

Cointegration and error correction modelling of  
agricultural commodity trade:  
The case of ASEAN agricultural exports to the EU

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*ACADEMIC DISSERTATION*

*To be presented, with the permission of the Faculty  
of Agriculture and Forestry of the University of Helsinki,  
for public examination in Auditorium XII, Unioninkatu 34, Helsinki,  
on September 12<sup>th</sup>, 2003, at 12 o'clock*

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## Preface

I am grateful to many scholars who have contributed directly or indirectly to this work. A special word of thanks is definitely due to Professor Lauri Kettunen, who has supported me in many ways throughout my research career, and more importantly, given me the encouragement I have often needed to keep going. I am also most fortunate and grateful for the guidance and suggestions received from Professor Jukka Kola.

I am likewise grateful to the pre-examiners of this dissertation, Professors Stephan von Cramon-Taubadel and Pekka Ilmakunnas, who carefully reviewed the manuscript and gave me very valuable comments. I wish to extend my thanks to Professor Juuso Vataja for agreeing to become my public examiner.

My colleagues at the MTT Economic Research have granted me over the years the possibility of working in friendly and open-minded environment. I have greatly benefited from daily discussions with Dr. Jyrki Aakkula, Dr. Juha Marttila, Dr. Jukka Peltola, and Professor Kyösti Pietola, in particular. The marginal productivities of the inputs of these friends are strictly positive in all cases.

My heartfelt thanks go to Jaana Ahlstedt for her expert help with managing thousands of details and arrangements, and to Sari Torkko for editorial assistance in the final stages of the production of this volume. I would also like to thank the editorial board of Agricultural and Food Science in Finland for accepting this study to be published in the Journal.

The early part of this dissertation took place at the Malaysian Agricultural Research and Development Institute, and I wish to thank my colleagues in Malaysia for inspiring discussions and support. Especially, I am thankful to Director Samion Haji Abdullah for offering me the opportunity to work there.

Financial support from the MTT Economic Research, the Ministry of Agriculture and Forestry, the Ministry of Trade and Industry, and the Tiura Agricultural Research Foundation is gratefully acknowledged.

Finally, I acknowledge the support and encouragement of my family. Special thanks go to my parents Tuulikki and Seppo whose support I have always been able to count on throughout my education. My greatest thanks, of course, are reserved for my wife and spiritual guru Ellen, as well as my son Weixin, for putting up with a husband and a father constantly dreaming about econometric equations and hammering away at a computer.

Helsinki, June 2003

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The objective of this study is to increase our understanding of the specification and estimation of agricultural commodity trade models as well as to provide instruments for trade policy analysis. More specifically, the aim is to build a set of dynamic, theory-based econometric models which are able to capture both short-run and long-run effects of income and price changes, and which can be used for prediction and policy simulation under alternative assumed conditions. A relatively unrestricted, data determined, econometric modelling approach based on the error correction mechanism is used, in order to emphasise the importance of dynamics of trade functions. Econometric models are constructed for seven agricultural commodities – cassava, cocoa, coconut oil, palm oil, pepper, rubber, and tea – exported from the Association of Southeast Asian Nations (ASEAN) to the European Union (EU). With the aim of providing broad commodity coverage, the intent is to explore whether the chosen modelling approach is able to catch the essentials of the behavioural relationships underlying the specialised nature of each commodity market.

The import demand analysis of the study examines two key features: (1) the response of EU's agricultural commodity imports to income and price changes, and (2) the length of time required for this response to occur. The estimations of the export demand relationships provide tests whether the exporters' market shares are influenced by the level of relative export price, and whether exports are affected by variations in the rate of growth of imports. The export supply analysis examines the relative influence of real price and some non-price factors in stimulating the supply of exports. The lag distribution (the shape and length of the lag) is found to be very critical in export supply relationships, since the effects of price changes usually take a long time to work themselves through and since the transmission of the price effects can be complex. The set of dynamic econometric models estimated in the study are then used to simulate the effects different types of trade policies. More specifically, attempts are made to quantify the effects of a unilateral tariff removal by the EU, an imposition of export subsidies and taxes by the ASEAN countries as well as exchange rate adjustments on ASEAN agricultural exports to the EU.

