnings in lost job			Earnings in current job			Gain in earnings	
	displaced	total weekly income	average weekly income	re-employed	total weekly income	average weekly income		
	(persons)	(cents)	(dollars)	(persons)	(cents)	(dollars)	(persons)	(per cent)
Agricultural wage and salary workers	45	1470140	326.70	36	1400965	389.16	17	37.8
Mining	37	2356424	636.87	25	1355960	542.38	4	10.8
Construction	356	21238194	596.58	274	14672596	535.50	101	28.4
Manufacturing	765	39732694	519.38	588	27990964	476.04	216	28.2
Durable goods	462	26680246	577.49	359	18213186	507.33	128	27.7
Non-durable goods	303	13052448	430.77	229	9777778	426.98	88	29.0
Transportation and public utilities	220	12201018	554.59	180	9084157	504.68	67	30.5
Wholesale and retail trade	803	29052995	361.81	670	24796805	370.10	276	34.4
Finance, insurance and real estate	128	6280699	490.68	113	5185563	458.90	41	32.0
Services	912	43577352	477.82	734	33734398	459.60	307	33.7
Professional services	836	39255368	469.56	673	30090845	447.12	280	33.5
Other service industries	76	4321984	568.68	61	3643553	597.30	27	35.5
Sub-total	3266	155909516	477.37	2620	118221408	451.23	1029	31.5
Not in universe (-1)	0	0	0.00	0	0	0.00	0	
No response (-9)	8	301289	376.61	30	1198196	399.40	1	
Total	3274	156210805	477.13	2650	119419604	450.64	1030	

Note: Data refer to persons with tenure of 3 years or more who lost or left a job between January 1993 and 1995 because of plant closure or relocation, downturn in work, or the abolition of positions or shifts.
Source: See Table 5.1.

Table 5.5 Health insurance status of displaced workers, 1993–95

Industry	All displaced	Health insurance in lost job		Currently have health insurance		Re-employed and have health insurance		Had health insurance before and after	
	(persons)	(persons)	(per cent)	(persons)	(per cent)	(persons)	(per cent)	(persons)	(per cent)
Agricultural wage and salary workers	57	11	19.3	23	40.4	18	31.6	9	15.8
Mining	44	26	59.1	23	52.3	14	31.8	17	38.6
Construction	429	169	39.4	213	49.7	168	39.2	118	27.5
Manufacturing	881	582	66.1	562	63.8	442	50.2	417	47.3
Durable goods	533	372	69.8	344	64.5	281	52.7	258	48.4
Non-durable goods	348	210	60.3	218	62.6	161	46.3	159	45.7
Transportation and public utilities	262	148	56.5	188	71.8	147	56.1	121	46.2
Wholesale and retail trade	954	381	39.9	552	57.9	450	47.2	288	30.2
Finance, insurance and real estate	153	84	54.9	106	69.3	88	57.5	65	42.5
Services	1050	522	49.7	727	69.2	600	57.1	407	38.8
Professional services	958	459	47.9	655	68.4	547	57.1	353	36.8
Other service industries	92	63	68.5	72	78.3	53	57.6	54	58.7
Sub-total	3830	1923	50.2	2394	62.5	1927	50.3	1442	37.7
Not in universe (-1)	329	0	0.0	0	0.0	0	0.0	0	0.0
No response (-9)	52	14	26.9	12	23.1	9	17.3	10	19.2
Total	4211	1937	46.0	2406	57.1	1936	46.0	1452	34.5

Note: Data refer to persons with tenure of 3 years or more who lost or left a job between January 1993 and 1995 because of plant closure or relocation, downturn in work, or the abolition of positions or shifts.
Source: See Table 5.1.

Table 5.6 Displaced workers by occupation, 1993–95 (persons)

Occupation	All displaced	Re-employed in same occupation	
	(persons)	(persons)	(per cent)
Total	6608	1280	19
Managerial and professional specialty	832	299	36
Executive, administrative and managerial	441	134	30
Professional specialty	391	165	42
Technical, sales and administrative support	1163	288	25
Technicians and related support	106	40	38
Sales occupations	459	103	22
Administrative support, including clerical	598	145	24
Service occupations	381	108	28
Precision production, craft and repair	561	199	35
Mechanics and repairs	133	55	41
Construction trades	270	98	36
Other precision production, craft and repair	158	46	29
Operators, fabricators and labourers	831	186	22
Machine operators, assemblers and inspectors	388	81	21
Transportation and material moving occupations	210	68	32
Handlers, equipment cleaners, helpers and labourers	233	37	16
Farming, forestry and fishing	57	11	19
Armed forces	3	0	0
Sub-total	6383	1764	28
Not in Universe (1)	2726	182	
No response (-9)	54	7	

Note: Data refer to persons with tenure of 3 years or more who lost or left a job between January 1993 and 1995 because of plant closure or relocation, downturn in work, or the abolition of positions or shifts.
Source: See Table 5.1.

Re-employment

When surveyed in January 1996, 74 per cent of displaced workers held new jobs, somewhat higher than the proportion that was found in 1990 and 1988 (72 per cent), and well above the 60 per cent noted in the first survey in January 1984.

Increases in re-employment among displaced workers since the second half of the 1980s reflected overall improvement in national economic conditions. Herz (1991) argues that the timing of individual survey periods may affect the re-employment rate. Because of movements in the business cycle, a larger proportion of the displacements occurred lately in the surveyed period during the period when economy is slowing down than during the period when economy starts to boom. Thus, those displaced when economy is slowing down had less time, on average, before the survey date to find a job than did those displaced when economy starts to boom.

As in previous surveys, the January 1996 study showed that the likelihood of finding new jobs varied markedly by industry. For example, 72 per cent of displaced manufacturing employees were re-employed in January 1996, compared with 76 per cent of displaced services workers. Workers who lost jobs in durable goods manufacturing had a relatively higher re-employment rate—75.4 per cent, compared with non-durable goods manufacturing at 67.8 per cent. Similar patterns are apparent in the services industry: the professional services re-employment rate is 76.5 per cent but for other service industries, the re-employment rate is 69.6 per cent.

Changing industries

Many of the workers displaced between 1993 and 1995 who found new jobs no longer worked in the industries from which they had been displaced. The proportion re-employed in work similar to the jobs they had lost varied by industry. Half of the workers displaced from services, for example, were re-employed in new service industry jobs in January 1996. In contrast, only 28 per cent of displaced durable goods manufacturing workers found new jobs in the same sector.

Since the services industries were expanding throughout the 1993–95 period, a disproportionate share of workers who changed industries moved into services jobs. For example, of the 72 per cent of re-employed displaced manufacturing workers, one-third found new manufacturing jobs, and the remainder were spread among other industries

Re-employed displaced workers were more likely to change occupations than to change industries (see Table 5.6), in contrast to the result Herz obtained for the 1985–89 period.

Unemployment duration

Although for all industries, on average, there is a 74 per cent re-employment rate, in January 1996 the duration of unemployment for those re-employed varied. As shown in Table 5.3, the average unemployment duration (the sum of the number of weeks which had passed when the displaced took a new job in an industry divided by the persons of re-employed) varies across industries. Average unemployment duration for those displaced from the manufacturing industry is 15.9 weeks, which is higher than the average for all industries—12.3 weeks. Average unemployment duration before re-employment for those displaced from durable manufacturing is 16.5 weeks, slightly higher than that for those displaced from non-durable manufacturing—14.9 weeks.

Loss of earnings

While workers displaced between 1993 and 1995 had an easier time finding new jobs than did those displaced earlier in the decade, earnings patterns in the new jobs were quite similar to those noted in the earlier study periods. Table 5.4 shows the status of earnings of displaced workers between 1993 and 1995. Across industries, average weekly incomes in current jobs were almost all less than earnings in lost jobs (only workers displaced from agriculture, and wholesale and retail trade increased their average weekly income). In the mining sector almost 9 out of 10 suffered earnings losses and for manufacturing industry, 7 out of 10 suffered earnings losses. Even in the agricultural sector, 62 per cent of workers suffered earnings losses.[3]

Health insurance losses

As shown in Table 5.5, about 50 per cent of workers displaced between 1993 and 1995 were covered by some form of group health insurance in their lost jobs, down significantly from 74 per cent in January 1990 and 78 per cent in January 1984. About 1 in 4 of those who had previously been covered were no longer covered by any group plan at the time of the January 1996 survey.

As would be expected, the previously covered workers who were unemployed in January 1996 or who had left the labour force were most likely to be without health insurance. According to the survey data, about 40 per cent had no coverage compared

[3] It should be noted that such decreases are somewhat understated (and increases overstated), as the figures are not adjusted for inflation.

with the results of previous surveys. However, coverage among displaced workers in all employment status groups was up substantially. The fact that coverage increased, even for non-employed workers, suggests that they relied more heavily than in the past on the plans of their spouses or other family members. The substantial increase in the number of dual-earner families during the 1980s and 1990s makes such a scenario plausible.

Geographical movement

Some displaced workers moved to another city or county looking for work opportunities. Although the percentage is low relative to other indicators—8.4 per cent of all industries—there is variation across industries. The mining sector has the highest rate of geographical movement—13.6 per cent, followed by the service sector—10.3 per cent. For the manufacturing industry the rate is 7.7 per cent, slightly below the average for all industries. There is a large difference between professional services (9.8 per cent) and other services industries (15.2 per cent) and a small difference between durable (7.3 per cent) and non-durable (8.3 per cent) manufacturing. This may reflect the fact that professional services and durable manufacturing are often geographically concentrated and may more skill-specific. The prospect of finding a job in another place may be lower for this group of displaced workers.

The rate of re-employment for displaced workers who relocate is 89.2 per cent on average for all industries, while for agricultural and mining workers it is 50 and 66.7 per cent, respectively, well below all other industries.

To summarise, despite overall economic expansion, many workers continued to be displaced from long-held jobs during the early 1990s. However, the rate of post-displacement employment is high and increasing. But displaced workers who were re-employed in January 1996 were unlikely to be holding jobs with earnings comparable to those they had lost. A significant percentage of them changed industries and suffered a period of unemployment before finding a new job. And although increases in the number of dual-worker families and in the rate of re-employment led to an improvement in the incidence of health insurance coverage, many workers remained unprotected after losing their jobs. In order to find re-employment opportunities, some displaced workers relocated, but not all of them were successful.

Empirical estimation of adjustment costs and IIT

Model specification

The central hypothesis to be tested in this chapter is that across industries, the higher the level of IIT, the lower the adjustment costs. Following the analytical approach outlined in section 2, the following econometric model is proposed to test above hypothesis:

Adjustment costs variable $= f\,(IIT, \ldots)$ (5.1)

As this study focuses on the industry-specific effects on labour adjustment costs, in addition to the level of IIT, two other variables are included in the model as explanatory variables: an industry structural change variable (GIG) is proposed to capture the industries' growth effect and a dummy variable (DUM) is included to distinguish the effect on durable and non-durable manufactured goods. The final model can be specified as:

Adjustment costs variable $= f\,(IIT, GIG, DUM)$ (5.2)

Data

Given the industrial classifications used in the dataset, the empirical analysis is limited to the manufacturing industry, as international trade among other sectors is more limited.

The industry classification in this survey is different from the ISIC system. In order to link adjustment costs with IIT, a concordance is developed between the labour survey and industry data, as shown in Table 5.7.

Table 5.7 A concordance of industry classification between this survey and ISIC

Industry code	This survey Industry name	ISIC Industry code	Industry name
0	Manufacturing	300	Manufacturing
1	Lumber & wood prods, excl. furniture	331	Wood & cork prods excl. furniture
2	Furniture & fixtures	332	Furniture, fixture excl. prim. metal
3	Stone, clay, concrete, glass prods	361	Pottery, china, earthenware
		362	Glass & prods
		369	Other non-metal mineral prods
4	Primary metals	371	Iron and steel basic industries
		372	Non-ferrous metal basic industries
5	Fabricated metals	381	Fabricated metal products
	Not specified metal industries	n.a.	
6	Machinery, excl. electrical	382	Machinery excl. electrical
7	Electrical machinery, equip. supplies	383	Electrical machinery, appliance, & supplies
8	Motor vehicles & equip.	384	Transport equipment
	Aircraft & parts	384	Transport equipment
	Other transportation equipment	384	Transport equipment
9	Professional & photo equip., watches	385	Professional, scientific & measuring, controlling equip. n.e.c.
10	Toys, amusement & sporting goods	390	Other manufacturing industries
	Misc. & n.e.c. man. industries	390	Other manufacturing industries
11	Food & kindred prods	311	Food manufacturing
		312	Other food manufacturing
		313	Beverage industries
12	Tobacco prods	314	Tobacco manufactures
13	Textile mill prods	321	Manufacture of textiles
14	Apparel & other finished textile prods	322	Wearing apparel excl. footwear
15	Paper & allied products	341	Paper & products
16	Printing, publishing & allied inds	342	Printing, publishing & allied industries
17	Chemicals & allied prods	351	Industrial chemicals
		352	Other chemical prods
18	Petroleum & coal prods	353	Petroleum refineries
		354	Misc. prods of petroleum & coal
19	Rubber & misc plastic prods	355	Rubber products
		356	Plastic products n.e.c.
20	Leather & leather prods	323	Leather and prods excl footwear, apparel
		324	Footwear excl. rubber, plastic footwear

Notes: 1) n.a. means not available.
2) n.e.c. means not elsewhere classified.

Source: Author's construction.

Intra-industry trade levels are calculated as an average Grubel–Lloyd index over the years 1993 to 1995 for each manufacturing industry at the 4-digit level and are listed in Table 5.8.

Table 5.8 Intra-industry trade levels in manufacturing industries

Code	Industry	1993	1994	1995	Average
0	Manufacturing	70.24	70.09	71.32	70.55
1	Lumber & wood prods, excl. furniture	67.43	61.68	63.41	64.18
2	Furniture & fixtures	61.81	60.52	59.02	60.45
3	Stone, clay, concrete, glass prods	78.19	74.67	74.76	75.87
4	Primary metals	60.30	53.93	62.52	58.92
5	Fabricated metals	86.67	86.57	84.75	86.00
6	Machinery, excl. electrical	83.03	82.87	82.05	82.65
7	Electrical machinery, equip. supplies	81.06	80.06	79.33	80.15
8	Transport equipment	60.24	61.02	61.77	61.01
9	Professional & photo equip., watches	65.65	67.43	67.08	66.72
10	Other man. industries	33.11	32.84	33.93	33.29
11	Food & kindred prods	68.03	67.32	64.83	66.73
12	Tobacco prods	28.80	8.90	9.19	15.63
13	Textile mill prods	65.71	67.23	69.16	67.36
14	Apparel & other finished textile prods	26.33	27.63	29.64	27.87
15	Paper & allied products	77.11	80.09	79.46	78.89
16	Printing, publishing & allied inds	93.21	93.39	92.18	92.93
17	Chemicals & allied prods	84.33	84.00	84.94	84.43
18	Petroleum & coal prods	79.44	77.11	87.13	81.22
19	Rubber & misc. plastic prods	65.78	66.96	69.70	67.48
20	Leather & leather prods	45.12	39.30	36.81	40.41

Source: Author's calculation using ISIC trade data at International Economic DataBank, Australian National University.

The industry structural change variable is constructed as an average of the change of share of industry GDP in total GDP, and is listed in Table 5.9.

Table 5.9 Industry structure change in manufacturing industries

Code	Industry	1993–92	1994–93	1995–94	Average
0	Manufacturing	-0.666	0.254	0.739	0.109
1	Lumber & wood prods, excl. furniture	0.086	0.042	-0.008	0.040
2	Furniture & fixtures	0.019	0.002	-0.005	0.005
3	Stone, clay, concrete, glass prods	-0.007	0.032	-0.012	0.004
4	Primary metals	-0.059	0.129	0.023	0.031
5	Fabricated metals	-0.007	0.052	0.048	0.031
6	Machinery, excl. electrical	0.066	0.306	0.559	0.310
7	Electrical machinery, equip. supplies	0.075	0.129	0.448	0.217
8	Transport equipment	-0.058	0.206	-0.249	-0.034
9	Professional & photo equip., watches	-0.079	-0.098	0.005	-0.057
10	Other man. industries	0.011	-0.013	0.006	0.001
11	Food & kindred prods	-0.092	-0.280	0.003	-0.123
12	Tobacco prods	-0.139	-0.002	0.008	-0.045
13	Textile mill prods	-0.008	-0.002	-0.038	-0.016
14	Apparel & other finished textile prods	-0.027	-0.027	-0.051	-0.035
15	Paper & allied products	-0.107	0.032	-0.016	-0.030
16	Printing, publishing & allied inds	-0.038	-0.112	-0.044	-0.065
17	Chemicals & allied prods	-0.123	-0.016	0.053	-0.029
18	Petroleum & coal prods	-0.217	-0.161	-0.013	-0.130
19	Rubber & misc. plastic prods	0.045	0.052	0.033	0.043
20	Leather & leather prods	-0.004	-0.016	-0.011	-0.010

Source: Author's calculation using data of UNIDO and World Bank, World Tables, in International Economic DataBank, Australian National University.

As discussed above, measures of adjustment costs are proxies of the costs incurred by displaced workers including:

- Expected duration of unemployment;
- Probability of re-employment in the same industry;
- Probability of loss of income; and
- Geographical movements.

Not all the above measures are readily available. However, we can construct measures to capture these indicators.

Although this survey provides some information on unemployment duration, such as the year unemployment commenced, whether re-employment had occurred at the time of the survey, and number of weeks before re-employment, it is still not possible to determine the duration of unemployment for persons who remain unemployed. Two measures are used to overcome this problem.

The probability of continuing unemployment (cost 1). This measure can be constructed as 1 minus the probability of re-employment. The higher the probability of continuing unemployment, the higher the adjustment costs.

Unemployment duration for the re-employed (cost 2). This measure is constructed as average unemployment duration. The longer the average unemployment duration, the higher the adjustment costs.

Probability of re-employment in the same industry (cost 3) is a very straightforward measure which can be constructed as the percentage of persons of re-employed within the same industry over that of the total re-employed. The higher the percentage of re-employment within the same industry, the lower the adjustment costs.

For loss of income, a very direct measure is earnings. As the survey also provides information about health insurance, we can use the following measures:

Probability of loss of earnings (cost 4). This measure is constructed as the percentage of the re-employed whose current earnings are less than their earnings in the jobs they lost.

Probability of loss of health insurance (cost 5). This measure is constructed as the percentage of persons who do not now have health insurance, but who were covered in the job they lost. The bigger the percentage, the larger the adjustment cost.

Probability of incurring relocation costs in re-employment (cost 6). The survey asks questions related to the geographical movements of displaced worker (Since that job ended, have you moved to a different city or county? Was the reason for the move—to look for work or to take a different job?). From this information, it is easy to calculate the percentage of displaced workers who moved in order to look for work or to take a different job. The higher the percentage of people who moved for work, the greater the associated adjustment costs.

These six measures covering four dimensions of adjustment cost are summarised in Table 5.10.

Table 5.10 Adjustment costs for manufacturing, 1993–95

		cost 1	cost 2	cost 3	cost 4	cost 5	cost 6
0	Manufacturing	72.42	11.50	28.4	71.76	28.35	7.72
1	Lumber & wood prods, excl. furniture	77.14	4.83	33.3	73.33	33.33	2.86
2	Furniture & fixtures	74.07	4.67	40.0	56.00	44.44	0.00
3	Stone, clay, concrete, glass prods	68.97	9.14	25.0	74.07	45.00	3.45
4	Primary metals	67.74	14.52	42.9	80.77	33.33	12.90
5	Fabricated metals	80.70	18.28	17.4	75.00	30.95	1.75
6	Machinery, excl. electrical	80.37	13.18	23.3	70.97	25.64	8.41
7	Electrical machinery, equip. supplies	75.28	15.24	34.3	62.67	29.69	6.74
8	Transportation equipment	73.63	12.68	28.4	81.82	27.85	10.99
9	Professional & photo equip., watches	75.86	9.66	22.7	73.08	33.33	10.34
10	Other manufacturing industries	68.42	9.82	19.2	74.19	30.00	10.53
11	Food & kindred prods	65.63	10.55	28.6	64.15	17.14	9.38
12	Tobacco prods	100.00	77.00	0.0	100.00	0.00	0.00
13	Textile mill prods	56.00	4.72	28.6	77.27	46.15	8.00
14	Apparel & other finished textile prods	63.89	9.82	41.3	67.21	36.11	4.17
15	Paper & allied products	60.71	11.36	23.5	77.27	10.00	14.29
16	Printing, publishing & allied inds	73.75	10.00	37.3	70.27	20.83	10.00
17	Chemicals & allied prods	75.00	8.33	22.2	76.67	17.24	8.33
18	Petroleum & coal prods	100.00	1.00	0.0	0.00	0.00	0.00
19	Rubber & misc. plastic prods	65.63	9.00	4.8	74.19	33.33	9.38
20	Leather & leather prods	88.89	24.67	25.0	87.50	33.33	0.00

Source: Author's calculation based on the survey data in US Bureau of Census, 'February 1996 Displaced Worker, Job Tenure, and Occupational Mobility Supplement'.