The results suggest that concepts such as cointegration and error correction specification are well suited for the study of agricultural trade flows, which are typically non-stationary time series. The error correction specification is found to provide a good representation of the data-generating process for agricultural commodity flows from ASEAN countries to the EU. Furthermore, the study shows the importance of inspection of the time series properties and the examination of both short- and long-run adjustment when studying trade functions. The different dynamic responses are often critical to the outcomes of the types of trade policies considered.

*Key words:* agricultural trade, European Union, ASEAN, econometric models, cointegration, error correction mechanism.

## I Introduction

### I.1 Background

International trade is an important field where the interrelationship between the volume of trade and trade policies attracts increasing attention of policy-makers, scholars and analysts. The completion of the Uruguay Round of GATT negotiations in 1994, and the success of the last WTO ministerial meeting in Doha on November 2001 to launch a new comprehensive round of trade talks (WTO 2001), have kept trade issues high on the international policy agenda. Agricultural trade and agricultural trade policy occupy a special niche in the discussion and analysis of international trade. It is well known that international markets for major agricultural commodities are highly complex and diverse. The markets are characterised by specialised conditions of production, transport and marketing arrangements as well as demand responses. Furthermore, international markets of agricultural commodities are closely linked to the domestic agricultural policies followed by individual countries. Most of the countries channel special attention and public expenditure to their agricultural sectors, sometimes to farmers and sometimes to consumers. This often comes in the form of a deliberate action to tip the scales of the domestic or international market in favour of local producers and/or consumers (Houck 1986).

In spite of the impediments to agricultural trade erected over the years by national governments – which have severely inhibited trade expansion – agriculture’s worldwide dependence on trade has been growing each year. In other words, international agricultural trade has been expanding more rapidly than world’s output of agricultural products. Since 1960, each 1 percent increase in agricultural output has been accompanied by 2 percent trade increase. Nevertheless, a characteristics often noted in the in-

ternational trade literature has been the tendency of world trade in agricultural commodities to lag behind trade in manufactured goods. Moreover, it is noted that agricultural commodity exports from the less developed countries have grown at a slower rate than agricultural commodity exports from the industrialised countries. Despite an aggressive export drive by some of the less developed countries, most of them have found difficult to capture a larger share of the world’s agricultural markets (Lord 1991).

Yet, the rate of growth of agricultural commodity exports is of major concern to producers and economic policy-makers in the less developed world, particularly in the countries that are highly specialised in the exports of only a few commodities. Trade in agricultural commodities still dominates the export performance of the economies in these countries. Moreover, agriculture constitutes a significant part of the whole economy and employs much of the population in many less developed countries (LDCs). Changes in prices of agricultural commodities, consequent to changing economic environment or trade policies, can significantly affect country’s income distribution. Increasing agricultural exports as an intermediate step toward restoring external balance of payments equilibrium, for example, was a central component of most economic stabilisation and structural adjustment programs of the LDCs initiated in the 1980s and 1990s.

Interest has accordingly shifted towards investigating the performance of the less developed countries’ commodity exports in the existing international trade environment and under conditions brought about by various policy initiatives. Since industrialised countries are traditionally the main market outlets for the less developed countries’ agricultural commodities, the link between the export performance of the less developed countries and the economic growth and trade policies of the industrialised countries has

been a hotly debated topic in the international trade literature<sup>1</sup>.

Several studies have argued that high import protection of major importing countries, i.e. industrialised countries, has inhibited the expansion of agricultural exports of some LDCs. The EU, Japan, and the USA, in particular, have been the targets of the criticism that their highly protectionist agricultural policies and/or their export subsidies for agricultural products are harmful to the hopes of economic development of many less developed countries<sup>2</sup>. Other studies (see Singer 1950, Prebisch 1959, Lewis 1980, Islam and Subramanian 1989) have suggested that comparatively slower expansion for less developed countries' agricultural commodity exports is explained by low income elasticities and price elasticities of foreign demand.

On the other hand, a number of authors have pointed to the success of those less developed countries who have adopted outward-oriented development strategies as a proof of the irrelevance of this so called 'elasticity pessimism' (see, for example Balassa 1971, Riedel 1984, Muscatelli et al. 1992). Proponent's of that view have tended to suggest that economic policies in the less developed countries are generally more effective in expanding trade than are economic growth rates or import policies in the industrialised countries. Accordingly, a number of economists (for example, Bond 1985, Cleaver 1985, Wattleworth 1988, Boussard and Gerard 1996) have provided evidence that real exchange rates, domestic marketing arrangements and other government interventions play a highly significant role in boosting agricultural export supply from LDCs. Considerable evidence exists for example that overvalued currencies have a strong

dampening effect on agricultural output in developing economies (Jaeger and Humphreys 1988, Krueger et al. 1988, Elbadawi 1992, Ghura and Grennes 1993).

Consequently, it has been argued that the challenge to each country lies in its capacity to manage its agricultural commodity exports in the face of changing economic environment (Johnson 1968, Balassa 1989). In addition, it has been shown that the growth of exports and that of national economy could be accelerated following the introduction of export promotion schemes (Balassa 1975, Fitzgerald and Monson 1987). However, some recent empirical studies (Nogués 1990, Reinhart 1995, Barrett 1999, Rakotoari-soa and Shapouri 2001) have cast doubt on the ability of individual small exporting countries to take advantage of economic policies such as exchange rate adjustment or export promotion schemes for generating higher export revenues in the face of imperfectly competitive markets.

In light of such conflicting evidence and policy implications, this study attempts to increase our understanding of the structure and characteristics of international agricultural commodity trade and to provide instruments for policy analysis. More specifically, it attempts to model behavioural responses of exporters and importers of agricultural commodities by considering three separate issues in detail. The first issue is the long-term relationship between the rate of economic growth and the level of agricultural commodity imports in the importing countries. The other two issues concern the ability of the agricultural exporting countries to influence the level of their exports. The first of these depends on product heterogeneity, which would suggest that exporting countries could alter the demand for their exports through relative price changes. The second concerns the magnitude of the effect that national policy initiatives, in either the importing or the exporting countries, could have on trade flows.

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<sup>1</sup> The evolution of this debate has been described, for example, by Little (1982), Balassa (1989), Papageorgiou et al. (1991), and Dean et al. (1994).

<sup>2</sup> There is a vast literature on the effects of EU and US protection against agricultural export of developing countries. See, for example, Sampson and Yeats (1977), Tangermann (1979), Valdes and Zietz (1980, 1986), Koester (1982), Lundborg (1982), and Matthews (1985).



## 1.2 Earlier research on empirical trade modelling

Empirical models of international trade have been widely employed as forecasting and policy analysis tools for the various agricultural commodity markets. As a result, the literature on empirical commodity models is quite large. Models have served as a means for better understanding the structure and parameters of the behavioural relationships underlying commodity markets. Yet there is no model which can serve all purposes. The choice of theoretical framework, the extent of regional and sectoral desegregation and the choice of data sets and estimation methods determine the domain of applicability of the model. The appropriate analytical approach to modelling is therefore dictated largely by the purpose for which the model has been constructed. Several studies (for example, Sarris 1981, Thompson and Abbott 1983, Labys and Pollak 1984, Goldin and Knudsen 1990) have surveyed the various analytical approaches and their applications. The recent work by Tongeren et al. (2001) provides a comprehensive assessment of the present state of applied modelling in the area of agricultural trade and trade policies.

The core of the modern analysis of trade is the factor proportions theory – the Heckscher-Ohlin (HO) model and its extensions. This theory explains trade by differences between countries in the relative abundance of factors (Dixit and Norman 1980). Specifically, the suggestion is that relative abundance of physical capital leads to the export of relatively capital-intensive products, whereas abundance of cheap labour leads to exports of labour-intensive goods. Subsequently, a number of empirical studies have examined a wide variety of the model's testable propositions. Although some weak tests are favourable to the HO model, there is now overwhelming evidence that the model is rejected when confronted with strong tests (Bowen et al. 1987, Borkakoti 1998). It has been noted, in par-

ticular, that trade theory based on factor proportions yields rather unrealistic conclusions about the level and distribution of trade. It implies, for example, specialisation of production and, on the other, trade flows based on transportation costs.