An overall measure of adjustment costs should include all these dimensions. As these indicators are expressed in different terms (for example, probability of loss of health insurance is in percentage form, and average unemployment duration is in weeks), it is difficult to compare measures. Moreover, although it may be possible to express all these measures in uniform terms, it is still very difficult to find an accurate weighting for these measures, and hence an overall measure of adjustment costs. This is an area for future work on labour adjustment costs.

There were 20 original observations. Due to unreliable adjustment cost indicators for industries 12 and 18, 18 observations are available for regression.

Estimation

To test the model specified above, an Ordinary Least Square (OLS) estimation has been applied to the six adjustment cost indicators.[4] In order to obtain a reliable estimation, the following diagnostic tests were conducted and the final regression results are summarised in Table 5.11.

In the application of an Ordinary Least Square regression, it is generally assumed for hypothesis testing that the residuals follow a normal distribution. In large samples, the central limit theorem ensures that estimators are asymptotically normal, but small samples do not possess such a characteristic. Therefore, a normality test must be implemented first to ensure the validity of the OLS being applied to this small sample

[4] As most of the adjustment costs indicators are zero or 1 variables, the least squares method is also called the linear probability model.

case. The Jarque–Bera LM test is often used to test for departures from normality (Greene 1993). This test is used to conduct the normality test in this analysis. Failure does not indicate cause of action, but it can often be explained in practice by the presence of outliers. In this exercise, I use the LM test to test for outliers until normality is ensured. (That is why we start with the uniform 18 observations, but end up with different observations for all the cases.)

Several explanatory variables are proposed in the estimation: the IIT levels, the structural change variable and the dummy variable for durable goods. Which of these variables should be included in or omitted from the final regression is determined by a statistical test. Ramsay's RESET test is used to test for misspecification of functional forms (an omitted variables test in practice). The conventional method of examining the t-ratios and $\overline{R}^2$ is used to determine the omission of a particular variable.

For cross-sectional data, we have to be very careful about the problem of hetroscedasticity. Though the estimated coefficients are unbiased, the efficiency of the estimators will be very much affected. A number of tests have been used to detect this problem. With the presence of heteroscedasticity in some cases, White's (1980) heteroscedastic-consistent covariance matrix estimation is used to correct the estimators for an unknown form of heteroscedasticity. The results presented in Table 5.11 are corrected for this problem.

Table 5.11 Regression results for adjustment costs and IIT

	Indicator 1 cost 1	Indicator 2 cost 2	Indicator 3 cost 3	Indicator 4 cost 4	Indicator 5 cost 5	Indicator 6 cost 6
IIT	0.157**	-0.174	0.131	-0.175*	-0.220**	-0.095**
t-ratio	2.712	-1.696	1.721	-1.971	-3.118	-2.351
GIG	8.937	12.592**				
t-ratio	1.211	2.207				
DUM	7.344**				5.040	-2.775*
t-ratio	3.072				1.428	-1.888
Constant	55.905**	28.844**	18.068**	86.504**	41.535**	16.730**
t-ratio	12.944	3.835	3.793	13.779	8.973	5.420
R-square	0.533	0.236	0.174	0.206	0.272	0.230
R-square adjusted	0.433	0.108	0.105	0.153	0.175	0.111
No. of obs.	18	15	14	17	18	16

Notes: 1) Cost 1: re-employment rate; Cost 2: average unemployment duration for re-employed; Cost 3: Probability of re-employment in the same industry; Cost 4: probability of loss of earnings; Cost 5: probability of loss of health insurance; Cost 6: probability of moving for re-employment.
2) * Significant at 10 per cent of critical value.
3) ** Significant at least at 5 per cent of critical value.

Source: Author's estimation.

Interpretation of results

The final regression results are as shown in Table 5.11. Although there are three possible explanatory variables, not all of them are included in the final regression in consideration of model specifications. The main objective in this chapter is to look at the relationship between adjustment costs indicators and the level of IIT across manufacturing industries in the United States. As expected, the six indicators of adjustment costs all have the correct sign with respect to the level of IIT, with some more significant than the others.

The first indicator of adjustment costs is the re-employment rate for displaced workers. The coefficient of IIT is positive and significant at the 2 per cent level. This result implies that, across US manufacturing industries, the higher the level of IIT for that industry, the higher the possibility of re-employment after displacement. In other words, the higher the level of IIT in an industry, the lower the possibility of no re-employment and therefore the lower the adjustment costs for displaced workers in that industry.

Indicator 2 measures the average unemployment duration for the re-employed. The coefficient of IIT is negative and significant at only the 12 per cent level. A direct interpretation of this is that the higher the level of IIT, the shorter the average unemployment duration for the re-employed for that industry. There could be many possible reasons for this, including the possibility that IIT is less occupationally or geographically segmented, so that workers displaced from an industry with higher IIT levels may find re-employment opportunities more quickly and adjustment costs would be smaller.

Indicator 3 in Table 5.11 is the probability of re-employment within the same industry for those re-employed. The coefficient of IIT is positive and significant at the 9 per cent level. This means that if the IIT level of that industry is higher, then for those re-employed displaced workers, the possibility of re-employment within the same industry is higher. The implication of this result is that if displaced workers are re-employed within the same industry, they may need less retraining and may be re-employed sooner, and adjustment costs are lower.

Indicator 4 in Table 5.11 is the probability of loss of earnings for displaced workers which is an income-related indicator. The coefficient of IIT in this case is negative and significant at the 7 per cent level. This implies that the higher the level of IIT in an industry the lower the probability of loss of earnings. In regard to adjustment costs, there are two findings: displaced workers have yet to be re-employed at the time of the survey, they suffer an absolute loss of earnings; and some of the re-employed receive lower wages than before, and they suffer a relative loss of earnings. The negative relationship between IIT and the probability of loss of earnings reveals that firstly, the higher the level of IIT in an industry, the higher the rate of re-employment and therefore the lower the probability of suffering an absolute loss of earnings. Secondly, the higher the level of IIT in an industry, the lower the probability of suffering a relative loss of earings following re-employment.

Another aspect of loss of income is measured as indicator 5—the probability of loss of health insurance. The coefficient of IIT is negative and significant at the 1 per cent level. As the measure of the probability of loss of health insurance is constructed as the percentage of persons who had health insurance in their lost job but do not have health insurance in their current job, the negative relationship between the level of IIT and the probability of loss of health insurance directly indicates that if an industry has a relatively high level of IIT, displaced workers will have a lower likelihood of sacrificing their health insurance in seeking re-employment.

Indicator 6 describes the geographical movements of displaced workers. Although the actual percentage of persons who relocated to seek work is low compared with other indicators, the overall trend across industries reveals that there is a negative relationship between the level of IIT and the probability of geographical movement. It was argued earlier that in theory, IIT is more geographically concentrated than inter-industry trade. If workers are displaced from an industry with a relatively high level of IIT, they may expect there to be more opportunities for re-employment if they stay where they are rather than moving to another city or county. However, it is demonstrated in the case of indicator 3 that there is a positive relationship between the level of IIT and the probability of re-employment within the same industry. A geographical perspective may also provide support for the above result in the sense that, when workers are displaced from an industry with a high level of IIT and that industry is geographically more concentrated, the probability of re-employment within that same industry is high.

As well as the main points outlined above, there are some other interesting relationships between the adjustment cost variables and some of the other explanatory variables in the regressions. One of the variables is structural change, which measures the average change of share of industry GDP in total GDP. The positive coefficient for the re-employment rate for those displaced (but only significant at 75 per cent confidence intervals) can be explained by the fact that when an industry's share of GDP is larger, there is a better chance for the workers originally displaced from that industry to be re-employed. Another example is the explanation of the structural change effect on the average unemployment duration for re-employed workers, where a positive coefficient would mean that the larger the increase of an industry's GDP share in total GDP, the longer the unemployment duration for those re-employed. This seems to contradict the generally accepted observation that if an industry is expanding, then the displaced should be quickly re-absorbed. In fact, in 1993–95, while the re-employment rate was high, the unemployment duration for those re-employed was longer when the industry from which the workers were originally displaced was expanding. This may be explained intuitively as follows. The reasons for workers' displacment from an industry in this study are plant or company closure or relocation; a plant or company may have continued to operate but workers lost or left jobs because of a downturn in work or the abolition of positions or shifts. But during that time, if an industry was expanding relative to other industries, it could have been the case that while some plants or companies closed or some positions were abolished, other plants or companies or positions may have been established. For re-employed displaced workers who took steps such as training to meet requirements for new jobs, unemployment duration is simply the time gap between the closure of one plant and the establishment of another.

Another explanatory variable is a dummy variable to distinguish between durable and non-durable goods. The inclusion of this variable is justified in the cases of costs 1, 5 and 6. Workers displaced from durable manufacturing tend to have a high re-employment rate with a high probability of loss of health insurance. Displaced workers in non-durable manufacturing have a high propensity to move to another place to seek re-employment opportunities. This is because the workers displaced from durable manufacturing may have skills which are more industry-specific, and the prospects for re-employment as a result of moving to another place tend to be small.

In summary, the hypothesis that the adjustment costs of intra-industry trade are lower than those of inter-industry trade is supported empirically by adjustment cost indicators in relation to IIT levels: they are positive and significant in relation to re-employment rates and the probability of re-employment in the same industry and they are negative and significant in relation to average unemployment duration, probability of loss of earnings and health insurance, and probability of moving for re-employment.

Alternative method: logit model

In the last section, adjustment cost indicators for each industry are first calculated, then the hypothesis that adjustment costs of displaced workers are lower when the industry from which they were originally displaced has a higher degree of intra-industry trade specialisation than others is tested using an OLS estimation. The empirical results strongly support this hypothesis. But the small number of observations used in the test may lead to doubts about the strength of the hypothesis testing. Given the nature of each adjustment cost indicator,[5] we can also apply the logit model to test the hypothesis.[6]

To conduct logit analysis I propose the following explanatory variables.

The first and most central variable is the level of intra-industry trade. As discussed in the section on the analytical framework, there are many aspects of intra-industry trade to be considered in explaining adjustment costs. Intra-industry trade is positively associated with the re-employment rate, and the rate for re-employment within the same industry, and negatively associated with the loss of health insurance and the loss of earnings, and costs arising from moving for work and unemployment duration.

[5] Most of the adjustment cost indicators specified above are in the nature of dichotomous variables. For instance: $Y = \begin{cases} 1 & \textit{when a person is re-employed} \\ 0 & \textit{otherwise} \end{cases}$

[6] In this case, the number of observations corresponds to individuals.

Apart from this industry-specific factor,[7] some individual characteristics that affect labour adjustment costs are included in the estimation. Age is one factor that reduces a worker's mobility. Older workers generally find it harder to get a new job in another industry. This is because their capability for learning new skills is more limited, and they also have to put up with a loss in pay, seniority and job satisfaction. Older workers may, therefore, lack both the ability and the inclination to seek re-employment in another industry (Cheh 1974). This argument has been supported empircally by Haber, Ferman and Hudson (1963) and Lipsky (1967).

Gender is another factor that may affect labour adjustment costs. It is argued that the impact of displacement fell most severely on females in 1974. This was probably because of the concentration of women in semi-skilled and unskilled jobs. Marriage can also deter women from relocating or travelling to areas enjoying employment expansion (Bureau of Industry Economics, 1983). Crossley et al. (1994) also provide evidence of gender differences in displacement costs.

Lack of skills may also inhibit the re-employment of displaced workers. If import-competing industries are less skill-intensive than export industries, and the former contract while the latter expand, there may be short-term labour adjustment costs for unskilled labour employed in import-competing industries (Cheh 1974).

[7] The inclusion of structural change as an explanatory variable is not justified in most cases of OLS estimation.

Finally, union membership is clearly important in determining the extent of labour adjustment costs. Unions can provide members with protection especially when they have strong bargaining power.

We therefore specify the following variables for each industry to proxy:

Dependent variable:

$$\text{Adjustment cost 1: } \begin{cases} 1 & \textit{When a person is re-employed} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\text{Adjustment cost 2: } \begin{cases} 1 & \textit{When a person is re-employed in the same industry} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\text{Adjustment cost 3: } \begin{cases} 1 & \textit{When there is no earning loss} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\text{Adjustment cost 4: } \begin{cases} 1 & \textit{When there is no health insurance loss} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\text{Adjustment cost 5: } \begin{cases} 1 & \textit{When a person moves to seek work} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\text{Adjustment cost 6: } \begin{cases} 1 & \textit{When unemployment duration is above average} \\ 0 & \textit{Otherwise} \end{cases}$$

Independent variables:

IIT: Intra-industry trade levels, which are calculated using the Grubel–Lloyd index, are shown in Table 5.8.

Age: A series of numbers which are the actual ages of people in the sample.

$$\text{Sex dummies} \begin{cases} 1 & \textit{Male} \\ 0 & \textit{Female} \end{cases}$$

$$\text{Union membership } \begin{cases} 1 & \textit{Union member} \\ 0 & \textit{Otherwise} \end{cases}$$

Education level: a series of initial code numbers from the survey which is used to estimate the skill level of displaced workers in the jobs they lost. The higher the number, the higher the skill levels.

The regression results by applying the logit model are summarised in Table 5.12.[8]

By applying a logit model, we get the same relationship between adjustment cost indicators and IIT levels (or dummies) as in the OLS regression analysis: intra-industry trade levels (or dummies) are positively associated with the re-employment rate and the rate for re-employment within the same industry, and negatively associated with loss of health insurance, loss of earnings, cost of moving for work and unemployment duration. Only the earnings loss indicator is insignificant.

For some other explanatory variables:

Age: The older the worker, the more difficult it is to gain re-employment; the older the worker, the more likely he or she is to suffer earning losses in re-employment; the older the worker, the less likely to have health insurance loss when taking a new job; the older the worker, the shorter the duration of unemployment for the re-employed who are advantaged by cumulative working experience; the older the worker, the less likely to move to another place to seek re-employment.

[8] In the case when the dependent variable is re-employment, intra-industry trade dummies are used instead of levels of intra-industry trade after the failure of the use of IIT levels. Educational levels are omitted from the estimation, as there is a high statistical collinearity between IIT and educational levels (0.98) in this case.

Table 5.12 Regression results from logit model estimation

	Constant	IIT	Age	Sex	Union	Education
Re-employment	1.570	0.301[a]	-0.025	0.535	-0.313	
T-ratio	5.214**	1.965**	-3.778**	3.423**	-1.609	
Same industry re-employment	0.354	0.012	-0.007	0.424	0.475	-0.570
T-ratio	0.188	1.743*	-0.711	1.898*	1.704*	-1.193
Earning loss	0.156	-0.003	-0.036	0.121	-0.531	0.038
T-ratio	0.094	-0.465	-3.906**	0.602	-2.111**	0.903
Health insurance loss	-13.751	0.009	0.038	0.276	1.379	0.281
T-ratio	-9.728**	2.078**	5.623**	1.771*	6.670**	8.804**
Unemployment duration	0.457	-0.301	-0.018	0.259	-0.447	0.015
T-ratio	0.327	-1.808*	-2.365**	1.526	-2.036**	0.427
Moving for work	-7.650	-0.464	-0.035	0.209	-0.073	0.166
T-ratio	-2.985**	-1.678*	-2.666**	0.714	-0.189	2.560**

T value: 10% significance level—1.645; 5% significance level—1.960.

Notes: 1) * significant at 10 per cent significance level.
2) ** significant at least at 5 per cent significance level.
3) [a] intra-industry trade dummies are used: IITD equals to 1 when the level of an industry's intra-industry trade is above average, 0 otherwise.

Source: Author's calculation.

Sex: Males tend to have an advantage in securing re-employment; males tend to be more likely to be re-employed within the same industry; they tend to have fewer health insurance losses; but males' unemployment duration is longer than females'.

Union: Union membership helps displaced workers find re-employment within the same industry, there are no health insurance losses and duration of unemployment is shorter, but there are earning losses from re-employment.

Education: Education levels are used here to represent the skill levels of displaced workers. The higher the level of skills, the more likely to be re-employed; the higher the level of skills, the less likely to be re-employed within the same industry (not significant); the higher the level of skills, the less likely to have health insurance losses; the higher the level of skills, the more likely to move to another place to seek re-employment.

Conclusion

Using data from the US 'Current Population Survey, February 1996: Displaced Worker, Job Tenure, and Occupational Mobility', this chapter tested the central hypothesis that adjustment costs for labour associated with an industry with a high degree of intra-industry trade specialisation are lower than those in an industry with an inter-industry trade specialisation.

To test this hypothesis a linear probability model (OLS estimation) is applied. The results from this test support the hypothesis strongly: the six adjustment costs all have a negative and significant relationship with the level of intra-industry trade across industries. In consideration of the small number of observations used in the above test, an alternative model—a logit model—was also applied. The inclusion of some socio-economic variables including sex, age and educational level, statistically affected the significance of the level of IIT in explaining labour adjustment costs. But five of the six adjustment cost indicators have expected and significant coefficients of IIT, which supports the hypothesis that there are lower labour adjustment costs associated with an industry with a high degree of intra-industry trade specialisation. At the same time, these results indicate that industry-specific factors in terms of trade specialisation do have an effect on labour adjustment costs.

Labour adjustment costs here are measured in terms of several adjustment cost indicators. An overall measure of labour adjustment costs is not constructed due to the availability of information. Constructing an overall measure and test of labour adjustment costs under different trade patterns would offer an overall assessment of the argument that adjustment costs under intra-industry trade are lower than those under inter-industry trade.

Appendix

Table 5.A1 Displaced workers by manufacturing industries, 1993–95

Industry	All displaced (persons)	Displaced due to plant closed or position abolished (persons)
Manufacturing	881	881
Durable goods	533	533
Lumber & wood prods, excl. furniture	35	35
Furniture & fixtures	27	27
Stone, clay, concrete, glass prods	29	29
Primary metals	31	31
Fabricated metals	57	57
Machinery, excl. electrical	107	107
Electrical machinery, equip. supplies	89	89
Transportation equipment	91	91
Motor vehicles & equip.	25	25
Aircraft & parts	29	29
Other transportation equipment	37	37
Professional & photo equip., watches	29	29
Other manufacturing industries	38	38
Toys, amusement & sporting goods	7	7
Misc. & n.e.c. mfg industries	31	31
Non-durable goods	348	348
Food & kindred prods	64	64
Tobacco prods	1	1
Textile mill prods	25	25
Apparel & other finished textile prods	72	72
Paper & allied products	28	28
Printing, publishing & allied inds	80	80
Chemicals & allied prods	36	36
Petroleum & coal prods	1	1
Rubber & misc. plastic prods	32	32
Leather & leather prods	9	9
Subtotal	3830	3830
Not in universe (-1)	2726	329
No response (-9)	52	52
Total	6608	4211

Source: See Table 5.1.

Table 5.A2 Geographical movements of displaced manufacturing workers, 1993–95

Industry	Total displaced (persons)	Moved to seek work (persons)	(per cent)	Moved and re-employed (persons)	(per cent)
Manufacturing	881	68	7.72	59	86.8
Durable goods	533	39	7.32	35	89.7
Lumber & wood prods, excl. furniture	35	1	2.86	1	100.0
Furniture & fixtures	27	0	0.00	0	
Stone, clay, concrete, glass prods	29	1	3.45	0	0.0
Primary metals	31	4	12.90	3	75.0
Fabricated metals	57	1	1.75	1	100.0
Machinery, excl. electrical	107	9	8.41	8	88.9
Electrical machinery, equip. supplies	89	6	6.74	6	100.0
Transportation equipment	91	10	10.99	10	100.0
Motor vehicles & equip.	25	4	16.00	4	100.0
Aircraft & parts	29	1	3.45	1	100.0
Other transportation equipment	37	5	13.51	5	100.0
Professional & photo equip., watches	29	3	10.34	3	100.0
Other manufacturing industries	38	4	10.53	3	75.0
Toys, amusement & sporting goods	7	0	0.00	0	
Misc. & n.e.c. mfg industries	31	4	12.90	3	75.0
Non-durable goods	348	29	8.33	24	82.8
Food & kindred prods	64	6	9.38	4	66.7
Tabacco prods	1	0	0.00	0	
Textile mill prods	25	2	8.00	1	50.0
Apparel & other finished textile prd.	72	3	4.17	2	66.7
Paper & allied products	28	4	14.29	3	75.0
Printing, publishing & allied inds	80	8	10.00	8	100.0
Chemicals & allied prods	36	3	8.33	3	100.0
Petroleum & coal prods	1	0	0.00	0	
Rubber & misc. plastic prods	32	3	9.38	3	100.0
Leather & leather prods	9	0	0.00	0	
Subtotal	3830	323	8.43	288	89.2
Not in universe (-1)	329	0	0.00	0	
No response (-9)	52	3	5.77	1	33.3
Total	4211	326	7.74	289	88.7

Source: See Table 5.1.

Table 5.A3 Re-employment of displaced manufacturing workers, 1993–95

Industry	All displaced	Re-employed		Re-employed in same industry		Total unemployment duration	Average unemployment duration
	(persons)	(persons)	(per cent)	(persons)	(per cent)	(weeks)	(weeks)
Manufacturing	881	638	72.42	181	28.4	10131	15.9
Durable goods	533	402	75.42	111	27.6	6625	16.5
Lumber & wood prods, excl. furniture	35	27	77.14	9	33.3	169	6.3
Furniture & fixtures	27	20	74.07	8	40.0	126	6.3
Stone, clay, concrete, glass prods	29	20	68.97	5	25.0	265	13.3
Primary metals	31	21	67.74	9	42.9	450	21.4
Fabricated metals	57	46	80.70	8	17.4	1042	22.7
Machinery, excl. electrical	107	86	80.37	20	23.3	1410	16.4
Electrical machinery, equip. supplies	89	67	75.28	23	34.3	1356	20.2
Transportation equipment	91	67	73.63	19	28.4	1154	17.2
Motor vehicles & equip.	25	21	84.00	7	33.3	207	9.9
Aircraft & parts	29	24	82.76	4	16.7	684	28.5
Other transportation equipment	37	22	59.46	8	36.4	263	12.0
Professional & photo equip., watches	29	22	75.86	5	22.7	280	12.7
Other manufacturing industries	38	26	68.42	5	19.2	373	14.3
Toys, amusement & sporting goods	7	5	71.43	1	20.0	47	9.4
Misc. & n.e.c. mfg industries	31	21	67.74	4	19.0	326	15.5
Non-durable goods	348	236	67.82	70	29.7	3506	14.9
Food & kindred prods	64	42	65.63	12	28.6	675	16.1
Tobacco prods	1	1	100.00	0	0.0	77	77.0
Textile mill prods	25	14	56.00	4	28.6	118	8.4
Apparel & other finished textile prods	72	46	63.89	19	41.3	707	15.4
Paper & allied products	28	17	60.71	4	23.5	318	18.7
Printing, publishing & allied inds	80	59	73.75	22	37.3	800	13.6
Chemicals & allied prods	36	27	75.00	6	22.2	300	11.1
Petroleum & coal prods	1	1	100.00	0	0.0	1	1.0
Rubber & misc. plastic prods	32	21	65.63	1	4.8	288	13.7
Leather & leather prods	9	8	88.89	2	25.0	222	27.8
Subtotal	3830	2833	73.97	1135	40.1	34800	12.3
Not in universe (-1)	329	0	0.00	180		0	
No response (-9)	52	14	26.92	7	50.0	311	22.2
Total	4211	2847	67.61	1322	46.4	35111	12.3

Source: See Table 5.1.

Table 5.A4 Earnings statusof displaced manufacturing workers, 1993–95

Industry	Earning in lost job			Earnings in current job			Gain in earnings	
	displaced (persons)	total weekly income (cents)	average weekly income (dollars)	re-employed (persons)	total weekly income (cents)	average weekly income (dollars)	(persons)	(per cent)
Manufacturing	765	39732694	519.38	588	27990964	476.04	216	28.24
Durable goods	462	26680246	577.49	359	18213186	507.33	128	27.71
Lumber & wood prods, excl. furniture	30	1283356	427.79	24	1016535	423.56	8	26.67
Furniture & fixtures	25	1055951	422.38	18	839178	466.21	11	44.00
Stone, clay, concrete, glass prods	27	1571854	582.17	15	746020	497.35	7	25.93
Primary metals	26	1362084	523.88	18	771677	428.71	5	19.23
Fabricated metals	52	2919786	561.50	38	1939539	510.41	13	25.00
Machinery, excl. electrical	93	6312998	678.82	78	4543836	582.54	27	29.03
Electrical machinery, equip. supplies	75	4129040	550.54	70	3232856	461.84	28	37.33
Transportation equipment	77	5203410	675.77	59	3129030	530.34	14	18.18
Motor vehicles & equip.	20	967581	483.79	16	745160	465.73	8	40.00
Aircraft & parts	26	1944253	747.79	21	1140515	543.10	2	7.69
Other transportation equipment	31	2291576	739.22	22	1243355	565.16	4	12.90
Professional & photo equip., watches	26	1620116	623.12	18	1138375	632.43	7	26.92
Other manufacturing industries	31	1221651	394.08	21	856140	407.69	8	25.81
Toys, amusement & sporting goods	5	141600	283.20	4	136440	341.10	2	40.00
Misc. & n.e.c. mfg industries	26	1080051	415.40	17	719700	423.35	6	23.08
Non-durable goods	303	13052448	430.77	229	9777778	426.98	88	29.04
Food & kindred prods	53	2050124	386.82	44	2189165	497.54	19	35.85
Tobacco prods	1	63462	634.62	0	0	#DIV/0!	0	0.00
Textile mill prods	22	595223	270.56	14	433518	309.66	5	22.73
Apparel & other finished textile prods	61	1687847	276.70	46	1439528	312.94	20	32.79
Paper & allied products	22	1476436	671.11	17	844078	496.52	5	22.73
Printing, publishing & allied inds	74	3279047	443.11	57	2495731	437.85	22	29.73
Chemicals & allied prods	30	1980483	660.16	26	1373198	528.15	7	23.33
Petroleum & coal prods	1	74600	746.00	1	80000	800.00	1	100.00
Rubber & misc. plastic prods	31	1594672	514.41	18	767926	426.63	8	25.81
Leather & leather prods	8	250554	313.19	6	154634	257.72	1	12.50
Subtotal	3266	155909516	477.37	2620	118221408	451.23	1029	31.51
Not in universe (-1)	0	0		0	0		0	
No response (-9)	8	301289	376.61	30	1198196	399.40	1	12.50
Total	3274	156210805	477.13	2650	119419604	450.64	1030	31.46

Source: See Table 5.1.

Table 5.A5 Health insurance status of displaced manufacturing workers, 1993–95

Industry	All displaced	Health insurance in lost job		Currently have health insurance		Re-employed and have health insurance		Had health before and after	
	(persons)	(persons)	(per cent)	(persons)	(per cent)	(persons)	(per cent)	(persons)	(per cent)
Manufacturing	881	582	66.06	562	63.79	442	50.17	417	47.33
Durable goods	533	372	69.79	344	64.54	281	52.72	258	48.41
Lumber & wood prods, excl. furniture	35	12	34.29	21	60.00	18	51.43	8	22.86
Furniture & fixtures	27	18	66.67	15	55.56	11	40.74	10	37.04
Stone, clay, concrete, glass prods	29	20	68.97	17	58.62	13	44.83	11	37.93
Primary metals	31	21	67.74	18	58.06	12	38.71	14	45.16
Fabricated metals	57	42	73.68	38	66.67	33	57.89	29	50.88
Machinery, excl. electrical	107	78	72.90	71	66.36	61	57.01	58	54.21
Electrical machinery, equip. supplies	89	64	71.91	61	68.54	49	55.06	45	50.56
Transportation equipment	91	79	86.81	65	71.43	53	58.24	57	62.64
Motor vehicles & equip.	25	19	76.00	18	72.00	17	68.00	14	56.00
Aircraft & parts	29	25	86.21	22	75.86	19	65.52	19	65.52
Other transportation equipment	37	35	94.59	25	67.57	17	45.95	24	64.86
Professional & photo equip., watches	29	18	62.07	17	58.62	14	48.28	12	41.38
Other manufacturing industries	38	20	52.63	21	55.26	17	44.74	14	36.84
Toys, amusement & sporting goods	7	3	42.86	5	71.43	5	71.43	2	28.57
Misc. & n.e.c. mfg industries	31	17	54.84	16	51.61	12	38.71	12	38.71
Non-durable goods	348	210	60.34	218	62.64	161	46.26	159	45.69
Food & kindred prods	64	35	54.69	39	60.94	29	45.31	29	45.31
Tobacco prods	1	1	100.00	1	100.00	1	100.00	1	100.00
Textile mill prods	25	13	52.00	11	44.00	7	28.00	7	28.00
Apparel & other finished textile prods	72	36	50.00	32	44.44	23	31.94	23	31.94
Paper & allied products	28	20	71.43	22	78.57	14	50.00	18	64.29
Printing, publishing & allied inds	80	48	60.00	58	72.50	45	56.25	38	47.50
Chemicals & allied prods	36	29	80.56	29	80.56	23	63.89	24	66.67
Petroleum & coal prods	1	1	100.00	1	100.00	1	100.00	1	100.00
Rubber & misc. plastic prods	32	24	75.00	21	65.63	14	43.75	16	50.00
Leather & leather prods	9	3	33.33	4	44.44	4	44.44	2	22.22
Subtotal	3830	1923	50.21	2394	62.51	1927	50.31	1442	37.65
Not in universe (-1)	329	0	0.00	0	0.00	0	0.00	0	0.00
No response (-9)	52	14	26.92	12	23.08	9	17.31	10	19.23
Total	4211	1937	46.00	2406	57.14	1936	45.97	1452	34.48

Source: See Table 5.1.

6 Foreign Direct Investment and Intra-industry Trade

Introduction

It is argued in the theoretical analysis (in Chapter 2) that in the face of trade liberalisation, adjustment costs under intra-industry trade are lower than those under inter-industry trade. A factor supporting this argument is the role of foreign direct investment (FDI). Two aspects were taken into account when considering the adjustment implications of the role of foreign direct investment in IIT. The first aspect of the argument is that much intra-industry trade is in parts and components rather than in final goods, which are horizontally or vertically differentiated. However, as the traded components from foreign subsidiaries and host country suppliers are produced in the same 'industry' and rely upon similar skills, transferability of labour from contracting to expanding activities may be easier than the reverse. Furthermore, without FDI in the first place, the host country's counterparts would face more inter-industry adjustment in the face of increased import competition.

The second aspect is that firms undertake the costs of retraining labour as rationalisation takes place. As a result, resource relocation under IIT is quicker and smoother, significantly reducing the costs of dislocation and unemployment and reducing the need for government assistance to smooth the transition process.

For these factors to provide support for the hypothesis that adjustment costs under intra-industry trade are lower than those under inter-industry trade, a crucial assumption is that intra-industry trade is closely related to foreign direct investment. But there has not been much theoretical analysis of the linkage between FDI and IIT and, in particular, there is little empirical research. As an alternative approach, taking intra-firm trade as a consequence of FDI, some researchers have studied IIT in the context of intra-firm trade to link FDI and IIT. Again, the empirical evidence linking intra-firm trade and IIT is thin.

Norman and Dunning (1984) come to no firm conclusion on the issue of whether intra-industry trade and FDI should be viewed as substitutes or complements. Agmon (1979) and MacCharles (1987) are in no doubt. They argue that FDI and intra-industry trade are complementary rather than substitutive. Markusen (1983) considers a variety of circumstances in which factor movements and commodity trade are likely to be complements rather than substitutes. A more rigorous theoretical analysis of the linkage between FDI and IIT is conducted by Greenaway and Milner (1986) using the OLI paradigm.[1] Further models of intra-firm intra-industry trade are developed by Mainardi (1986) in situations where any intra-firm trade is likely to be intra-industry trade.

As mentioned earlier, empirical evidence on the link between intra-industry trade and intra-industry trade is remarkably thin. In measuring the determinants of FDI, in a study of 27 industries in 30 countries, however, Baldwin (1979) found that product differentiation affects FDI. Furthermore, although some studies suggest that FDI and

[1] OLI represents *ownership* advantage, *locational* considerations and *internalisation* gains.

IIT are closely linked, other empirical studies find no evidence to support such a connection. For example, as a determinant in explaining IIT, the activities of MNEs are found to be totally insignificant in Wickham and Thompson's (1989) study.

Other evidence from the literature links IIT and foreign direct investment by examining the relationship between IIT and intra-firm trade. A case study by Bonturi and Fukasaku (1993) concludes that intra-industry trade in manufactured goods among developed countries often takes the form of intra-firm trade. Other case studies provide evidence on intra-firm trade in particular industries where intra-industry trade is prevalent (Casson et al. 1986). When Caves (1981) includes a proxy which directly measures intra-firm trade in a study of intra-industry trade in a multi-country and multi-industry study in the principal OECD countries, intra-firm trade turns out to be positively and significantly related to the pattern of intra-industry trade.

Thus, although there is some evidence consistent with a positive association between FDI and intra-industry trade, it is rather slight. For this reason, there is considerable merit in conducting further empirical study of the linkage between FDI and IIT.

Intra-industry trade and multinational enterprises—a theoretical explanation

Various theoretical developments contribute to understanding of the linkage between FDI and IIT. Agmon (1979) argues that the factors which are likely to result in the emergence of MNEs are precisely those factors that one can expect to result in intra-industry trade; thus one can expect the two to go hand in hand. MacCharles (1987) sees FDI followed by intra-industry trade as an avenue to exploit firm-specific advantages as well as a means of acquiring information about foreign markets. In this setting, the linkages between FDI and IIT are intuitively observed. More rigorous explanations are conducted by Greenaway and Milner (1986) and Mainardi (1986). These are discussed below.

The OLI paradigm

Dunning (1981) proposed an 'eclectic' approach known as 'the OLI paradigm' to explain the motives that may underlie foreign direct investment. According to this approach, foreign direct investment will occur when three conditions hold. First, the firm must enjoy certain ownership advantages in a foreign market and have a competitive advantage over local producers. The ownership advantage may take the form of technical know-how or patent protection. The second condition is the existence of specific locational advantages to produce in the foreign market. This locational advantage can take the form of access to raw materials, the availability or relatively cheap labour, or the ability to 'jump' over import restrictions. The third condition is the opportunity to exploit ownership and locational advantage through internal markets, rather than through other 'arms-length' arrangements.

The linkage between FDI and IIT using the framework discussed above is based on the assumption that the goods one is dealing with are differentiated. According to Greenaway and Milner (1986), in the case of differentiated goods, ownership advantage may take the form of brand image. Locational advantages are perceived as flowing from differences in factor prices across countries, and perhaps the ability to respond more readily to changes in tastes through being located in the foreign market.

Internalisation may not only reduce uncertainty and encourage trade, it might also facilitate the exploitation of vertical economies of scale.

Models of intra-firm intra-industry trade

Based on the work of Hirsch (1976) and Agmon and Hirsh (1979), Mainardi (1986) argues that any intra-firm trade is likely to be intra-industry trade. In this model it is assumed that a given firm is pursuing a strategy of cost minimisation and the firm is assumed to be considering arms-length export via FDI. Further, it is assumed that the commodites produced are differentiated. The conditions for FDI in country B on the part of a firm based in country A are stated by Mainardi as follows:

$$\lambda_i a_{iq} P_q < \bar{\lambda}_i \bar{a}_{iq} \bar{P}_q \qquad (6.1)$$

$$\lambda_i a_{iq} P_q < \delta_i b_{iq} \hat{P}_q \qquad (6.2)$$

$$\lambda_i a_{iq} P_q < \tilde{\lambda}_i \tilde{a}_{iq} \tilde{P}_q \qquad (6.3)$$

$$\lambda_i a_{iq} P_q < \breve{\lambda}_i \breve{a}_{iq} \breve{P}_q \qquad (6.4)$$

where

λ_i = marketing costs incurred by the subsidiary for its sales in country B;

$\bar{\lambda}_i$ = marketing costs incurred by the parent company for its export and sales in country B;

δ_i = marketing costs incurred by the marginal indigenous supplier in country B;

$\tilde{\lambda}_i$ = marketing costs incurred by an alternative foreign subsidiary located in country C;

$\breve{\lambda}_i$ = marketing costs incurred by an alternative foreign subsidiary for its export and sales in country B;

a_{iq} = technical production coefficients;

P_q = unit prices of input q.

Equation (6.1) relates the marketing and production costs of the subsidiary in the host country to the marketing and production costs of the parent company undertaking arms-length transactions. The costs of the subsidiary and local competitors are compared in equation (6.2), equation (6.3) gives the possibility of investment in a third country and equation (6.4) compares the costs of the subsidiary and competing subsidiaries of other MNEs.

By separating production and marketing costs for both the parent company and the subsidiary, 'horizontal' intra-firm intra-industry trade will take place if the following conditions hold:

$$\lambda_i < \overline{\lambda}_i \quad \text{and} \quad a_{iq} > \overline{a}_{iq}\overline{P}_q \quad (1 \le i \le j) \qquad (6.5)$$

$$\gamma_i > \overline{\gamma}_i \quad \text{and} \quad a_{iq}P_q < \overline{a}_{iq}\overline{P}_q \quad (j \le i \le n) \qquad (6.6)$$

where

γ_i = marketing costs incurred by the subsidiary for its export and sales in country A; and

$\overline{\gamma}_i$ = marketing costs incurred by the parent company in country B.

Condition (6.5) means that, for some product varieties, the parent company has a production cost advantage and for the same varieties, the subsidiary has an advantage in marketing costs. For a range of other varieties, the opposite situation may prevail (6.6). In these circumstances an MNE pursuing a strategy of cost minimisation would produce varieties $1 \rightarrow j$ in country A to be sold in countries A and B. Varieties $j+1 \rightarrow n$ are produced in country B and sold in countries A and B.

Following from this, Greenaway and Milner (1986) argue that intra-firm, intra-industry trade will also occur because of location-specific production cost advantages and location-specific marketing cost advantages. Location-specific production cost advantage is related to economies of scale and scope. There may be an optimal plant size for a given number of varieties which necessitates specialisation by varieties. Differences in location-specific marketing costs are considered to be access to local consumers, and an ability to respond to changes in tastes and preferences, as well as lower freight costs.

In regard to vertically differentiated commodities, 'quality' is assumed to be a function of relative capital input. Differences in initial factor endowments would result in parent companies producing 'high-quality' varieties in capital-abundant countries whilst their subsidiaries specialise in 'low-quality' varieties in labour-abundant countries.

As noted above, MNEs can make available to their subsidiaries significant advantages through FDI, by means of their control of management expertise and knowledge about new products and production technologies. This knowledge and management expertise flows on an intra-firm basis and therefore provides foreign subsidiaries with comparative advantages over their counterparts in host countries. MNEs also have more flexibility in rationalising production through access to the products of affiliates and the marketing channels of parents. As a result, subsidiaries are better able to reduce costs and gain access to export markets and this gives rise to international intra-firm and intra-industry trade and resource relocation.

FDI and IIT are linked because multinationals engage in international specialisation by establishing plants as specialist suppliers of components to affiliates. The specialisation of production activities across nations allows MNEs to overcome the problems of small-scale production and diversity of activities that would exist if the plants were producing for the domestic market alone. At the same time, subsidiaries owned by multinationals in host countries are more efficient and competitive than their domestic counterparts. Therefore, much of the host country's international trade takes the form of intra-firm trade as MNEs trade products and components among themselves on a two-way basis.

Data availability and limitations

Empirical study of the linkage between FDI and IIT is mainly hampered by the relative scarcity of detailed data on FDI. The only systematic information available on FDI and intra-firm trade is that produced by the US Department of Commerce.

In the United States, a company is defined as an affiliate if the 'parent' company owns 10 per cent or more of its voting stock. If the parent company owns more than 50 per cent of the voting stock, the affiliate company is considered to be a subsidiary of the parent company, and it is called a majority-owned foreign affiliate (MOFA). Some benchmark surveys (US Department of Commerce 1977, 1982, 1987 and 1994) provide data for foreign affiliates of US companies. These data are at a good level of disaggregation and the nationality of parent and affiliate companies is also available. Besides the benchmark surveys, annual surveys are also available, although they are limited in coverage in some instances. Thus the US Department of Commerce provides 'universe' estimates on an annual basis. A serious limitation is that some disaggregated data are not disclosed for reasons of confidentiality.

Recent developments of US foreign direct investment

Until the First World War, nearly all international investment was portfolio investment (Sodersten and Reed 1994). According to Henderson et al. (1997), US investment was different. From the beginning, Americans investing abroad have shown a greater propensity to transfer know-how than financial capital.