Until recently, spatial equilibrium models have been one of the most popular approaches to agricultural trade modelling, particularly for purposes of trade policy analysis<sup>3</sup>. The spatial equilibrium formulation offers an efficient means of examining the effects of changes in transport costs on the net trade positions of trading regions. In their critical survey of agricultural trade models, Thompson and Abbott (1983), however, argued that spatial equilibrium models, which rely on transportation costs, provided inadequate explanations of observed agricultural trade flows. They noted a number of other factors that explain levels of trade: product heterogeneity by country of origin, importers' diversification of supply sources, historical and political ties between trading partners, and switching costs to importers. This suggests that the perfectly competitive market assumption of the spatial equilibrium formulation may not adequately approximate the behaviour of the different market participant in international agricultural market.

The work by Armington (1969) provided an explanation of the observed trade flows between countries that were not predicted by spatial equilibrium models. Armington hypothesised that importers have different demands for the same commodity originating from different foreign suppliers, which offered a way of deriving well-defined import demand functions, since an imported commodity is considered to be different from the same good produced domestically. Armington used a constant elasticity of substitution (CES) functional form to describe preferences among imports from various countries. Consequently, the combination of product differentia-

<sup>3</sup> Examples of spatial equilibrium models are Bawden (1966), Bates and Schmitz (1969), Schmitz and Bawden (1973), Shei and Thompson (1977), and Dixit and Sharples (1987). There also exists a spatial equilibrium version of USDA's SWOPSIM model (Roningen et al. 1991).

tion by country of origin and a CES functional form for preferences has become known as the Armington assumption.

Use of Armington assumption implies a departure from a perfectly competitive market structure of international trade, recognising that individual commodities are not perfectly homogeneous. Therefore, it has often been adopted in empirical studies on international trade in both partial and general equilibrium frameworks. Its applications range from modelling of trade to the evaluation of government policies<sup>4</sup>. The first attempt to use the methodology for agricultural trade was made by Grennes et al. (1977). They used the model to predict trade in wheat, arguing that wheat is not really homogeneous and factors such as state trading, monopolistic competition, and cross-hauling give justification to the use of Armington-approach. Abbott et al. (1988) used this approach to explain why the Russian grain embargo caused price movements in a direction opposed to that predicted by spatial equilibrium models.

Empirical research on product differentiation and imperfect competition in international trade increased sharply in the 1980s, and agricultural trade research recognised its importance. For example, the studies by Paarlberg and Abbott (1986, 1987) and Thursby and Thursby (1990) on the world wheat market provide valuable insights into the nature of trade policies in imperfectly competitive markets. Using conjectural variation approach these studies offer a useful framework for evaluating complicated policy responses to imperfect competition. The approach, however, has been criticised as an ad hoc way to model dynamic features in a static framework. The topic of product differentiation has also been treated extensively in the trade literature and a common framework has emerged for

its analysis. Helpman and Krugman (1985) have provided a synthesis of this research, although they have not attempted to unify all the recent developments in international trade theory, since the results depend on the particular type of market structure being considered.

The development of imperfect competition in international trade theory also necessitated the computable general equilibrium (CGE) approach provided by Dixit and Norman (1980). The CGE models, where trade is always assumed to be in equilibrium, have usually explained trade flows by the Armington assumption of product heterogeneity by country. These models have been used to study the economic effects of trade policies, such as tariffs and non-tariff barriers (NTBs), in a variety of settings<sup>5</sup>. Some are multi-country models that focus on analysing the effects of global trade policies or policy changes such as the latest Uruguay Round agreements. Others focus on analysing commercial policies of a single country. Although rich in detail and theory, the CGE models do not lend themselves to validation since the equations are deterministic (Lord 1991). Another problem is that CGE models are usually static. Yet, some users of trade policy analyses need information on the time path of adjustment of demand, supply, and price.