Between the wars, the United States began to emerge as a major source, primarily of direct investments, as American industrialists began to establish foreign operations in the image of their pre-Depression home-market successes. Following the Second World War, the United States became the primary supplier of international finance, first in the form of official loans and gifts, and secondly in the form of FDI, as

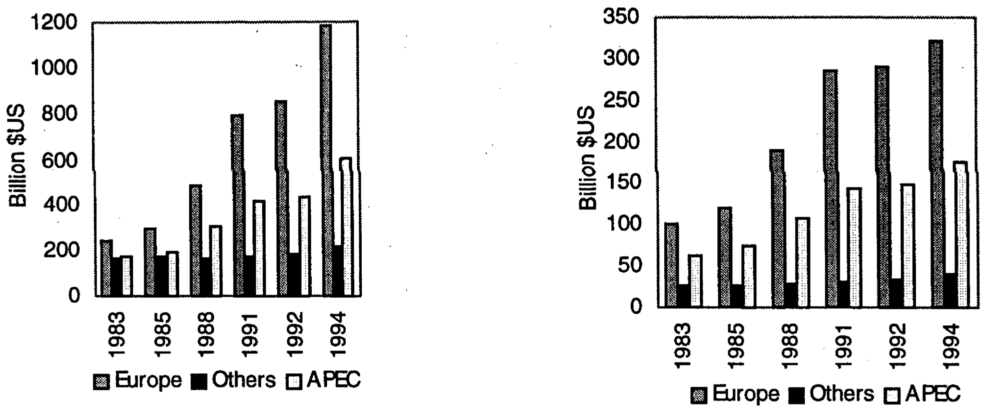
American firms made major contributions to postwar industrial reconstruction. By 1960, the United States was supplying about two-thirds of all international investment. By the 1980s, the European Union and Japan had joined in exporting their management technology through FDI. In the 1990s, with the fall of Soviet communism and the liberalisation of third-world economies, FDI became the main instrument for global industrialisation.

Trends and patterns

Figure 6.1 Total assets of US affiliates, region by destination, 1983–94

All industries

Manufacturing



Source: Author's construction using data from 'Total assets of affiliates, of majority-owned non-bank foreign affiliates of non-bank U.S. parents', in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

As shown in Figure 6.1, recent US FDI in terms of total assets of affiliates has increased substantially. This is more pronounced for industries as a whole than for manufacturing. The increase in Europe is much more significant than in APEC. Table 6.1 shows that the share of manufacturing in US foreign direct investment in all industries increased in the late 1980s from 35 per cent to around 38 per cent and declined in the early 1990s to around 29 per cent. This is because US foreign direct investment shifted towards (away from) manufacturing from (to) other industries, such as the wholesale and finance sectors. From a regional perspective, this decrease in the share of manufacturing in all sectors is more significant for Europe (from 40 per cent in 1983 to 27 per cent in 1994) than for APEC (from 40 per cent in 1983 to 34 per cent in 1994), developed APEC (from 39 per cent to 35 per cent) and developing East Asia (from 30 per cent to 29 per cent). MOFAs follow the same pattern and change of commodity structure as total affiliates.

Table 6.1 US foreign direct investment in manufacturing, (per cent), 1983–94

	1983	1985	1988	1991	1992	1994
Total						
All countries	35.03	36.49	37.93	35.99	33.87	28.86
Europe	40.46	41.54	40.77	36.80	33.65	26.84
APEC	39.97	42.37	40.58	39.52	38.18	34.21
Canada, Australia, Japan	39.10	41.94	39.42	38.16	37.72	34.77
East Asian developing	30.44	32.38	38.99	38.47	35.49	29.37
Others	20.55	19.76	23.53	22.82	23.39	22.63
Majority-owned						
All countries	32.39	33.19	34.15	33.30	32.30	26.87
Europe	40.96	40.41	39.06	36.11	34.03	27.18
APEC	36.22	38.52	35.08	34.61	34.66	29.14
Canada, Australia, Japan	36.09	38.67	33.93	33.53	33.23	28.23
East Asian developing	26.30	28.28	31.58	31.41	32.32	26.04
Others	15.84	14.91	17.60	17.40	18.72	18.85

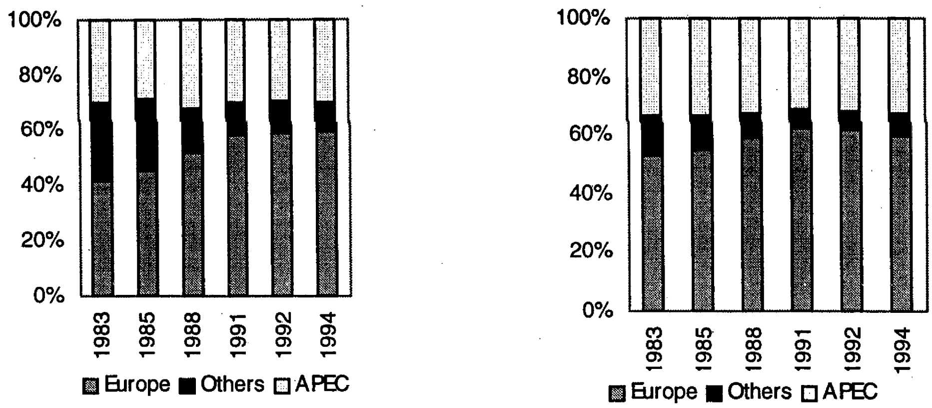
Source: Author's calculation based on data from 'Total assets of affiliates of total and majority-owned non-bank foreign affiliates of non-bank US parents', in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

The changing pattern of US foreign direct investment is also reflected in changing geographical patterns. Among MOFAs in all industries, Europe accounts about 40 per cent of all US foreign direct investment in 1983, while APEC only accounts for around 30 per cent and the rest of the economies take the remaining 30 per cent.

Following a big change in 1988 and until 1994, Europe's share increased to almost to 55 per cent and the share of APEC increased to 35 per cent, with the rest of the economies shrinking to 10 per cent. But this geographical change is not observed in MOFA manufacturing industry, in which US direct investment in Europe is initially high—more than 50 per cent. It increases significantly over the 1980s and decreases slightly in the early 1990s, but still accounts for around 60 per cent of total investment in MOFA manufacturing. This change is accompanied by a large decrease in the rest of the economies' share in total MOFA manufacturing while APEC economies experience no significant change.

Figure 6.2 US foreign direct investment by regions, 1983–94

MOFA in all industries MOFA in manufacturing



Source: Author's construction using data from 'Total assets of affiliates, country by industry of majority-owned non-bank foreign affiliates of non-bank US parents', in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

A further look at geographical changes in the APEC and European regions reveals different patterns. Both for MOFAs in all industries and MOFAs in manufacturing, US direct investment in developed APEC economies decreased significantly while it increased markedly in developing East Asian economies, especially in the early

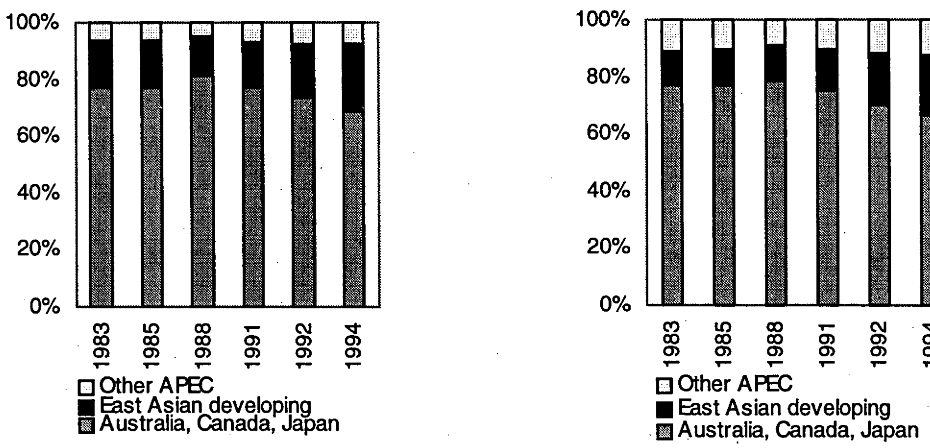
1990s. This may have been because of the good economic prospects in developing East Asian economies or the transfer of labour-intensive operations to East and Southeast Asia in the wake of the appreciation of the yen. Another factor may have been the investment boom in China (Petri 1995).

US direct investment in Europe is mainly in EC-12 economies, where MOFAs account for more than 80 per cent of all industries and MOFAs manufacturing take almost 95 per cent. This concentration increases for MOFAs in all industries over the 1980s and the early 1990s and declines slightly in 1994. There is no significant change for MOFA manufacturing: it increased slightly in 1988 and decreased thereafter, falling slightly short of the 1983 level.

Figure 6.3 US foreign direct investment in APEC, 1983–94

MOFAs in all industries

MOFAs in manufacturing

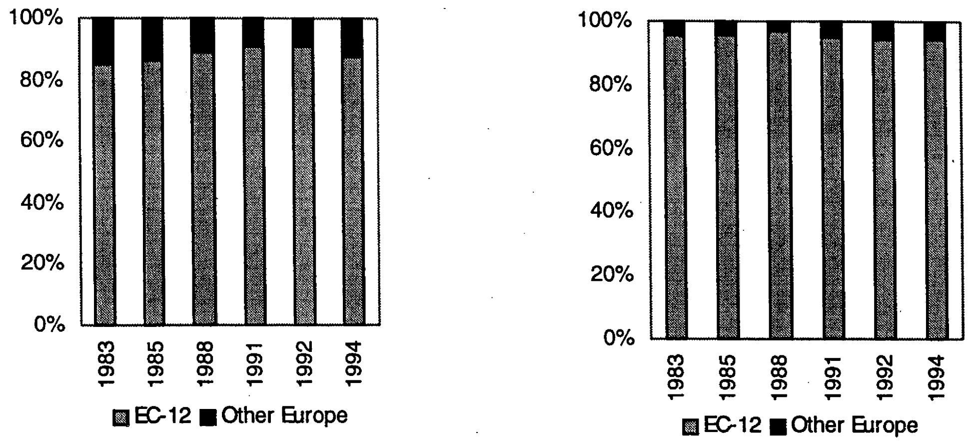


Source: See Figure 6.2.

Figure 6.4 US foreign direct investment in Europe, 1983–94

MOFAs in all industries

MOFAs in manufacturing



Source: See Figure 6.2.

FDI and intra-firm trade

Petri (1995) argues that there are highly visible American export platforms in developing East Asia in the 1970s. Table 6.2 reveals that from 1983 to 1994, sales by affiliates from a regional perspective predominantly target the local market. For all countries, local sales by affiliates account for about 65 per cent of all sales in 1983, increasing to 67 per cent in 1994. Sales to other foreigners for all countries, which account for 24 per cent of total sales, decreased almost 2 per cent in 1994. The share of local sales in total sales for APEC (around 70 per cent) is about 10 per cent higher than that for Europe (around 60 per cent), while the share of sales to other foreigners in total sales for APEC (around 10 per cent) is about 20 per cent lower than that for Europe (around 30 per cent). For developing East Asia, local sales are low in 1983 (38 per cent) and increase to 53 per cent in 1994; sales to other foreigners are 34 per cent in 1983 and decrease to 29 per cent in 1994.

Table 6.2 Sales by US affiliates, region of affiliate by destination, 1983–94

	1983	1985	1987	1988	1991	1992	1994
Share of local sales in total sales							
All countries	64.76	63.83	66.14	65.34	66.35	65.91	66.91
Europe	62.29	61.65	63.40	61.80	64.27	64.00	64.77
APEC	72.53	69.50	71.44	71.41	72.25	71.04	70.51
East Asian developing	38.48	34.47	38.53	41.76	n.a.	51.78	52.58
Others	57.42	58.18	64.67	65.15	58.00	59.52	65.57
Share of sales to other foreigners in total sales							
All countries	24.36	23.50	22.96	23.72	23.55	24.04	22.61
Europe	33.77	33.25	32.05	33.23	31.73	32.21	31.18
APEC	10.07	10.18	9.41	9.71	9.82	10.60	10.91
East Asian developing	34.05	36.45	32.42	34.38	27.91	n.a.	28.74
Others	23.68	20.70	15.81	16.73	19.28	18.91	16.30

Note: n.a. means not available.
Source: Author's construction using data on 'Sales by affiliates, country of affiliates by destination of majority-owned non-bank foreign afffiliates of non-bank US parents', in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

Another characteristic of US direct investment is the existence of substantial intra-firm trade. As shown in Table 6.3, the share of intra-frim trade in total MNE trade increased between 1983 to 1994 at the global level, accounting for a substantial proportion of total MNE trade. Moreover, it can be seen from Table 6.4 that the share of intra-firm trade in national trade may also be substantial—26 per cent on average for exports and 16 per cent on average for imports.

Table 6.3 US intra-firm trade in US MNEs' trade, 1983–94

	A	B	B/A
US exports shipped by US parents			
	Total (US$ million)	To affiliates (US$ million)	Share (per cent)
1983	146212	49397	33.8
1985	164138	61852	37.7
1987	166425	66414	39.9
1988	199704	79378	39.7
1991	239674	97124	40.5
1992	245475	104679	42.6
1994	317251	134311	42.3
US imports shipped to US parents			
	Total (US$ million)	From affiliates (US$ million)	Share (per cent)
1983	115135	43632	37.9
1985	139416	54027	38.8
1987	150865	60379	40.0
1988	163117	69491	42.6
1991	193343	83483	43.2
1992	199858	92614	46.3
1994	240617	119438	49.6

Source: Author's calculation using data on 'US exports (imports) associated with US parents and their foreign affiliates of non-bank US parents' in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

Table 6.4 US intra-firm trade in US total trade, 1983–94

	Total exports (US$ million	Intra-firm exports (US$ million)	Share (per cent)	Total imports (US$ million)	Intra-firm imports (US$ million)	Share (per cent)
1983	194620	49397	25.38	267971	43632	16.28
1985	205239	61852	30.14	358705	54027	15.06
1987	243682	66414	27.25	422407	60379	14.29
1988	304886	79378	26.04	459017	69491	15.14
1991	397705	97124	24.42	507020	83483	16.47
1992	420812	104679	24.88	551591	92614	16.79
1994	476190	134311	28.21	687096	119438	17.38

Sourcse: For intra-firm trade data, see Table 6.3; Total exports and imports are from UN commodity trade data in International Economic DataBank, Australian National University.

The observed US intra-firm trade is mainly conducted with APEC economies—62 per cent for exports and 72 per cent for imports in 1983—although the regional share of US total intra-firm trade is declining. Among APEC economies, Canada alone accounts for 65 per cent on average of APEC's total US intra-firm trade. Together with Japan and Mexico, these economies account more than 80 per cent of APEC's total US intra-firm trade.

Table 6.5 Regional distribution of US intra-firm trade, 1983–94

	1983	1985	1987	1988	1991	1992	1994
Exports							
All countries	100	100	100	100	100	100	100
Europe	31.39	29.57	29.80	31.26	32.65	32.52	30.69
Others	6.88	5.81	5.29	4.89	13.94	14.80	15.58
APEC	61.73	64.62	64.91	63.85	53.42	52.67	53.74
APEC	100	100	100	100	100	100	100
Canada	66.95	68.84	65.34	62.47	64.20	64.16	58.71
Japan	5.55	6.46	8.32	9.82	15.25	14.17	13.93
Mexico	7.25	8.63	9.40	9.48	17.38	19.28	19.82
Imports							
All countries	100	100	100	100	100	100	100
Europe	12.16	13.62	17.31	16.84	15.42	15.40	15.13
Others	15.88	10.98	8.97	9.10	19.20	21.28	20.70
APEC	71.96	75.40	73.72	74.06	65.38	63.31	64.16
APEC	100	100	100	100	100	100	100
Canada	67.53	65.33	60.22	62.27	66.92	67.63	68.16
Japan	2.25	3.05	4.69	4.41	3.63	3.72	4.07
Mexico	6.25	8.52	10.57	10.69	16.96	19.93	22.47

Source: Author's calculation using data on 'US Merchandise trade with affiliates, by country of affiliate of majority-owned non-bank foreign affiliates of non-bank US parents', in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

One can see from Table 6.6 that US intra-firm trade is mainly concentrated in manufacturing, although exports are declining and imports are increasing. Manufacturing intra-firm trade is mainly from three sectors: transportation equipment; machinery; and chemicals.

Table 6.6 Sectoral structure of US intra-firm trade, 1983–94

	1983	1985	1987	1988	1991	1992	1994
Exports							
All industries	100	100	100	100	100	100	100
Petroleum	2.89	2.56	2.04	1.54	2.22	1.77	1.45
Manufacturing	69.40	70.48	69.76	68.29	65.69	66.36	59.46
Food and kindred products	1.57	1.12	1.23	2.01	1.39	1.86	1.55
Chemicals and allied products	7.87	6.91	8.10	7.51	7.53	7.58	7.26
Primary and fabricated metals	1.25	1.47	1.24	1.48	1.39	1.31	1.22
Machinery, except electrical	11.04	11.08	10.26	9.89	12.38	12.07	10.31
Electric and electronic equipments	10.39	8.85	9.70	8.73	8.89	8.76	8.26
Tansportation equipment	29.41	34.35	32.69	31.97	25.67	25.54	23.36
Other manufacturing	7.87	6.60	6.55	6.69	8.44	9.25	7.50
Wholesale trade	25.69	25.43	26.91	28.78	30.41	30.07	36.57
Other industries	2.02	1.64	1.29	1.38	1.68	1.79	2.52
Imports							
All industries	100	100	100	100	100	100	100
Petroleum	24.91	20.83	13.70	9.77	11.73	10.37	6.62
Manufacturing	66.39	70.89	74.27	78.52	77.92	79.15	82.86
Food and kindred products	0.89	1.15	1.00	0.93	1.29	1.35	1.51
Chemicals and allied products	4.04	3.40	3.84	3.88	4.40	4.42	4.09
Primary and fabricated metals	0.91	1.08	1.69	2.15	0.98	1.03	1.16
Machinery, except electrical	6.78	7.76	11.63	13.22	16.53	16.35	18.28
Electric and electronic equipments	13.60	13.62	13.73	13.17	12.41	13.40	12.33
Transportation equipment	35.66	39.37	37.16	39.26	35.37	35.56	39.34
Other manufacturing	4.51	4.50	5.22	5.90	6.94	7.04	6.15
Wholesale trade	6.45	6.63	10.08	9.92	9.25	9.28	9.83
Other industries	2.26	1.65	1.96	1.79	1.10	1.20	0.69

Source: Author's calculation using data on 'US merchandise trade with affiliates by industry of affiliates of majority-owned non-bank foreign affiliates of non-bank US parents', in *U.S. Direct Investment Abroad*, US Department of Commerce, various years.

In summary, the volume and structure of US direct investment abroad have changed dramatically since 1983. Investment has increased more in Europe than in APEC and the share of investment in manufacturing has declined. Sales of affilates are concentrated in local markets. There is no strong evidence that there are US export platforms in developing East Asia.[2] Most importantly, as US direct investment abroad increases, US intra-firm trade also increases. The proportion of US intra-firm trade in US MNE trade is substantial and increasing.

Relationship between FDI and IIT

As we can see above, US direct investment abroad and US intra-firm trade go hand in hand. Some theoretical studies argue that there is a link between FDI and IIT because intra-firm trade is trade in differentiated products. Therefore, one way of looking at the linkage between FDI and IIT is to seek empirical evidence to support the linkage between intra-firm trade and IIT. In practice, this approach is often restricted by data limitations (see Greenaway 1987). Other approaches, including the construction of a model of the determinants of FDI with product differentiation and the construction of a model of determinants of IIT with multinational activities as explanatory variables, also involve substantial data requirements. A direct and straightforward way is to look at the association between the two variables, that is, to examine association between an economy's direct investment in various destinations and its IIT with the host economies.

[2] At an individual country level, US investment in Hong Kong and Singapore in the 1980s and Indonesia in the 1990s exhibits the pattern of export platforms.

The FDI data are obtained from 'Total assets of affiliates of US non-bank parents in Europe and APEC individual economies', in *U.S. Direct Investment Abroad* (US Department of Commerce). IIT is calculated as Grubel–Lloyd indices using data from UN commodity trade and UNIDO export and import data at the 4-digit level.[3] FDI for total non-bank foreign affilates of non-bank US parents and majority-owned non-bank foreign affiliates of non-bank US parents are included in the estimation. Industries are classified at two levels, all industries and manufacturing, as it is believed that IIT is mainly concentrated in manufacture. Also, as the previous section revealed, the regional patterns of US FDI vary. Despite conducting an analysis on pooled European and APEC economy data, a separate analysis of Europe and APEC is expected to offer different results, as the patterns of US FDI in these regions are different. This analysis is conducted over four years: 1985, 1988, 1991 and 1994.