One of the early attempts to simulate trade flows between countries that were not explained by relative abundance of factors was based on gravity models. This approach, developed by Tinbergen (1962), Pöyhönen (1963), and Linne-  
mann (1966), explained trade flows by the income of each of the trading partners and the distance between them. The model was designed to have predictive abilities given that the predetermined variables in the model, such as income and population, could be forecasted. The model was originally considered a robust empirical relationship without firm theoretical foundations, but since the late 1970s several theoretical developments have appeared in support of the grav-

<sup>4</sup> Empirical models using the Armington-assumption have been developed, for example, by Grennes et al. (1977), Johnson et al. (1979), Sarris (1983), Thursby et al. (1986), Babula (1987), Goddard (1987), Abbott (1988), Alston et al. (1990), Duffy et al. (1990), Haniotis (1990), Ito et al. (1990), and Honma (1991).

<sup>5</sup> See Shoven and Whalley (1984), Srinivasan and Whalley (1986), DeMelo (1988), and Hertel (1997) for surveys of CGE trade modelling literature.

ity model. Anderson (1979) made the first formal attempt to derive the gravity equation from a model that assumed product differentiation. Helpman and Krugman (1985) and Helpman (1987) used a differentiated product framework with increasing returns to scale to justify the gravity model. Subsequently, Bergstrand (1985, 1989) gave a microeconomic foundation to the gravity model within the framework of a general equilibrium model of world trade. More recently, Deardorff (1998) has offered a theoretical derivation of the gravity model even from the Heckscher-Ohlin framework. Parallel to the search for a solid theoretical foundation for the gravity model, researchers have also examined the econometric issue of what is the correct way of specifying and estimating the model<sup>6</sup>.

Another method that has been widely used to analyse past export performance is the constant market share (CMS) approach. The CMS method partitions the performance of a country's exports of a good into the structural components, which are associated with the growth in foreign demand and the geographical distribution of exports, and the share adjustment effect, which is associated mainly with the country's export competitiveness. The method has been used, among others, by Richardson (1971), Balassa (1978), Jepma (1981), Fatimah and Abdul Aziz (1992), Mohammad and Habibah (1993), Lloyd (1994), and Mad Nasir et al. (1998) to analyse changes in export shares and changes in competitiveness. Predictive power is usually given to the method by forecasting future trade shares as equal to past ones, or by projecting future changes in trade shares as equal to historically observed ones. Although this approach is not a bad first approximation for aggregated group of commodities, it is inappropriate for individual volatile agricultural commodities (Sarris 1981). The method does not offer a means of determining why ex-

ports market shares of a country have varied. Therefore, it has been used primarily to provide an accounting framework for assessing past export performances.

Econometric modelling has been particularly effective and useful approach in increasing our knowledge of the behavioural relationships underlying various agricultural commodity markets. Econometric models serve both as a means to estimate the parameters and to test the hypothesis that the estimated parameters satisfy the relevant restrictions imposed by the economic theory. At the same token, econometric models lend themselves to validation and provide efficient simulation instruments, which can be used for prediction and policy studies – for example, for testing the operation of different trade policy schemes under alternative assumed conditions. Moreover, considerable progress has been made recently in the development of dynamic econometric modelling of commodity markets. These models have reached a point where they are able to capture the important time lags – biological, decision making, commercial, and transportation – which occur in real world commodity markets. A model that operates entirely within one time period may miss many of the important consequences of policy actions and of subsequent market adaptation.

## 1.3 Research focus

There is no doubt, in view of the importance of the agricultural commodity markets to the less developed countries, that in-depth studies of the world's agricultural commodity markets are needed. But to address all the issues discussed above, one needs a vast amount of information about the many aspects of agricultural commodity trade, as well as substantial resources and a long period of data preparation and research. In order to limit the scope of the present effort, this research focuses on agricultural trade relations between the Association of Southeast Asian Na-

<sup>6</sup> Recent empirical applications, which have contributed to the improvement of the performance of the gravity equation, include, among others, Mátyás (1997), Chen and Wall (1999), Breuss and Egger (1999), Egger (2000, 2001), and Carillo and Li (2002).

tions (ASEAN) and the EU. More specifically, the focus is on the structure and operational characteristics of ASEAN agricultural commodity exports to the EU.