There are many ways to analyse the associations between two variables.[4] Due to the nature of FDI and IIT data—FDI data are in values and IIT data are in percentage form—Spearman's rank correlation is used in the estimation.

The formula for Spearman's rank correlation coefficients is defined as:

$$\theta = \frac{\sum (R_i - \bar{R})(S_i - \bar{S})}{\sqrt{\sum (R_i - \bar{R})^2 \sum (S_i - \bar{S})^2}}$$

[3] These data are obtained from the International Economic DataBank, Australian National University. See Chapter 4 for the definition, problems and justification of Grubel–Lloyd index as a measure of IIT.
[4] See Chapter 1 for a more detailed discussion.

where R_i is the rank of the ith x value, S_i is the rank of the ith y value, and $\overline{R}$ and $\overline{S}$ are the means of the R_i and S_i values, respectively. Averaged ranks are used in the case of ties (Mendenhall and Reinmuth 1978).[5]

Originally, 15 APEC economies and 17 European economies were included in the survey and estimations of US direct investment abroad using US Department of Commerce data. Due to confidentiality limitations, in some years, some economies' data are not disclosed. The estimated Spearman's correlation coefficients between FDI and IIT and the number of observations used are reported in Table 6.7.

From these estimates of Spearman's rank correlation coefficients, the hypothesis that there is a positive association between FDI and IIT is supported strongly. There is a positive relationship between US foreign direct investment in European and APEC economies together and US IIT with these economies. This positive association is evident at a 1 per cent significance level for all industries, for manufacturing, for total non-bank foreign affiliates, and for majority-owned non-bank foreign affiliates for all the years estimated.

[5] When there are no ties in either the R or the S observations, the expression for θ can be reduced to the simpler expression as often appeared in some of the text books: $\theta = 1 - \frac{6\Sigma d_i^2}{n(n-1)}$ where $d_i = S_i - R_i$ and n is the number of observations.

Table 6.7 Estimated Spearman's correlation coefficients between FDI and IIT

	All industries		Manufacturing	
	Total	Majority-owned	Total	Majority-owned
All economies				
1985	0.562**	0.597**	0.643**	0.586**
	(31)	(31)	(31)	(29)
1988	0.551**	0.604**	0.576**	0.636**
	(31)	(31)	(31)	(31)
1991	0.641**	0.649**	0.659**	0.789**
	(31)	(32)	(30)	(32)
1994	0.588**	0.548**	0.583**	0.617**
	(31)	(32)	(29)	(32)
Europe				
1985	0.801**	0.818**	0.859**	0.799**
	(17)	(17)	(17)	(15)
1988	0.791**	0.816**	0.774**	0.774**
	(17)	(17)	(17)	(17)
1991	0.796**	0.796**	0.770**	0.789**
	(17)	(17)	(16)	(17)
1994	0.755**	0.755**	0.746**	0.748**
	(17)	(17)	(15)	(17)
APEC				
1985	0.364	0.368	0.468*	0.333
	(14)	(14)	(14)	(14)
1988	0.307	0.411	0.407	0.485*
	(14)	(14)	(14)	(14)
1991	0.472*	0.461*	0.567*	0.630*
	(14)	(15)	(14)	(15)
1994	0.346	0.249	0.394	0.496*
	(14)	(15)	(14)	(15)

Notes: 1) Data in parenthesis are the number of observations.
2) * significant at 5% critical value.
3) ** significant at least at 1% critical value.
4) Critical values are obtained from 'Critical values of Speearman's rank correlation coefficient', in *Statistics for Management and Economics*.

Source: Author's calculations.

When the estimation is conducted for Europe and APEC economies seperately, however, the results are different. The results obtained from European economies are consistent with the pooled sample: positive and siginificant at a 1 per cent significance level. Although the results obtained from APEC economies exhibit a positive association between FDI and IIT, they are only significant at a 5 per cent significance level in 1991 for all industries, in 1985 and 1991 for total manufacturing, and in 1988, 1991 and 1994 for majority-owned manufacturing.

These different results for Europe and APEC are not surprising as US direct investment to these regions has been observed to be different. US direct investment abroad is mainly concentrated in developed economies; the investment volume in Europe is larger than in APEC; and in APEC, US direct investment is mainly concentrated in a few economies such as Canada, Japan and Mexico.

It is also argued that to some extent, trade in parts and components between northern firms and southern counterparts takes the form of non-equity subcontracing arrangements. That is, intra-industry takes place, but at arm's length. Oman (1989) argues that non-equity forms of corporate networking based on outward-oriented industrialisation have been important in the recent economic development of Asia Pacific economies.

Conclusion

One of the factors that supports the central hypothesis that adjustment costs under intra-industry trade are lower than those under inter-industry trade is related to the activities of MNEs. This argument crucially depends on a linkage between FDI and

IIT. This chapter, therefore, reassessed the linkage between FDI and IIT both theoretically and empirically.

Theoretically, the linkage between FDI and IIT can be explained using an OLI paradigm by assuming the goods traded are differentiated vertically or horizontally. Mainardi (1986) also demonstrates in a theoretical model that all intra-firm trade can be regarded as intra-industry trade. Using data in 'U.S. Direct Investment Abroad' from the US Department of Commerce, the patterns of and changes in US direct investment abroad are examined and it is found that intra-firm trade is growing hand in hand with FDI. A further examination, using Spearman's rank correlation coefficients, reveals that US direct investment to European and APEC economies and intra-industry trade with these economies is positively and significantly correlated.

Although this study is conducted using US data alone, the underlying theory is generalisable. One can expect similar results in other economies given the availability of data.

7 Determinants of Intra-industry Trade: A Case Study of Asia Pacific Economies

Introduction

So far the thesis has examined relative adjustment costs under different trade patterns from several angles. In the face of trade liberalisation, the conclusion is that adjustment costs under intra-industry trade are lower than those under inter-industry trade. This result supports the argument that successful economic integration of European economies may have been based partly on their high levels of intra-industry trade. What, then, of APEC economies and their attempts to proceed with trade liberalisation? The level of intra-industry trade among APEC economies remains low. It may therefore be that trade liberalisation among APEC economies will involve high adjustment costs. What are the trends in trade specialisation in the region? If there is a tendency towards increased intra-industry trade, this could ease the burden of adjustment to regional trade liberalisation.

Whether further close economic integration and trade liberalisation will be followed by lower adjustment costs will depend upon the determinants of intra-industry trade. A large number of studies have explored the origion of IIT. Theoretical studies of the determinants of IIT, as surveyed in Chapter 2, are extensive. But most empirical studies of IIT deal with European or OECD economies, and there is little empirical analysis of the determinants of IIT for APEC economies. Asia Pacific economies differ considerably from European economies and among themselvies in respect of per capita income, size of economy and level of industrialisation, exposure to external trade, commodity patterns of trade and so on (see Pacific Economic Cooperation Council 1995 and Fukasaku 1992). The question is whether the theoretical explanations of IIT that emerge from empirical studies of developed economies, have relevance to countries sch as those in the Asia Pacific region.

Previous empirical studies suggest that the level of intra-industry trade among developed economies is high. It has been recognised in the last few years that intra-industry trade among less developed countries (LDCs) is becoming more significant. This is especially so among the most dynamic group of LDCs—Asian newly industrialising economies (NIEs)—whose impressive economic performance is the key element in East Asian and Pacific growth. Following earlier work (Fukasaku 1992; Lee 1989; Loertcher and Wolter 1980; Lowe 1991), this chapter examines the determinants of intra-industry trade using data from economies in this region for 1975, 1985 and 1995. The analysis will not only help to identify the main determinants of intra-industry trade but also to clarify the peculiarities of economic adjustment in this region. The findings from this exercise should provide insight into the prospects of future economic integration among the economies of Asia and the Pacific.

Literature survey

Theoretical explanations of IIT

A review of theoretical models of IIT was conducted in Chapter 2 with ithe aim of drawing out the adjustment implications of inter- versus intra-industry trade. These models are summarised below for the purpose of examining the determinants of intra-industry trade in Asia Pacific economies.

The first group of models incorporates competition between a large number of firms. There are several models that explain intra-industry trade within the Heckscher–Ohlin framework. These models are based on factor endowment differences and specify production as different combinations of basic factors such as capital and labour in a way that is consistent with constant returns to scale and perfect competition, demonstrating that the pattern of intra-industry trade is driven by relative endowments. One well-known such model was developed by Falvey (1981). Based on differences in factor endowments, this model reveals that intra-industry trade occurs along vertically differentiated products giving the reciprocal demand for both high and low qualities of a product between two countries. On the other hand, models incorporating monopolistic competition, scale economies in production and diverse consumer tastes, intra-industry trade along horizontally differentiated products has been explained by Spence (1976), Dixit and Stiglitz (1977), Krugman (1979) and Lancaster (1980). The main idea behind these models is that if the number of varieties enters directly into consumers' utility function (desire for variety), but the economies of scale limit the number of varieties in production, then IIT indeed may take place and, by increasing the number of varieties, have positive welfare effects.

The second group comprises oligopolistic models focused on the strategic interdependence between firms in an industry. A distinguishing feature of these models is the form of conjecture assumed to influence a firm's decision. Brander and Krugman (1983), using a Cournot-type conjecture, developed a model which explains intra-industry trade in an identical commodity which is often referred to as two-way trade or 'cross-hauling'. That this two-way trade can occur is a consequence of price being above marginal cost in both markets, both producers seeking to maximise their profit by selling to both markets, taking the sales of the other producer as given so long as transportation costs are not high.

Empirical studies

Several economists have estimated the degree of intra-industry trade. The results of a comparative study undertaken by Greenaway and Milner (1989) suggest three important findings. First, as expected, the level of IIT is lower when a more detailed level of industry classification is applied. Second, the level of IIT is higher for manufacturing than for other industries. Third, among different economies, intra-industry trade is dominant for all developed market economies (DMEs), especially in trade between the DMEs. It is less important but still significant for the newly industrialising economies, but it is only of relatively minor importance for less developed countries.

Greenaway and Milner (1989) surveyed the literature on the testing of hypotheses about intra-industry trade. Their survey covers a wide range of empirical studies including those of Pagoulatos and Sorenson (1975), Finger and De Rosa (1979), Loertscher and Wolter (1980), Caves (1981), Toh (1982), Lundberg (1982), Culem and Lundberg (1983), Havrylyshyn and Civan (1983), Bergstrand (1983), Tharakan (1984, 1986), Greenaway and Milner (1984) and Balassa (1986a, 1986b). Since then, other important studies have been published, such as those by Lee (1989), Lowe (1991), Fukasaku (1992) and Clark (1993). The hypotheses tested in these studies are either derived from various theories of IIT or suggested by more casual empiricism. According to Greenaway and Milner (1989), the hypotheses can be grouped under three headings: *country-specific* variations in intra-industry trade intensity for any given industry will depend on the characteristics of the trading partners; *industry-specific* variations in intra-industry trade intensity across industries will depend on commodity/industry-specific demand and supply characteristics; and *policy-based* variations in intra-industry trade intensity are influenced by policy/institutional factors.

The major country-specific hypotheses are that the average levels of IIT will be high: (1) in DMEs compared with LDCs because of differences in income and in economic structure; (2) in 'large' economies compared with 'small' ones since the scope for product diversity and economies of scale may be expected to be higher in the former; (3) when there is taste overlap between trading partners, since this may increase the scope for the exchange of differentiated commodies; and (4) when trading partners are geographically close, either because proximity means lower transport costs or because of similarities of culture and taste.

There are five industry-specific hypotheses. IIT will be higher: (1) the greater the product differentiation; (2) in commodities where there is scope for scale economies; (3) when the market structure tends towards monoplistically competitive conditions; (4) when there is potential for product cycle trade and/or technological differentiation; (5) when there are more multinational corporations.

The two policy-based hypotheses are that IIT will be greater when tariffs and non-tariff barriers are low; and when economies are subject to some form of economic integration.

Existing econometric studies which test some of these hypotheses generally confirm the expected signs of the estimated coefficients and are sometimes statistically significant, although this is not always the case. In some, the scale economy variables are less consistent; and tariff barriers are often an insignificant variable. A major difficulty with such studies is to obtain data which are appropriate proxies for the explanatory variables, as economic theory suggests. This is especially so for two important industry-specific explanatory variables: product differentiation and scale economies. Given these difficulties, the explanatory power of the regressions in these sudies is often low. Another feature of the econometric studies in the field is that there are very few studies of vertical product differentiation and the activities of multinational corporations as they affect IIT. Greenaway, Hine and Milner (1994) use an intuitively plausible criterion to disentangle vertical and horizontal IIT in the bilateral trade of the United Kingdom, and show that in that country over two-thirds of all IIT is vertical. From this finding, it is worthwhile to distinguish between horizontal and vertical IIT and to work on their explanations separately. On the other hand, using the case of the automobile industry, Becuwe and Mathieu (1992) show that intra-firm trade is the major determinant of intra-industry trade in that industry.

Model specifications

In the literature, there is no consistent theoretical framework to analyse intra-industry trade. Different models explain intra-industry trade under different assumptions. But the major difference arises from the different types of intra-industry trade, namely vertical and horizontal intra-industry trade. To undertake a proper empirical examination of the determinants of intra-industry trade in Asia Pacific economies, these characteristics of intra-industry trade must be taken into account in specifying an econometric model for IIT.

Vertical intra-industry trade

One well-known model, which explains vertical intra-industry trade, was developed by Falvey (1981). This model reveals that vertical intra-industry trade is driven by differences in factor endowments giving the reciprocal demand for both high and low qualities of a product between two countries.

This model is grounded in a two-country, two-factor setting, where initially each country has different endowments of capital and labour and capital is industry-specific. Further it is assumed that at least one sector produces a differentiated rather than a homogeneous commodity. The commodity is assumed to be vertically differentiated. Quality is determined by the capital–labour ratio. Demand for different product qualities is assumed to be a function of the product quality's relative price and consumer income. It is assumed that where varieties of a commodity do vary by quality consumers will always prefer a higher quality to a lower quality variety. However, choice is income-constrained, and some consumers may be initially confined to consume a 'low' quality variety. As income increases, however, they will switch from th 'low' quality to a high quality variety.

On the basis of these assumptions, Falvey (1981) demonstrated that as long as there exists a demand for both high quality and low quality products, intra-industry exchange will take place. As a consequence of the assumption that a higher capital–labour ratio results in a higher quality product, a capital-abundant country will export relatively high quality products, whilst a labour-abundant country will export relatively low quality products.

Clearly, the relative capital intensity of production is a major causal force behind this model.

Following from this, a hypothesis can be generated that the larger the difference in factor endowments, the higher the degree of vertical intra-industry trade. Accordingly, the econometric model can be specified as:

$$IIT_{ij}^{V} = f(RDK_{ij}) + u_{ij} \qquad (7.1)$$

where

IIT_{ij}^{V} represents bilateral vertical intra-industry trade;

RDK_{ij} represents the difference in factor endowments of the countries concerned;

u_{ij} represents the error term.

Horizontal intra-industry trade

There is a large body of literature explaining intra-industry trade along horizontally differentiated products. In the survey of the determinants of intra-industry trade in Chapter 2, they are grouped under circumstances of monopolistic and oligopolistic competition. In summary, these models have several implications for horizontal intra-industry trade.

- Similarities in production stucture, consumers' tastes and initial factor endowments are necessary for the presence of horizontal intra-industry trade. These are the conditions for the presence of horizontal intra-industry trade under Neo-Chamberlinian models.[1] For example in Krugman's (1979) study, it is assumed that there are two economies which are identical in every respect. Every variety of differentiated products enters the consumers' utility function symmetrically and each variety will be produced in only one country. When trade opens, there will be welfare gains for consumers in both countries due to the fact that the number of post-trade varieties available in both countries is greater than

[1] Examples of neo-Chamberlinian models can be found in Krugman (1979, 1980 and 1982); Dixit and Norman (1980); and Venables (1984).

the number available to either under autarky. The gains of opening up economy to trade is the increase in the scale of production, leading to lower unit costs and prices.

- Economies of scale are important in determining horizontal intra-industry trade. Also as mentioned above in the discussion of neo-Chamberlinian models, the incentive to opening up to trade from the production side is the gains which result from increases in the scale of production leading to lower unit costs of production. This means that economies producing differentiated products and trading can take advantage of the larger market.

- Diversity in consumer preferences plays an important role in determining horizontal intra-industry trade. Neo-Hotelling models explain horizontal intra-industry trade based on the assumption of diverse preferences. For example, in the basic Lancaster model, assuming initial factor endowments are the same, horizontal intra-industry trade takes place as a consequence of preference diversity from demand and decreasing costs from production. This is because consumers in both countries can enjoy the variety closer to their ideal one with trade than under autarky. Both countries will also benefit from lower product prices due to exploitation of scale economies.

- Geographical factors to some extent determine horizontal intra-industry trade. For example intra-industry trade could occur between countries with a common border. Because of low transportation costs in the parts of the country adjacent to the border, it is sometimes cheaper to trade products across the border than to transport the product within the country.[2] Further, when countries are geographically close, consumers tend to have a similar cultural environment and therefore similar tastes which is a necessary conditon in some models for the generation of horizontal intra-industry trade. Finally under Brander and Krugman's (1983) oligopolistic model, trade in identical commodities can occur when transportation costs are low.

- Trade restrictions or barriers will diminish any international trade.

Based on the results derived above, and together with previous empirical studies, the following hypotheses can be formulated for horizontal intra-industry trade.

(1) The smaller the difference in per capita income between two countries, the more similar are consumer tastes, hence the higher the degree of horizontal intra-industry trade. This is because similarity in economic development is an important factor affecting the similarity of consumer tastes.

(2) The smaller the difference in factor endowments between two countries, the higher the degree of horizontal intra-industry trade. Similarities in factor endowment are one of the characteristics explaining horizontal intra-industry trade. At the same time it is a necessary condition for economies to have a similar production structure and to exhibit similar consumer tastes.

[2] This explanation can also be applied in explanation of across-border inter-industry trade and vertical intra-industry trade.

(3) The larger the economic size of countries, the more varieties of differentiated goods can be produced under the condition of economies of scale, hence the greater the degree of horizontal intra-industry trade.

(4) The lower the trade barriers and transportation costs, the greater the level of horizontal intra-industry trade.

(5) The higher the levels of development among countries, the higher the capability to develop and produce highly horizontally differenciated goods. These countries are characterised by highly differentiated demand which allows for the exploitation of economies of scale in the production of a wide variety of individual commodities.

Accordingly, the econometric model for this study will be as follows:

$$IIT_{ij}^{H} = f\,(RDC_{ij}, RDK_{ij}, LNY_{ij}, BIAS_{ij}, DUMs) + v_{ij} \qquad (7.2)$$

where IIT_{ij}^{H} denotes th bilateral horizontal IIT of country *i* with country *j*. RDC_{ij} is a proxy variable indicating similarities in demand and tastes between countries. The hypothesis is that similarities in demand and consumer tastes between two countries create markets for differentiated products, thereby increasing intra-industry trade. RDK_{ij} is included in the regression equation as a proxy variable representing similarities in the relative factor endowments between two countries. LNY_{ij} is a variable indicating the average market size of the countries involved. Variable $BIAS_{ij}$

is the overall measure of trade resistance between economies. *DUMs* are the dummy variables to capture the effects of economic integration and similarity in extent of economic development.

Theory suggests that there are different determinants of vertical and horizontal intra-industry trade. Accordingly, the empirical model can be specified as (7.1) and (7.2). To test these models, the key issue is to disentangle total bilateral intra-industry trade into vertical and horizontal trade respectively. As noted in the last section, so far only one or two studies have disentangled intra-industry trade empirically. For example, Greenaway, Hine and Milner (1994) used an intuitively plausible criterion to disentangle the bilateral intra-industry trade of the United Kingdom. To follow their criterion to disentangle intra-industry trade in Asia Pacific economies involves massive data requirements and calculations. Further, it is expected that there are no comparable data available for all economies in this region. Hence, an examination of the determinants of intra-industry trade can only be conducted at an aggregate level. However, it is still possible to examine the determinants by looking at the relative importance of vertical or horizontal intra-industry trade in total intra-industry trade. That is to say, if vertical intra-industry trade is dominant in total bilateral intra-industry trade, empirical tests will reveal that the total bilateral intra-industry trade is explained by differences in factor endowments and vice versa.