Agricultural trade relations between ASEAN countries and the EU have barely been studied so far. There is, however, a growing need for information on and analysis of these issues. On the side of ASEAN, the economies are highly dependent on the industrially advanced countries both as markets for exports and as sources of imports of capital goods (Dent 1997). This is because the industrial countries are traditionally the major consumers of ASEAN's primary commodities, and more recently, the main market outlets for ASEAN's growing manufactured exports as well. In general terms, the export structure of ASEAN, dominated by geographic-specific primary commodities and low-cost manufacturers, is inherently complementary with the export structure of the EU, based on high-quality foodstuffs and specialised machinery and instruments.

Trade relations between the countries of ASEAN and the countries of the EU have a long history. Merchant adventurers, colonialists, traders, and foreign investors from Europe have in the past three centuries brought about a continuous exchange of goods, interests, and ideas with Southeast Asia. In more recent times, mutual cooperation among Southeast Asian countries, on the one hand, and the European countries, on the other, have led to the creation of two economic groupings, ASEAN and the EU, dedicated to the idea of mutual benefits through trade (Simandjuntak 1997). Currently, the ASEAN grouping has a membership of ten countries<sup>7</sup>. It is comparable to the EU in population size but is very

much smaller in economic size as measured by GDP and trade volume.

ASEAN countries (with the exception of Singapore) are well endowed with natural resources, both land and mineral. Agriculture has, therefore, remained one of the key sectors of their economies, in spite of the evident success of the manufacturing sector during the last decades. Agriculture accounts for 12 percent of output, 46 percent of employment, provides about 15% of all export revenues, and plays a major role in reducing rural poverty (Niemi, 1998). Furthermore, the export-oriented agricultural sector provided the "silver lining" for the ASEAN economies in the light of the economic slowdown and substantial currency devaluations in the late 1990s.

The EU, which represents one of the world's largest markets for raw materials and agricultural products, has a considerable influence on the structure of world agricultural trade. Furthermore, the EU is an attractive and very sought-after market for exporters throughout the world, with imports of nearly € 65 billion in 2000. The EU remains an important destination for ASEAN agricultural products as well, accounting for about 16% of total ASEAN agricultural exports. It ranks second (after Japan) among ASEAN's export destinations for agricultural products. During the ten-year period between 1990 to 2000, the total ASEAN agricultural exports to the EU rose from € 4.3 billion to € 6.2 billion (USD 5.7 billion), showing an average annual growth rate of 3.7%. Over the years, ASEAN countries have also managed to increase their market share in the EU quite substantially. By 2000, ASEAN countries represented 7.8% of extra-EU agricultural imports, compared to 3.6% in 1977. Furthermore, the agricultural trade balance has also clearly tilted in favour of ASEAN, with a trade surplus of € 4.1 billion in 2000.

Despite the success in penetrating to the EU market, ASEAN has been concerned with agricultural protection policy of the EU (Daquila 1997). The two major irritants in EU-ASEAN agricultural trade relations have been the variable levies/tariffs and other interventions imposed

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<sup>7</sup> ASEAN, originally made up in 1967 of five very different but geographically close countries (Indonesia, Malaysia, the Philippines, Singapore and Thailand), was by no means the first attempt at regional organisation in Southeast Asia, but in the post-colonial years it has proved the most durable. Brunei joined the Association in 1984 and Vietnam in 1995. Laos and Myanmar became official members of the Association in July 1997, and Cambodia in 1998.

by the EU on products such as sugar and rice, and discriminatory measures against ASEAN tropical products – such as cocoa, vegetable oils, fruits, tobacco and coffee – that compete with the products from the African, Caribbean and Pacific countries (ACP countries)<sup>8</sup>. These discriminatory measures have usually included tariffs to protect ACP exporters.