The empirical model of the determinants of intra-industry trade therefore can be specified as:

$$IIT_{ij} = f(RDC_{ij}, RDK_{ij}, LNY_{ij}, BIAS_{ij}, DUMs) + \varepsilon_{ij} \tag{7.3}$$

where

IIT_{ij} represents total bilateral intra-industry trade between economies.

ε_{ij} represents the error term.

One of the hypotheses is changed from (7.2) so that if bilateral intra-industry trade is predominantly vertical, the larger the differences in factor endowments the higher the degree of total intra-industry trade, and if bilateral intra-industry trade is predominantly horizontal, the more the similar the factor endowments the higher the degree of total intra-industry trade.

Data description and issues

Intra-industry trade can be measured using the Grubel—Lloyd index.[3] RDC_{ij} is a proxy variable indicating similarities in demand and tastes between countries. It is defined as the relative difference in per capita income and is given by:

$$RDC_{ij} = \frac{|PCY_i - PCY_j|}{(PCY_i + PCY_j)} \qquad (7.4)$$

where PCY denotes the per capita income of the countries. We expect a negative sign on the coefficient of this variable.

[3] See Chapter 4 for definition of, problems with and justification for the use of this measure.

$BIAS_{ij}$ is the overall measure of trade resistance between economies. Drysdale (1967) defined an index of country bias for each commodity:

$$B_{ij}^{k} = \frac{X_{ij}^{k}}{X_{i}^{k}} / \frac{M_{j}^{k}}{M_{w}^{k} - M_{i}^{k}} \tag{7.5}$$

where X_{ij}^{k} is a country's exports of commodity k to country j.

A weighted average of indices of country bias for all commodities k yields an index B_{ij} of country bias in i's aggregate export trade with j:

$$B_{ij} = \sum_{k} (B_{ij}^{k} \frac{\overline{X}_{ij}^{k}}{\overline{X}_{ij}}) \tag{7.6}$$

where $\overline{X}_{ij}^{k}$ is the hypothetical value of X_{ij}^{k} obtaining when B_{ij}^{k} equals unity, and $\overline{X}_{ij}$ is the hypothetical value of X_{ij} obtaining when all B_{ij}^{k} equal unity. The ratio $\overline{X}_{ij}^{k} / \overline{X}_{ij}$ is equal to the percentage contribution of commodity k to complementarity in i's exports to j. But due to data limitations, the variable distance (*LDIS*) is a proxy for the trade barriers between two countries including transportation, insurance costs and geograghical proximity. It is calculated as a natural logarithm of the distance (in kilometres) between major seaports of the two countries. The justification for this proximation is that relative distance is a powerful determinant of country bias in trade (Drysdale and Garnaut 1982).

RDK_{ij} is a proxy variable representing the relative factor endowments between two countries, which is measured by relative difference in capital stock per head and is given by:

$$RDK_{ij} = \frac{|PCK_i - PCK_j|}{(PCK_i + PCK_j)} \tag{7.7}$$

where *PCK* denotes the per capita capital stock of the countries. This captures the degree of product differentiation on the supply side, based on the fact that demand for product differentiation can be met from the supply of such products when the two countries' factor endowment are similar. We expect a negative sign on the coefficient of the variable when horizontal intra-industry trade dominates and a positive sign on the coefficient of the variable when vertical intra-industry trade dominates. But the relative difference of per capita capital stock is highly correlated to the relative difference in per capita income. The existence of multicollinearity prevents these two variables from being included simultaneously in a regression equation (Fukasaku 1992). Given this problem, we will omit the *RDC* variable. This proposition can be justified in the following way: when the variable *LDIS* is a proxy for economic barriers between the two countries, as some economists argue, this variable may actually capture other effects, such as similarity of culture and tastes.

LNY_{ij} is the average market size of the countries involved. It is measured by

$$LNY_{ij} = \log(GNP_i + GNP_j) \tag{7.8}$$

where *GNP* is Gross National Product, and the expected sign for the coefficient is positive.

The regression equation includes several dummy variables in order to capture the special features of bilateral trade relationships as well as the extent of economic development that are not specified by the explanatory variables noted above:

DUM1 ASEAN trade arrangements (+)

DUM2 North American trade arrangements (+)

DUM3 Australia–New Zealand bilateral trade (+)

DUM4 Developed countries bilateral trade (+)

DUM5 NIEs bilateral trade (+)

DUM6 Developing countries bilateral trade (-)

DUM7 Developed and NIEs countries bilateral trade (+)

Dummies 1–3 are intended to capture the effect of economic regional integration on intra-industry trade. Dummies 3–6 measure the relationship between bilateral intra-industry trade and the development level of the economies. Australia and New Zealand are small natural-resource-based developed countries; the other developed countries in the Asia Pacific region are included in D4. Considering the dynamism of Asia Pacific economies and possible changes in trade patterns, D7 is set to represent the bilateral intra-industry trade between developed countries and NIEs.

Thus, the final test equation becomes:

$$IIT_{ij} = f\,(RDK_{ij}, LNY_{ij}, LDIS_{ij}, DUMs) + u_{ij} \qquad (7.9)$$

This study focuses on the Asia Pacific region and includes 18 economies: Brunei, Chile, China, Indonesia, Malaysia, Papua New Guinea, Philippines, Thailand and Mexico, which are regarded as developing countries; Hong Kong, Taiwan, Korea and Singapore, which are NIEs; and Japan, Canada, the United States, Australia and New Zealand are developed countries, among which Australia and New Zealand, which are natural-resource-based developed countries.

Most of the data were extracted and calculated from STARS, the International Economic DataBank (IEDB) at the Australian National University for the years 1975, 1985 and 1995. The IIT index is calculated using UN industrial data from IEDB ISIC Trade Data on manufacturing at the 4-digit level. As shown in Tables 7.1, 7.2 and 7.3, there are 255 observations for each year (Brunei, Chile and Papua New Guinea cannot be found as reporters), but due to missing data for some economies, the actual usable data are 234 for 1975 and 1985, and 230 for 1995. The data of IIT that are summarised in Table 7.4 indicating that the IIT index varies over a wide range (from 0 to 75.8). Clearly, there is an increasing trend in the level of IIT over the years observed.

Table 7.1 Bilateral intra-industry trade in manufacturing among APEC economies, 1975

	Australia	Brunei	Canada	Chile	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Mexico	New Zealand	PNG	Philippines	Singapore	Taiwan	Thailand	USA
Australia	.	0.1	14.4	0.0	4.0	16.7	4.6	10.8	14.2	8.2	10.6	31.8	5.1	10.6	19.6	7.5	12.2	19.3
Canada	11.8	.	.	14.3	9.4	10.1	0.2	10.9	18.2	24.5	16.2	12.5	.	8.2	13.5	5.7	7.6	62.0
China	4.3	0.0	9.6	0.1	.	4.6	0.0	8.1	0.0	5.2	6.8	6.3	0.0	0.3	2.0	.	0.0	33.4
Hong Kong	16.3	10.1	9.0	2.2	0.4	.	14.6	12.4	9.2	36.5	9.3	20.7	0.3	27.1	28.2	17.8	19.3	26.7
Indonesia	5.5	.	1.3	0.0	0.0	12.8	.	4.6	0.6	20.0	0.0	0.8	0.0	2.1	25.6	6.1	2.0	9.9
Japan	12.5	0.0	12.4	2.1	8.4	13.9	4.0	.	35.8	12.1	11.2	11.3	2.4	2.9	6.4	22.6	6.8	34.0
Korea	13.9	0.0	17.4	4.3	0.0	16.4	1.9	34.6	.	4.7	7.6	6.6	0.0	7.7	19.9	11.0	13.0	24.1
Malaysia	10.6	9.6	7.0	0.0	5.2	31.9	15.7	11.2	5.8	.	0.2	5.2	6.7	15.3	41.2	6.9	10.8	19.4
Mexico	5.5	0.0	10.1	13.5	7.7	28.7	0.0	7.7	0.0	0.0	.	4.0	0.0	9.8	0.7	.	6.8	19.0
New Zealand	27.1	0.0	11.4	0.0	5.1	19.0	0.7	10.5	5.7	3.9	1.0	.	2.7	1.8	5.2	13.8	6.7	4.7
Philippines	9.7	0.0	10.5	0.0	0.3	23.6	20.0	2.6	17.3	10.7	1.4	1.6	0.0	.	57.6	4.2	3.1	7.4
Singapore	22.1	1.2	10.2	1.3	2.0	31.4	.	8.4	20.0	46.0	3.7	9.4	5.2	37.7	.	21.0	17.4	36.7
Taiwan	8.7	6.1	3.1	0.3	.	26.1	1.9	20.2	12.3	17.6	8.8	11.4	0.0	4.3	18.6	.	8.3	24.5
Thailand	12.6	0.0	6.5	.	0.0	19.1	9.7	6.9	11.5	13.2	13.6	2.8	0.0	2.9	7.5	5.4	.	7.2
USA	17.9	0.6	64.8	4.9	34.0	26.9	6.0	31.8	21.6	34.5	47.8	7.7	1.2	11.8	37.3	26.9	8.7	.

Source: Author's estimation using data from *UN commodity trade* from the International Economic DataBank, Australian National University.

Table 7.2 Bilateral intra-industry trade in manufacturing among APEC economies, 1985

	Australia	Brunei	Canada	Chile	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Mexico	New Zealand	PNG	Philippines	Singapore	Taiwan	Thailand	USA
Australia	.	0.0	15.3	2.3	25.6	20.7	11.8	8.4	26.0	16.0	3.7	45.6	4.7	13.6	39.9	8.1	14.5	13.7
Canada	25.4	.	.	20.9	7.0	14.9	2.6	9.4	16.7	10.0	25.0	15.2	0.0	6.6	41.8	6.9	10.7	67.9
China	24.9	0.4	6.7	0.3	.	47.7	10.1	10.8	.	22.2	13.5	22.9	0.0	12.2	17.0	.	12.3	13.9
Hong Kong	22.2	7.4	13.3	3.6	34.3	.	19.6	9.3	7.6	44.8	18.8	25.7	0.9	29.9	22.4	9.3	27.8	25.6
Indonesia	4.1	.	1.5	0.0	11.4	8.1	.	5.8	12.3	21.3	0.2	3.1	0.5	50.7	18.1	7.5	9.1	11.7
Japan	9.9	0.3	9.3	5.0	11.2	11.6	6.3	.	37.1	13.1	13.3	11.6	6.8	24.7	12.4	36.7	13.5	23.2
Korea	26.5	0.2	9.5	40.8	.	45.4	15.3	41.7	.	59.8	4.4	23.6	1.2	26.1	47.1	60.5	13.6	34.1
Malaysia	12.1	3.0	13.6	1.0	22.2	48.6	28.5	18.3	18.7	.	0.8	12.0	2.8	18.4	48.5	18.0	22.4	57.6
Mexico	10.4	.	18.3	8.9	14.2	14.6	2.2	11.4	3.2	2.7	.	1.1	0.0	2.7	6.5	.	0.8	61.5
New Zealand	40.6	0.0	14.2	0.7	24.3	24.6	2.0	9.6	29.5	14.0	1.1	.	8.1	2.6	10.4	17.1	20.0	15.6
Philippines	17.1	0.0	5.2	0.0	12.9	42.9	35.9	32.0	6.4	26.5	1.6	2.2	1.0	.	29.0	11.7	7.3	29.2
Singapore	38.6	5.9	40.6	12.1	18.0	33.0	.	15.1	30.8	50.9	34.3	11.3	11.1	52.7	.	47.3	26.2	54.2
Taiwan	9.7	0.2	6.3	1.1	.	14.4	9.6	37.0	55.9	20.5	19.5	18.0	1.0	13.3	39.4	0.0	14.4	23.0
Thailand	19.6	0.0	4.4	0.0	15.5	32.6	10.5	12.4	9.6	22.9	0.2	16.6	1.8	6.2	18.4	11.5	.	26.4
USA	18.5	1.0	65.4	10.5	15.0	23.6	11.8	19.9	26.7	57.4	69.3	22.0	1.1	42.7	48.5	18.5	31.9	.

Source: Author's estimation using data from *UN commodity trade* from the International Economic DataBank, Australian National University.

Table 7.3 Bilateral intra-industry trade in manufactuing among APEC economies, 1995

	Australia	Brunei	Canada	Chile	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Mexico	New Zealand	PNG	Philippines	Singapore	Taiwan	Thailand	USA
Australia	.	0.3	24.5	8.9	22.3	40.6	24.4	13.2	39.1	30.9	12.7	56.7	9.6	16.6	43.3	17.6	34.8	18.3
Canada	28.8	0.0	.	17.7	27.5	29.6	11.9	9.7	23.1	9.0	20.7	25.5	7.3	26.8	19.8	18.1	19.1	69.6
China	23.9	.	26.5	5.1	.	52.4	23.9	38.9	49.6	24.3	7.3	14.7	.	.	54.6	.	22.2	17.1
Hong Kong	30.6	4.3	18.5	10.3	19.5	.	19.7	7.9	5.6	15.2	6.5	12.5	9.2	39.8	26.1	9.9	23.2	26.0
Indonesia	23.0	.	11.3	1.3	24.0	25.3	.	19.1	21.8	42.7	10.2	20.6	6.7	26.8	35.9	23.1	28.3	32.9
Japan	14.4	0.2	14.4	2.2	41.7	12.6	19.9	.	53.6	37.0	15.2	10.0	4.2	35.4	31.2	40.5	29.4	45.1
Korea	36.6	0.0	32.8	0.7	53.3	14.8	18.8	51.7	.	40.5	13.2	10.7	1.4	26.4	42.1	61.9	24.4	48.3
Malaysia	29.2	2.4	17.2	1.1	22.7	45.2	51.5	35.9	34.1	.	6.3	18.0	14.2	45.9	67.5	54.5	63.6	63.1
Mexico	21.0	0.0	26.9	9.8	8.2	21.1	8.2	19.1	10.5	6.3	.	2.6	0.0	3.3	26.1	7.6	19.2	66.9
New Zealand	54.5	0.1	19.4	5.9	14.5	21.0	18.8	10.4	11.4	13.6	1.0	.	3.8	5.9	19.7	13.7	16.0	17.7
Philippines	17.2	.	26.8	3.8	.	51.5	26.7	35.4	26.4	47.6	4.5	8.6	.	.	52.3	.	25.8	51.1
Singapore	43.2	6.3	32.4	1.2	54.4	50.4	.	37.1	43.3	75.5	36.5	26.0	5.0	52.3	.	75.8	59.6	51.5
Taiwan	16.2	.	17.0	1.3	.	38.3	21.8	38.6	56.7	49.4	8.8	14.3	.	.	62.5	.	38.0	37.5
Thailand	31.2	0.9	23.5	4.5	23.2	40.0	30.9	30.5	20.2	44.1	19.3	20.8	22.8	25.0	45.0	39.8	.	46.5
USA	27.7	1.7	68.8	15.8	17.1	39.9	23.9	38.4	40.5	47.1	70.4	32.0	4.4	49.9	48.0	34.2	41.3	.

Source: Author's estimation using data from *UN commodity trade* from the International Economic DataBank, Australian National University.

Table 7.4 Main statistics for the IIT index

Year	Observations	Mean	Standard deviation	Minimum	Maximum
1975	234	11.78	11.58	0.00	64.80
1985	234	18.76	15.54	0.00	69.30
1995	230	27.04	17.35	0.00	75.80

Source: Author's calculation based on data from Tables 7.1, 7.2 and 7.3.

There are no capital stock data on a comparable basis available for these economies. Therefore, following Lowe (1991), capital stock is calculated by cumulating gross investment over the previous 15 years with a depreciation rate of 5 per cent per year. This proximation can be justified by the construction of this variable: the variation in relative difference between capital stock per head will almost always be insensitive to the depreciation rate (Duc 1993).

Data on gross domestic investment and population are taken from the World Bank's *World Tables*. They are measured in US dollars at 1987 prices, and persons, respectively.

GNP data are taken from the World Bank's *World Tables*. For Hong Kong and Brunei, gross domestic product (GDP) is used, since there are no other available data. These data are also in US dollars at 1987 prices.

The distance data are estimated using *The Times Atlas of the World*.

Model estimation and hypotheses testing

Firstly, the model specified above has been estimated with Ordinary Least Square (OLS) estimations for each year using cross-sectional data. The regression results and selected statistics are reported in Table 7.5. $\overline{R}^2$ denotes R-square adjusted for degree of freedom.

To ensure the validity of our regression results, some diagnostic tests must be carried out. A possible source of problems is heteroscadasticity in disturbance terms in conducting the regression analysis based on the cross-sectional data. In order to see whether the assumption of homoscadasticity holds, the Glejser test, commonly regarded as a more powerful test, is applied for the years 1975, 1985 and 1995, respectively. Comparing the calculated results with the critical value, the null hypotheses of homoscadasticity was rejected at the 5 per cent level for each year.

When there is heteroscadasticity there can still be unbiased coefficients from th OLS regression, but the estimates are no longer efficient. One commonly used method to correct for heteroscadasticity is to use a logit transformation of the variables in the model. But this raises problems for the logit tranformation of the IIT indices, since these calculated indices could have any value in the range between 0 and 100, and some of these logit indices will have a negative sign. This causes a serious problem when OLS is used in the estimation of the logit model and it was apparent in conducting these tests.

Table 7.5 Regression results (OLS estimation)

	1975 A	1985 B	1995 C	Pooled D	1975 A'	1985 B'	1995 C'	Pooled D'
RDK	-2.25 (-0.83)	-11.09 (-2.79)	-14.96 (-3.08)	-12.95 (-5.63)	-2.25 (-1.06)	-11.09* (-2.29)	-14.96** (-3.17)	-12.95** (-5.41)
LNY	3.45 (3.13)	6.01 (3.84)	10.63 (6.23)	9.92 (11.49)	3.45** (2.88)	6.01** (3.31)	10.63** (5.92)	9.92** (11.04)
LDIS	-1.79 (-3.11)	-4.10 (-5.21)	-6.02 (-7.30)	-4.07 (-8.70)	-1.79* (-2.30)	-4.10** (-5.13)	-6.02** (-6.05)	-4.07** (-6.92)
DUM1	13.71 (2.54)	12.33 (3.57)	21.43 (5.83)	17.29 (8.38)	13.71** (3.62)	12.33** (3.19)	21.43** (5.90)	17.29** (6.91)
DUM2	17.05 (4.00)	17.19 (2.97)	3.55 (0.60)	10.30 (3.01)	17.05** (2.44)	17.19** (2.95)	3.55 (0.80)	10.30** (2.69)
DUM3	12.85 (1.94)	25.57 (2.85)	31.67 (3.41)	26.09 (4.89)	12.85** (4.13)	25.57** (8.27)	31.67** (9.88)	26.09** (5.96)
DUM4	5.01 (1.58)	-8.79 (-2.05)	-14.18 (-3.12)	-10.99 (-4.44)	5.01 (1.67)	-8.79 (-1.95)	-14.18** (-3.24)	-10.99** (-4.66)
DUM5	10.13 (3.47)	12.96 (3.28)	6.26 (1.40)	10.09 (4.22)	10.13** (4.15)	12.96** (2.35)	6.26 (0.85)	10.09** (3.03)
DUM6	-7.34 (-4.08)	-11.67 (-4.59)	-14.37 (-4.88)	-11.30 (-7.41)	-7.35** (-4.54)	-11.67** (-4.86)	-14.37** (-6.26)	-11.30** (-8.43)
DUM7	7.15 (3.92)	3.55 (1.33)	-3.14 (-0.93)	0.73 (0.46)	7.15** (4.55)	3.54 (1.24)	-3.14 (-0.93)	0.73 (0.48)
const.	-13.19 (-1.07)	-9.09 (-0.51)	-36.24 (-1.77)	-52.52 (-5.16)	-13.19 (-0.90)	-9.09 (-0.43)	-36.24 (-1.58)	-52.52** (-4.68)
$\overline{R}^2$	0.43	0.42	0.51	0.44				
Observations	234	234	230	698				

Note: 1) Numbers in parentheses are t-values.
2) * significant at 5 per cent level.
3) ** significant at 1 per cent level.

Source: Author's estimation.

Table 7.6 Test results for heteroscadasticity and misspecification

Year	Glejser test (χ^2, DF=10)	Reset test (F(DF1, DF2))
1975	61.56	3.42 (1, 220)
1985	47.32	1.85 (1, 220)
1995	42.88	2.65 (1, 216)
Critical value at 5%	18.3	3.84

Source: Author's estimation.

For these reasons, White's (1980) Heteroscadastic-Consistent Covariance matrix estimation was used to correct the estimates for an unknown form of heteroscadasticity. With correction for heteroscadasticity, the regression equations were re-estimated using the OLS estimations and the results are reported in columns D, E, F of Table 7.5. It should be noted that the regression coefficients are unchanged, as expected.