In relation to the above and particularly in view of the importance of the agricultural sector in the ASEAN economies, ASEAN has taken a special interest in encouraging the EU to liberalise its trade in agriculture. ASEAN hopes that with liberalisation, the member countries will be able to improve their market access for agricultural products in the EU. Thus, the ASEAN welcomed the Uruguay Round Agreement on Agriculture, which put certain limits on the EU's traditional agricultural policies, and reduced the scope for isolating domestic markets. The launching of the Doha Development Agenda and future WTO negotiations (WTO 2001) provide an important opportunity for extending the process of trade liberalisation.

## 1.4 Scientific interest

The scientific challenge of this study is to combine recent theories of the structure of trade and applied econometrics in order to provide a good representation of dynamic behavioural relationships underlying agricultural trade flows between ASEAN and the EU. International trade theory and econometric analysis interact in several ways. First, theory is used to derive hypotheses that can be tested econometrically. Second, the theory helps to specify structural relationships

in the model in a way than can lead to more appropriate estimation. Third, the theory helps to specify appropriate functional forms to estimate. Finally, econometric models can be used to assess the results of trade policies when they have been estimated in their structural form.

Economic theory is therefore the foundation on which modern structural econometric models are built. Yet there is considerable distance between theoretical specification and empirical implementation in practical econometric models. For instance, the theory may provide little evidence about the processes of adjustment, and which variables are exogenous and which are irrelevant or constant for the particular model under investigation (Hendry et al. 1984). Numerous accommodations must be made in order to build models that fit real world situation and correspond at least approximately to the underlying theory. This phenomenon is not unique to models of agricultural commodity markets, though because of imperfect understanding of the markets, lack of data, and frequent institutional interventions in the market process, it may be more pronounced with agricultural commodities than with other modelling activities.

The wide swings in demand, supply, and price for many commodity markets are characteristics of their structure and operation. The business cycles in industrial countries account for variations in demand for raw materials, which serve as industrial inputs. Weather and harvest conditions cause unanticipated changes in agricultural supply. Technological developments allow substitution between natural commodities and manmade substitutes. Long adjustment periods in supply and demand introduce cyclical characteristics into the dynamics of many markets. And finally, speculation frequently increases the volatility of price movements (Adams and Behrman 1976).

For these reasons, no model could hope to encompass the myriad essentially random aspects of international agricultural commodity trade. In other words, no matter how elegant or complete a model of international commodity trade might be, it has no way of coping with the

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<sup>8</sup> The EU trade policy favours certain non-member countries and trading blocs such as the ACP countries, which have preferential access to the EU markets. The privileged treatment of the ACP countries has far-reaching historical roots, since most of them are former colonies of the EU member countries.

possibility that extreme weather conditions might lead to crop failure and show up as an outlier in an otherwise immaculately constructed body of data on trade flows. Furthermore, the specialised nature of each commodity market means, on the one hand, that a great deal of detailed market information must underlie the structure of the econometric market model and must be brought to bear when the model is used for forecasting and simulation. On the other hand, full allowance for all specialised market conditions may stand in the way of recognising the behavioural generalities, which are the basis for econometric models (Greene 1997).

For the purpose of policy planning and forecasting agricultural trade, long-run dynamic properties of the model are of particular interest. However, estimating such long-run relationships is likely to pose some problems because the variables – such as income, the price level, trade flows, and exchange rates – used in the econometric trade analysis typically exhibit multicollinearity and non-stationarity<sup>9</sup>. Efficient inference in time-series econometrics requires taking account of this phenomenon.

Fortunately, recent research and a growing literature has shown that there are interesting and appropriate ways to analyse the structure and parameters of the long-run behavioural relationships in agricultural commodity markets, even though the variables are non-stationary. In particular, the use of dynamic specification with an error correction mechanism (ECM) in single-equation and multi-equation macroeconomic forecasting models has emerged as an especially effective approach in this field. Similarly, the concept of cointegration has become increasingly

popular, both as an underpinning of the error correction representation, and as a way of separating the specification and estimation of the long-run properties of an economic relationship and short-run dynamic adjustment towards the long-run equilibrium.