With correction for heteroscadasticity, the estimated coefficients of *RDK* and *LDIS* all have the expected negative sign and are significant at the 5 per cent level (*RDK* in 1995 is insignificant); the coefficients of *LNY* all have a positive sign and are significant at the 5 per cent level. For dummy variables 1, 2, 3 and 5, the estimations are consistent for each year with the expected positive sign, and all are significant, except dummy variable 5. But the coefficients of D7 are positive in 1975 and 1985, negative in 1995, significant in 1975 and insignificant in 1985 and 1995. Coefficients of D6 all have a negative sign and are very significant. Coefficients of D4 are positive in 1975 but negative in 1985 and 1995, insignificant in 1975 and significant in 1985 and 1995.

For the 1975, 1985 and 1995 pooled sample estimations, all coefficients have the expected signs (except D4) and all are significant (except D7).

Another diagnostic test which was conducted is the specification of the model, since any misspecification of the model will lead to biased estimates. Reset tests were applied to examine the test for misspecification. As the results in Table 7.6 show, they are not statistically significant at the 5 per cent level, so we cannot reject the null hypotheses for all equations for each year.

Since the same regression equations were applied over two decades, a test for structural change with the predictive test for stability was undertaken to test the hypotheses for parameter constancy. The tests can be carried out by using the following test statistic:

$$F = \frac{(RSS - RSS_1)/n_2}{RSS_1/(n_1 - k - 1)} \tag{7.10}$$

which has an F-distribution with degree of freedom n_2 and $n_1 - k - 1$. Here RSS = the residual sum of squares from the regression based on $n_1 + n_2$ observations and this has $(n_1 + n_2) - (k + 1)$ degree of freedom. RSS_1 = the residual sum of squares from the regression based on the n_1 observation; this has $n_1 - k - 1$ degree of freedom.

Table 7.7 Statistics for stability test

	1975, 1985	1985, 1995
RSS	53926	69616
RSS1	17013	31005
F(DF1,DF2)	2.07(234, 223)	1.21(230, 223)
F-tables	1.00	1.00

Source: Author's estimation.

These tests were conducted for the years 1975 and 1985, 1985 and 1995. We reject the hypotheses of stability of the parameters statistically for each case. According to the test results reported above, the parameters of the models vary with respect to their stability for different years under study and hence suggest that there is structural change over time.

Interpretation of results

With the use of proxy variables and regression equations including explanatory variables representing country characteristics, quantative interpretation of regression coefficients becomes rather difficult and may obscure the meaning. However, qualitative interpretation of the estimated coefficients still has good economic meaning since it comes directly from the theoretical models. Therefore we will focus on the qualitative interpretation of the estimated results.

The coefficients on *RDK* are negative and statistically significant (except in 1975), supporting the hypothesis that similarities in factor endowment increase the degree of intra-industry trade. At the same time, this result indicates that the intra-industry trade among economies in the Asia Pacific region is more likely dominated by horizontal intra-industry trade. The result, that there is a negative relationship between IIT and differences in factor endowment variable, is predictably consistent with that of Lowe (1991) given that we used his method to calculate the *RDK*: measuring relative resource endowments more accurately, we find that the link between resource dispersion and intra-industry trade remains strong. The insignificance of that coefficient in 1975 suggests that bilateral IIT among APEC economies was not explicitly driven by similarities in factor endowment at that time.

As discussed above, the size of the economies involved affects the extent of intra-industry trade by allowing exploitation of economies of scale. Regression results show that all the *LNY* variables have significant positive coefficients, suggesting that relative economic size is an important determinant of intra-industry trade.

The coefficient of the *LDIS* variable suggested that if the distance between two major seaports of countries *i* and *j* is longer than that of *i* and *k* countries, the *IIT* share of trade between countries *i* and *j* on average will be lower than the intra-industry trade share of trade between countries *i* and *k*. This is because, on one the hand, the longer the distance between economies, the greater the transportation costs. This will certainly have a negative effect on *IIT* between these economies. On the other hand, in geographically closer economies, culture and consumers' tastes tend to be more similar, and there, intra-industry trade is more likely to be driven by the demand side in these economies.

A very interesting finding from this study is that the economic integration dummies and economic development level dummies tend to play a important role in determining the extent of intra-industry trade in this region. The three coefficients of the dummies indicating the subeconomic groups in this region all have significant and positive signs and the shares explaining IIT show an increasing trend over time. More specifically, there is a statistically positive and significant relationships between economic integration and the level of intra-industry trade among these economies. This result suggests several underlying facts. Firstly, economic integration will positively affect consumers' tastes in the direction of diversification, therefore affecting intra-industry trade on the demand side. Secondly, FDI which results intra-firm trade is higher in a common market than in a non-integrated market. This follows from the greater ease of movement of capital within an integrated market. Thus there are sound reasons for expecting the potential for intra-firm trade, which may be recorded as intra-industry trade, to be greater in an integrated market than in a non-integrated market (Greenaway 1987). Thirdly, increased intra-industry trade arising from economic integration results mainly from the reduction in trade barriers among economies. This implies that trade liberalisation causes industries to move toward an intra-industry trade pattern. One of the reasons for this phenomenen is that the gains from trade liberalisation under intra-industry trade specialisation are greater than those under inter-industry trade specialisation. Another reason is that the adjustment costs associated with intra-industry trade are lower than those associated with inter-industry trade (the main finding of this thesis). In the face of trade liberalisation, short-term adjustment costs resulting from the closure of industries can be eased when countries engage in intra-industry trade specialisation rather than inter-industry trade specialisation.

Regression results for the four development level dummies reveal that on the one hand, countries with a higher development level tend to have larger scope for the realisation and expansion of trade in highly differentiated products. On the other hand, if a group of countries has a similar level of development, it will have similar preference structures and factor price relations, therefore the extent of intra-industry trade is greater. As the regression results reveal, while the coefficients of natural-resource-based developed countries and NIEs are positive, the coefficient of developing countries has a negative sign, which supports the above argument, but at the same time, the coefficient of the developed countries changes from a positive to a negative sign and from insignificance to significance over time, and that result seems to be at odds with the point discussed above. However, the coefficents of D7 indicating bilateral IIT between NIEs and developed countries change from positive to negative and from significance to insignificance. This contradiction may be explained by changes in the pattern of trade or interdependence between the economies, with both developed countries and NIEs increasing their intra-industry trade with developing countries over time.

Conclusion

This chapter examined empirically the determinants of intra-industry trade among Asia Pacific economies with a special focus on country characteristics. The results provide strong support for the hypothesis put forward to explain observed intra-industry trade and show that the main theoretical framework which is generally believed to be applicable to trade among developed countries can also be applied to trade in this region among developed, newly industralising and developing countries.

At the aggregate level, growth in intra-industry trade can in large part be explained by the convergence of factor endowments. The greater the relative difference in capital stock per head, the lower the share of intra-industry trade in total bilateral trade, since a similar production structure and overlapping tastes in two countries will ensure the potential gains from intra-industry trade. Simultaneous economic growth or a lowering of transaction costs among trading partners, either due to a relative decrease of prices for transport and communication services or to a removal of policy-imposed trade barriers, tend to be accompanied by an increase in intra-industry trade. This chapter also demonstrates that economic integration tends to have a positive effect on the development of intra-industry trade in the Asia Pacific region.

The analysis identified the main determinants of intra-industry trade. The findings from this chapter, together with the findings from previous chapters, raise important policy implications for current and future economic integration within economies in the Asia Pacific region. This will be discussed in next chapter.

8 Adjusting to Trade Liberalisation: Some Conclusions

Summary

This study examined adjustment costs associated with resource relocation under inter-industry trade and intra-industry trade patterns in the face of trade liberalisation.

Adjustment costs are defined in this study as costs arising from the adjustment process where greater import penetration leads to a contraction in domestic production. For example, resources are displaced from domestic production and may become temporarily unemployed. Redeployment of resources is costly for those involved in terms of temporary loss of earnings, relocation, job search and retraining expenses.[1]

It is argued theoretically that adjustment costs under intra-industry trade are likely to be lower than those under inter-industry trade. This argument is firstly supported using the specific-factors model. It is shown that from the perspective of market segmentation, intra-industry trade is both occupationally and geographically less segmented; in respect of factor price differences, the gap between factor prices before and after trade liberalisation for intra-industry trade is less than that for inter-industry trade. Therefore, under intra-industry trade, adjustment is likely to be smoother

[1] Increased import penetration is, of course, only one of many potential sources of adjustment cost and not necessarily the most important one. Yet the task here is simply to assess which kind of import penetration - that associated with growing inter-industry trade or that associated with growing intra-industry trade incurs the most severe adjustment burden.

because structural unemployment can be avoided and existing skilled labour and physical capital can be re-employed more effectively. Inter-regional mobility of capital and labour is not required in the process of adjustment and the adjustment response to price changes is faster.

The argument that adjustment costs are lower under intra-industry trade compared with those under inter-industry trade is also supported by the following two facts. Firstly, there are studies which indicate that there are linkages between intra-industry trade and foreign direct investment. Two aspects were taken into account when considering the adjustment implications from that perspective. The first is that much intra-industry trade is in parts and components rather than trade in final goods, which are horizontally or vertically differentiated. This IIT through intra-firm trade partly results from the fact that subsidiaries owned by multinationals are more efficient and competitive than the host country's countparts. However, as the traded components from foreign subsidiaries and host country suppliers are produced in the same 'industry' and rely upon similar skills, transferability of labour from contracting to expanding activities may be easier than it would otherwise be. The second aspect is that firms will undertake the costs of retraining labour as rationalisation takes place. As a result, resource relocation under IIT is quicker and smoother, significantly reducing the costs of dislocation and unemployment and lessening the need for government assistance to smooth the transition process.

Secondly, it is argued that it is possible for both factors of production to gain from trade liberalisation under intra-industry trade. Under inter-industry trade, a gain from trade liberalisation in one factor must accompanied by a loss in another factor.

Consequently, it is easier to manage the adjustment following trade liberalisation under intra-industry trade.

A survey of existing empirical studies relating to adjustment costs and intra-industry trade was conducted. Previous empirical studies of adjustment costs can be classified into five groups: the case study approach; the econometric approach; the CGE approach; the factor intensity approach; and the marginal intra-industry trade approach. All these approaches are subject to one or both of the following limitations in measuring adjustment costs: lack of dynamic features and indirect measurement. The dynamic factor demand model is therefore taken up as a possible vehicle for an empirical study of adjustment costs under different trade patterns.

Empirical analysis of adjustment costs associated with the intra-industry trade pattern and inter-industry trade was undertaken in four steps.

The first step was the introduction of a dynamic adjustment costs model. Based on earlier development of the adjustment costs model, Epstein (1981) has shown that by applying the familiar principles of duality and the envelope theorem to the value function, one can generate optimal solutions to quasi-fixed input and variable input and output supply.

Due to the fact that Epstein's dynamic adjustment costs model is based on the price-taking assumption of firms, the justification for the use of this model under economies of scale and imperfect competition was discussed. The result is that when economies of scale are external to firms and internal to the industry, the price-taking assumption of firms is maintained. When economies of scale are internal to firms, only when firms follow price competition can the 'price-taking' assumption be loosely attained.

The purpose of this discussion was to justify the use of the dynamic adjustment costs model in the case of inter-industry trade as well as intra-industry trade. The theoretical explanation of inter-industry trade is based on the conventional framework of perfect competition and constant returns to scale. But horizontal intra-industry trade involves product differentiation, economies of scale, monoplistic competition and oligopolistic behaviour, while vertical intra-industry trade is still explained under conditions of perfect competition and constant returns to scale.

The model provided the theoretical foundation of the empirical analysis. This model not only accounts for the relationships among multiple outputs, inputs and the exogenous shifter, it also allows for the imperfect adjustment of resources in response to changes in external forces.

The second step in conducting the empirical analysis was to test the hypothesis that intra-industry factor adjustment is associated with industries with high levels of intra-industry trade. The test was carried out as follows:

- The use of the dynamic adjustment costs model in the case of inter-industry trade and vertical intra-industry trade is straightforward, but in the case of horizontal intra-industry trade it relies on the fact that the existence of monoplistic competition is rare in reality and that existing theoretical explanations of horizontal intra-industry trade are based on an assumption of price competition.

- Optimal solutions of factor demand and output supply were derived following the steps described in Epstein's initial work on the dynamic adjustment costs model when the function of production is assigned in a quadratic form.

- Using data obtained from the OECD's international sectoral database in quasi-fixed input demand equations, adjustment coefficents were estimated at the subdivision level of ISIC manufacturing industries. Due to the availability of data, this derivation was conducted for Canada, Germany and the United States.

- In explaining the determinants of labour and capital adjustment coefficients, two effects—a trade specialisation effect and structural change effect—were specified in the empirical model. The results strongly support the hypothesis that the higher the degree of intra-industry trade specialisation in an industry, the stronger intra-industry factor adjustment.

Evidence obtained provided initial support for the central hypothesis that in the face of trade liberalisation, the adjustment costs of factor relocation under intra-industry trade specialisation are lower than those under inter-industry trade specialisation. From the perspective of adjustment costs, intra-industry factor adjustment means that there are likely to be fewer costs associated with retraining and relocating of labour, and that laid-off capital can be re-used more effectively.

Thirdly, the central hypothesis that the adjustment costs for labour associated with an industry with a high degree of intra-industry trade specialisation are lower than those with an inter-industry trade specialisation is tested by using data from the US 'Current Population Survey, February 1996: Displaced Worker, Job Tenure, and Occupational Mobility'.

The tests of this hypothesis were firstly conducted by applying a linear probability model (OLS estimation). The results from this test supported the hypothesis strongly: the six adjustment costs all have a negative and significant relationship with the level of intra-industry trade across industries. In consideration of the small number of observations used in the above test, an alternative model—a logit model—was also applied to test the hypothesis. The inclusion of some socio-economic variables, including sex, age and educational level, statistically affected the significance of the level of IIT in explaining labour adjustment costs. But five of the six adjustment cost indicators have expected and significant coefficients in respect of IIT, supporting the hypothesis that there are lower labour adjustment costs associated with an industry with a high degree of intra-industry trade specialisation.

One of the factors that supports the central hypothesis that adjustment costs under intra-industry trade are lower than those under inter-industry trade is related to the activities of MNEs and the fact that the linkage between FDI and IIT is crucial. Therefore, the fourth step in conducting the empirical analysis was to assess the linkage between FDI and IIT both theoretically and empirically.

Theoretically, the linkage between FDI and IIT can be explained using an OLI paradigm by asssuming that the goods traded are differentiated vertically or horizontally. Mainardi (1986) also demonstrates in a theoretical model that all intra-firm trade can be regarded as intra-industry trade. Using data on 'US direct investment abroad' from the US Department of Commerce, the patterns of and changes in US direct investment abroad are examined and it is found that intra-firm trade is growing hand in hand with FDI. A further examination, using Spearman's rank correlation coefficients, reveals that the relationship between US direct investment to European and APEC economies and intra-industry trade with these economies is positive and significantly correlated.

To draw policy implications based the theoretical and empirical analysis of adjustment costs under different trade patterns, it is necessary to examine whether the theoretical determinants of intra-industry trade can be verified empirically. Because existing empirical studies are mainly of European economies, this study tested the determinants of intra-industry trade among APEC economies for the years 1975, 1985 and 1995. It was found that the main theoretical framework which is generally believed to be applicable to trade among developed countries can also be applied to trade in APEC region among developed, newly industralising and developing economies. Similarity in resource endowments is a strong determinant in explaning IIT among economies in APEC region in 1985 and 1995 although it was insignificant in 1975. This suggests that the pattern of intra-industry trade has become horizontal in the last two decades. The level of economic development and similarity in stage of development are important determinants of intra-industry trade in this region. Distance also explains the development of intra-industry trade in the region because of its impact on transportation costs and consumer tastes. It was also found that there is a statistically positive and significant relationship between economic integration and the level of intra-industry trade among these economies.

Main findings

The most important finding of this study is that in the face of trade liberalisation, adjustment costs under intra-industry trade are lower than those under inter-industry trade. More detailed findings of this study can be outlined as follows:

- If an industry has a high degree of intra-industry trade specialisation, the intra-industy factor adjustment is more strongly evident.

- When labour adjustment costs are measured in terms of six indicators, there are lower labour adjustment costs associated with an industry with a high degree of intra-industry trade specialisation.

- There are strong linkages between foreign direct investment and intra-industry trade. This linkage is mainly channelled through intra-firm trade.

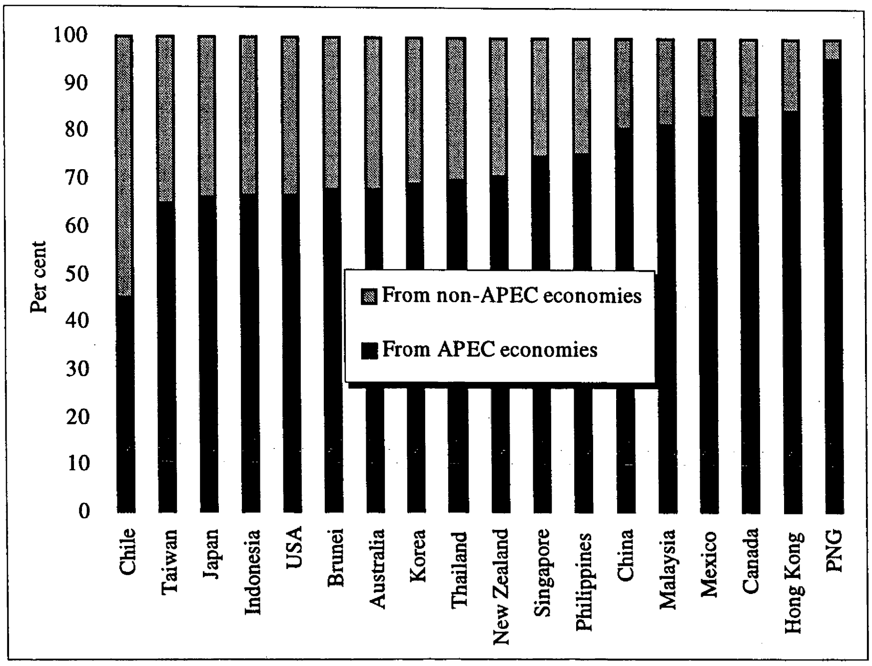
- Although APEC economies are more diverse than European economies, the theoretical determinants of IIT are also verified in this region.

Policy implications for trade liberalisation in Asia and the Pacific

The Asia Pacific Economic Cooperation process was initiated in 1989 in response to the growing interdependence among Asia Pacific economies. Begun as an informal dialogue group with limited participation, APEC has since become the primary regional vehicle for promoting open trade and practical economic cooperation. In the Bogor Declaration of Common Resolve, leaders of this region stated that the foundation of economic growth is open trade. They agreed that APEC member economies should work towards free trade and investment in the region, with the industrialised economies achieving the goal of free and open trade and investment no later than 2010 and developing economies no later than 2020.

There remain great challenges for regional economies in achieving APEC's stated goals. As shown in Figure 8.1, each individual APEC economy (except Chile), has more than 60 per cent of its total imports sourced from the APEC region itself. If these imports are to be subjected to restriction, then trade liberalisation among APEC region will bring about adjustment pressures in domestic production.

Figure 8.1 APEC economies' sources of imports, 1993 (per cent)



Source: author's calculation based on data from *UN Commodity Trade* in International Economic DataBank, Australian National University.

Table 8.1 shows that there are substantial trade barriers associated with the economies within the region both in terms of tariffs and non-tariff barriers (NTBs). Tariffs are probably the most transparent trade impediment and form of assistance. There are substantial tariffs in APEC economies. Manufacturing was the sector with the highest tariff levels, followed by agriculture and then mining. Almost all APEC economies, including high-income economies, apply tariffs.

Table 8.1 Tariff averages and frequency ratios of core non-tariff barriers, APEC economies, 1993 (per cent)

	Tariffs D1	D2	D3	Total	NTBs D1	D2	D3	Total
Australia	0.52	0.31	9.00	7.14	0.00	0.00	0.78	0.61
Canada	3.44	2.06	9.92	8.37	2.35	5.00	7.49	6.67
Chile	11.00	11.00	10.94	10.95	0.44	9.28	10.58	9.34
China	26.39	12.89	48.61	42.35	30.04	40.61	21.92	24.81
Hong Kong	0.00	0.00	0.00	0.00	0.12	0.00	0.14	0.12
Indonesia	12.72	4.75	21.21	18.51	0.18	0.50	4.13	3.31
Japan	3.77	0.02	6.47	5.48	26.41	0.29	7.29	8.60
Korea	11.87	2.79	12.51	11.39	4.06	5.05	1.86	2.44
Malaysia	8.76	4.51	9.96	9.24	25.94	1.73	2.43	4.89
Mexico	12.11	8.80	14.01	13.24	3.01	16.67	5.18	6.19
New Zealand	1.24	0.59	10.48	8.41	0.00	0.00	1.12	0.88
Philippines	27.25	19.92	30.52	29.02	15.32	37.50	39.44	36.62
Singapore	0.00	0.00	0.74	0.58	1.56	0.00	1.14	1.06
Taiwan	11.56	1.50	10.41	9.57	66.47	59.31	28.56	35.98
Thailand	30.53	19.45	41.29	37.67	3.57	2.05	16.91	13.86
USA	2.23	0.80	6.87	5.72	1.95	1.29	19.65	15.75

Notes: Data for 1993 cover all economies except Singapore (1989), Indonesia and the Philippines (1990), Chile, Malaysia, Mexico and Thailand (1991) and Korea and Taiwan (1992). No data were available for Brunei and PNG; D1 represents the division of agriculture, hunting, forestry and fishing, D2 represents the division of mining and quarrying, and D3 represents the division of manufacturing; NTBs are calculated by using the UNCTAD's NTB inventory as frequency ratios for core NTBs in the *Survey of Impediments to Trade and Investment in the APEC region.*
Source: Author's calculation based on the data from Appendix G in the *Survey of Impediments to Trade and Investment in the APEC Region*, 1995.

Non-tariff measures are defined as any non-tariff instrument that interferes with trade, thereby distorting domestic production (PECC 1995 and Petri 1995).

There are also substantial NTBs in APEC economies. Agriculture was the main sector with the highest level of NTBs, followed by manufacturing, then mining. All APEC economies apply NTBs, including, on occasions, high-income economies.

The results of a sectoral survey conducted by the Pacific Economic Cooperation Council (1995) reflect the fact that economies tend to protect sectors in which they do not have a comparative advantage—for example, high tariff protection is generally associated with areas of low comparative advantage. Under this situation, trade liberalisation causes the importable sector of each country to shrink, thereby causing relocation of labour and capital between sectors. The more an industry is protected before trade liberalisation, the more likely it is that the industry will contract after liberalisation. This relocation of labour and capital is not without cost; for example resources that are displaced from domestic production may become temporarily unemployed. The redeployment of resources will be costly for those involved in terms of temporary loss of earnings, relocation, job search and retraining expenses. When the costs are high, they can cause great disruption to domestic economic growth and stability. The result obtained from this study, that there are lower adjustment costs associated with intra-industry trade specialisation than with inter-industry trade specialisation, has significant policy implications for trade liberalisation in this region.

From the findings of this study outlined above, the following policy implications can be generated for APEC trade liberalisation.

Level of intra-industry trade

It has become an article of faith that the European Community's early liberalisation succeeded because of intra-industry trade: few industries disappeared in any of the original six members, although all European economies rationalised production by reducing runs of the varieties of product they produced and lengthening the production runs of the varieties retained. Rarely is this wisdom questioned, even when applied to any other liberalisation exercises that feature large shares of intra-industry trade. The results obtained from this thesis that there are lower adjustment costs associated with resource relocation under intra-industry trade than with inter-industry trade, therefore give firm support to this wisdom. From that perspecive, the answer to the question of whether APEC's trade liberalisation was and is taking place with similar ease therefore depends, among other things, on the level of intra-industry trade in and among economies in this region.

Table 8.2 Aggregate IIT index of manufactures, 1975, 1985 and 1995

	1975	Ranking	1985	Ranking	1995	Ranking
Australia	31.58	6	23.06	14	31.68	14
Brunei	0.07	18	0.49	18	33.89	13
Canada	60.44	3	70.69	2	68.97	3
Chile	9.1	15	10.74	16	23.13	17
China	18.48	11	24.08	13	38.38	10
Hong Kong	36.58	4	51.02	7	31.46	15
Indonesia	4.41	16	11.27	15	26.25	16
Korea	36.47	5	49.39	8	55.21	7
Japan	26.86	9	26.22	12	36.88	12
Malaysia	28.82	8	52.01	6	59.58	5
Mexico	25.75	10	53.91	5	60.65	4
New Zealand	17.07	12	28.38	11	37.65	11
Philippines	14.86	14	53.93	4	55.36	6
PNG	1.33	17	4.83	17	3.07	18
Singapore	61.35	2	71.27	1	77.1	1
Taiwan	30.24	7	39.97	9	54.95	8
Thailand	15.14	13	30.61	10	51.41	9
USA	61.93	1	60.53	3	70.72	2
Unweighted average	26.69		36.80		45.35	

Notes: These trade-weighted averages of IIT are calculated using the SITC International Trade Data of 5-9 manufactured products; Hong Kong's trade data include domestic exports only whereas Singapore's trade data include both domestic base trade and re-exports.
Source: Author's calculation using data from *UN Commodity Trade* in International Economic DataBank, Australian National University.

Table 8.2 presents the aggregate IIT index of manufactures for 18 Asia Pacific economies. This is a trade-weighted average IIT index calculated at the SITC 3-digit level. These figures reveal a number of interesting characteristics of the development of IIT among Asia Pacific economies. First of all, over two decades, the level of IIT has increased significantly, especially in some developing economies. In Brunei, Chile, China, Indonesia, Mexico, the Philippines and Thailand, the level of intra-industry trade was negligible in earlier years but had increased greatly by the mid 1990s.

In newly industrialised economies such as Hong Kong, Korea, Taiwan, Singapore and Malaysia, the level of intra-industry trade is increasing; up to the 1990s the level is over 50 per cent of total trade (except in Hong Kong). The very high level of IIT in Singapore is associated with the special position of this economy as the entrepot for China and the ASEAN countries. Entrepot trade usually involves minor processing and/or services such as packing and marketing.

Among developed countries in the region, while USA and Canada's IIT level increases from an initially high level, Australia and Japan's IIT has not increased greatly and their trade is still dominated by an inter-industry trade pattern. This is because these two economies have a strong revealed comparative advantage, in natural resources in the case of Australia, and manufacturing in Japan.

In the past two decades, the pattern of international trade within this region has seen significant changes. In 1975, there were only three economies whose trade was dominated by intra-industry trade. In 1994, nine out of 18 economies had a trading pattern dominated by intra-industry trade. The rest had a trade pattern still dominated by inter-industry trade.

Further examination of bilateral intra-industry trade reveals that a significant degree of intra-industry trade is among developed economies and NIEs. Among developing countries the level of intra-industry trade is not significant at all.[2]

In summary, in Asia Pacific economies, the intra-industry trade level among developed economies is relatively high but among less developed countries (LDCs), the level is still relatively low, although in the last few years the level of intra-industry trade has grown within the most dynamic group of LDCs—Asian newly industrialising economies (NIEs). The trade pattern of Asia Pacific economies was and still is characterised by inter-industry trade between economies, in contrast to Europe. Compared with relatively painless industrial adjustment to trade liberalisation in Europe, Asia Pacific economies might be expected to suffer higher adjustment costs in the face of trade liberalisation.

Despite the difficulties in adjusting to trade liberalisation for APEC economies, there are still some policy measures that can help smooth the path of trade liberalisation. Assuming that relocation of labour from one industry to another requires each worker to pay a fixed cost, a country has to bear a total adjustment cost which is linearly related to the number of workers relocated. Furusawa and Lai (1996) found in their study that the most cooperative and hence most efficient self-enforcing trade liberalisation path is the one of gradual trade liberalisation. They also found that an

[2] See Tables 7.1, 7.2 and 7.3.

increase in trade adjustment assistance, in the form of compensation for workers relocating out of the protected sector, will accelerate the pace of trade liberalisation and is welfare-improving. Based on these results and the current situation of APEC economies—large adjustment costs expected in the process of trade liberalisation—the introduction of trade adjustment assistance and gradual trade liberalisation is likely to smooth the path of trade liberalisation.

Growth of intra-industry trade

Since adjustment costs under intra-industry trade are lower than those under inter-industry trade, facilitating the development of IIT in Asia Pacific economies will help ease the adjustment process in further economic integration; and industrial structural adjustment will be less painful in future trade liberalisation. The following measures are considered to be important in facilitating the development of IIT.

<u>Economic development</u>

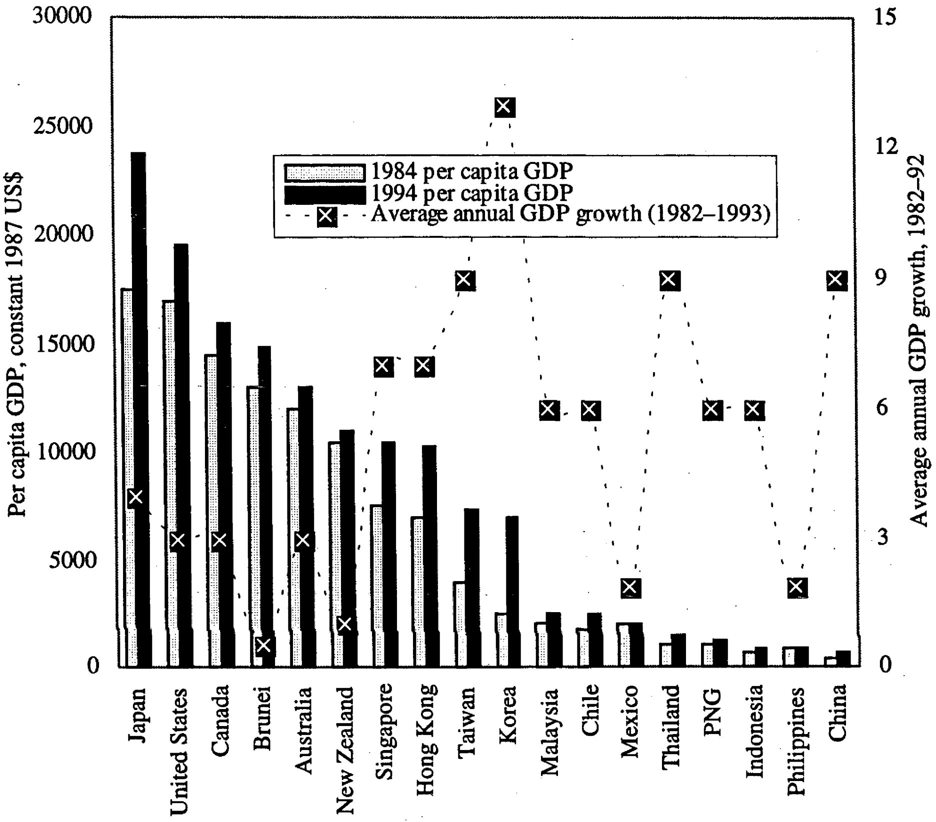
From previous empirical studies and the study in Chapter 7, it can be seen that economic development levels are important determinants of intra-industry trade in general. This is because the higher the level of development among economies, the higher the capability to develop and produce highly differentiated manufactured goods. These economies are characterised by highly differentiated demand which allows for the exploitation of economies of scale in the production of a wide variety of individual commodities. Further, the more similar the level of economic development, the more similar the consumers' tastes will be and the more likely it is that markets for differentiated products will be created.

The most notable feature of GDP levels in the APEC economies as a group is their diversity. APEC comprises very large and small economies; developing and developed economies; slowly and rapidly growing economies. It is made up of economies vastly different in size and at different stages of development.

The rapid growth of many Asia Pacific economies was led, particularly in the early years, by a rapid expansion in exports. This was especially the case in East Asia in respect of goods whose production required intensive use of their abundant labour. China and the more populous Southeast Asian economies are still at this stage. Some more advanced economies have come to rely more heavily on expanding and maturing domestic demand. Even so, trade expansion is important in terms of improving industrial structures and incomes (PECC 1995). Further expansion of exports and domestic demand will create new markets for differentiated products and consequently intra-industry trade.

Reconciling the diversity in development among APEC economies will also be important for the development of IIT in this region. As agreed at the summit in Bogor by economic leaders, industrialised economies will provide opportunities for developing economies to increase their economic growth and level of development. Developing economies are committed to aiming for high growth rates. If the development gap is narrowed in ways consistent with sustainable growth, equitable development and economic stability, the development of IIT is likely to be encouraged from the demand side.

Figure 8.2 Per capita GDP levels and GDP growth in APEC economies



Source: Adapted from *Survey of Impediments to Trade and Investment in the APEC Region.*

The recent financial crisis in East Asian economies will undoubtedly hamper economic growth, not only in those economies experiencing the crisis. This might obscure the development of IIT in the region. Early recovery from the crisis is therefore important for sustained economic growth and smooth adjustment in regional trade.

Convergence of factor endowments

One of the characteristics of Asia Pacific economies is their economic complementarity.

As Table 8.3 indicates, among the 18 economies of APEC, exports from Canada, China, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand and the United States are mainly in manufactured goods, while others mainly export primary goods. A detailed calculation of the Revealed Comparative Advantage (RCA) shown in Figure 8.3 reveals that there are strong complementarities in this region's exports. These complementarities give rise to the pattern of trade in this region, which is primarily of the Heckscher–Ohlin type in which the structure of exports among economies reflects differences in relative factor endowments.

Table 8.3 Structure of exports, 1992 (per cent)

	Manufactures	Primary
Australia	31.5	68.5
Brunei	0.0	100.0
Canada	63.2	36.8
Chile	14.5	85.5
China	79.2	20.8
Hong Kong	24.1	75.9
Indonesia	47.3	52.7
Japan	97.4	2.6
Korea, Rep.	92.6	7.4
Malaysia	64.9	35.1
Mexico	51.7	48.3
New Zealand	25.2	74.8
Papua New Guinea	7.2	92.8
Philippines	73.2	26.8
Singapore	77.9	22.1
Taiwan	91.9	8.1
Thailand	67.8	32.2
United States	75.5	24.5

Sources: World Bank: *World Tables* in International Economic DataBank, Australian National University.

These differences in relative factor endowment among economies in the region imply that there is significant scope for the development of horizontal intra-industry trade through the convergence of factor endowment among these economies. The policies adopted to achieve this development might include the removal of barriers to the mobility of factors including labour and capital, for example migration restrictions and impediments to investment.

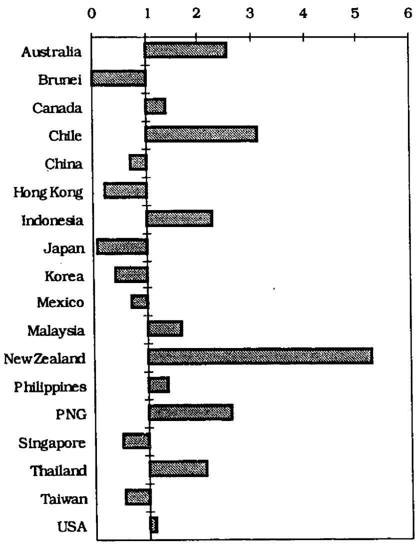
Economic integration

It is observed that lower transaction costs among trading partners, be they by a relative decrease in prices for transport and communication services or by a removal of policy imposed-trade and investment barriers, tend to be accompanied by an increase in intra-industry trade. That is, economic integration influences intra-industry trade among integrated economies positively.

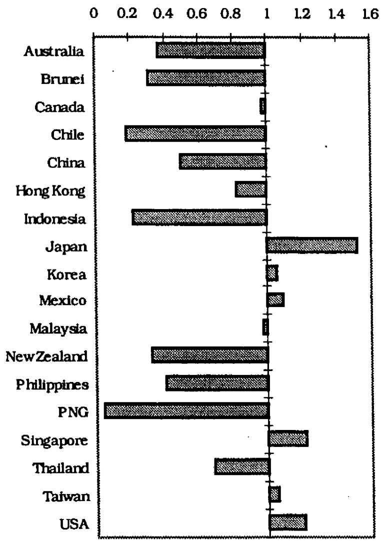
Economic integration, evidenced by a growing share of trade and investment among all member economies with other APEC members, is being driven by the private sector, which is seizing the opportunities created by the complementarity of the region's economies (PECC 1995).

Figure 8.3 Revealed comparative advantage, APEC economies, 1993

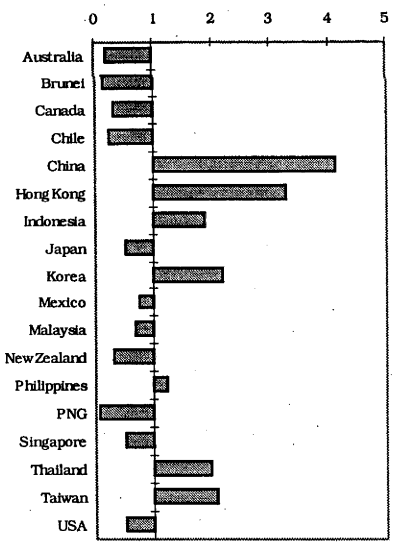
Agriculture intensive



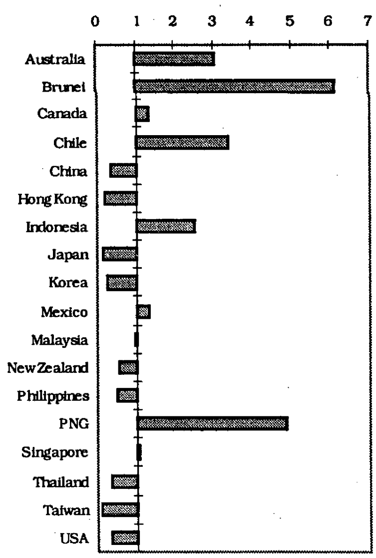
Capital intensive



Labour intensive



Mineral intensive



Source: Author's calculation based on the data from *UN Commodity Trade*, in International Economic DataBank, Australian National University.

Increased IIT from economic integration results mainly from reductions in trade barriers and increased foreign direct investment among economies. The commitment to liberalising trade and investment in the region by 2010 for the forum's developed economies and by 2020 for its developing members promises good prospects for the growth of intra-industry trade in economies within this region. But along the road to the achivement of this goal, the continued gradual reduction of trade and investment barriers will lead to trade expansion within the region and with the world. Goods, services, capital and investment will flow more freely among APEC economies in an incremental, positive manner and intra-industry trade will grow in a continuous and gradual manner. Adjustment to trade liberalisation at each stage will be smoother as this process proceeds.

However, there are also second-round (feedback) effects flowing from economic integration. If the spirit of openness and dynamic economic growth of APEC economies continues, people in APEC economies will share in the benefits of economic growth through more highly skilled and higher paying jobs and increased mobility. Improved education and training will produce rising literacy rates and provide the skills to maintain economic growth. Advances in telecommunications will shrink the barriers of time and distance in the region and link APEC economies so that goods and people move more quickly and efficiently. These developments will further encourage the growth of intra-industry trade.

In summary, there are significant impediments to trade growth among Asia Pacific economies. For this reason, there are large adjustment pressures to achieve the goal of free trade and investment in this region. Because of the lower adjustment costs associated with intra-industry trade compared with inter-industry trade, it is expected that APEC economies will experience a more difficult adjustment process than was the case for European economies, given that the level of intra-industry trade among APEC economies is still low. Thus, policies like gradual liberalisation and adjustment assistance are recommended in the pursuit of trade liberalisation. Further, it is recognised that the most significant characteristics of these economies are the remarkable diversity, complementarity and the increasingly interdependence they display. These characteristics provide challenges and opportunities for the further growth of intra-industry trade so that the pain from further trade liberalisation is likely to be minimised.

Directions for future research

There are three main directions in which future research might contribute to study in this field.

In analysing adjustment costs under different trade patterns, previous studies have been limited by two shortcomings: indirect measurement and lack of dynamic features. This study overcame these problems by using the dynamic adjustment costs model to test the hypothesis that, under intra-industry trade, intra-industry factor adjustments dominate. Further, labour adjustment costs, measured by means of six adjustment cost indicators under different trade patterns, were examined. The direct incoporation of adjustment cost measures into the dynamic adjustment costs model could therefore be a fruitful area for future study.

Secondly, labour adjustment costs in this study are measured in terms of several adjustment cost indicators. An overall measure of labour adjustment costs is not constructed due to the unavailability of information. Constructing an overall measure and test of labour adjustment costs under different trade patterns would offer an more complete assessment of the argument that adjustment costs under intra-industry trade are lower than those under inter-industry trade.

Finally, CGE modelling is often used to conduct welfare analyses of both economy-wide and global policy changes. Current studies using this framework measure welfare changes in terms of net gains. To set out the adjustment costs of factor relocation explicitly and measure them under different trade patterns in the face of trade liberalisation under this framework would be another fruitful direction for future research.

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