The application of the ECM and cointegration is a new and rapidly expanding area of econometrics (both theoretical and applied), as witnessed by the number of articles that have been published since the mid-1980s. It is new in that while the foundations of the ECM specification rest heavily on the seminal work of Sargan (1964), it was really only in 1986 (following the March special issue of the *Oxford Bulletin of Economics and Statistics*) that cointegration became a familiar term in the literature (Harris 1995). There have been, and continue to be, major new developments in this area. The present study attempts to utilise these new methodologies by constructing and operating a common model specification that is applied to the major type of agricultural commodities exported from the ASEAN countries to the EU.

Consequently, the study seeks to provide unified treatment of the economic theory, econometric modelling, and policy evaluation of trade in order to capture the essential features of the agricultural commodity markets with appropriate modifications to each of the commodities considered. Furthermore, the econometric models developed in the study are intended to capture the dynamics underlying trade and price formation in selected agricultural commodities exported from the ASEAN countries to the EU. The term dynamics refers here to the type of analysis in which the object is to trace and study the specific time paths of the variables, i.e. to consider the long periods of adjustment in agricultural commodity markets. This type of information is important because it fills a serious gap that marred trade analyses undertaken within a comparative-static framework.

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<sup>9</sup> If this is the case, the conventional hypotheses-testing procedures based either on small sample or asymptotic distributions of the estimates (based on t, F, chi-square tests, and the like) may be in suspect. The problems are often dealt with by taking first differences of all the variables before any estimation are done. Nonetheless, taking first differences is a major drawback because the long-run variation of the data is removed, and only short-run effects are explained by the model (Bentzen and Engsted 1992).

## 1.5 Objectives and methodology of the study

The objective of this study is to increase our understanding of the specification and estimation of agricultural commodity trade as well as to provide instruments for trade policy analysis. More specifically, the aim is to build a set of dynamic, theory-based econometric models which are able to capture both short-run and long-run effects of income and price changes on ASEAN major agricultural commodity exports to the EU, and which can be used for prediction and policy simulation under alternative assumed conditions. A relatively unrestricted, data determined, econometric modelling approach based on the error correction mechanism is used, in order to emphasise the importance of dynamics of trade functions. Econometric models are constructed for seven agricultural commodities – cassava, cocoa, coconut oil, palm oil, pepper, rubber, and tea – exported from ASEAN to the EU. With the aim of providing broad commodity coverage, the intent is to explore whether the chosen modelling approach is able to catch the essentials of the behavioural relationships underlying the specialised nature of each commodity market.

As a summary of the earlier discussion, each of the following issues will be assessed in the remainder of the study: 1) to examine and explain the recent pattern, composition, and trends in ASEAN-EU agricultural trade; 2) to estimate short-run and long-run elasticities of import and export demand (supply) for commodities exported from ASEAN countries to the EU by applying a theory-based, dynamic econometric modelling framework; 3) to identify and measure quantitatively short-term and long-term relationship between the rate of economic growth in the EU and the growth rate of EU commodity imports; and 4) to examine the capacity of the ASEAN countries to influence the level of their commodity exports to the EU.

The approach to the analysis of agricultural

commodity trade adopted in the study is one that builds from theory and dynamic specification to estimation and validation, and finally to policy analysis. The theoretical framework is based on recent theories of trade in the presence of imperfectly competitive markets. The theory adopted embodies important recent advances in consumer preferences that give rise to product heterogeneity in international trade; it describes equilibrium conditions in such a market; and it makes explicit the constraint that need to be imposed if complete systems of trade are to be formulated and estimated.

Empirical analysis is based on econometric models that capture the dynamics underlying trade and price formation in commodity markets, and it is conducted by means of recently developed econometric concepts. Among these, the so-called ‘general to specific’ approach advocated by Hendry (1986) is applied in the context of data series whose (non-) stationary properties are investigated. Furthermore, the notion of cointegration (Engle and Granger 1987) of a set of variables is analysed. The approach follows closely the modelling strategy developed in a series of papers by Davidson et al. (1978), Hendry and Richard (1983), Hendry (1986), Lord (1991), and Urbain (1992). The application of this modelling strategy to a set of selected commodities exported from ASEAN countries to the EU offers an opportunity to test the validity of the chosen approach. The empirical analysis of the study will be conducted with a sample of annual data that cover ASEAN’s major commodity exports to the EU from 1961 to 2000.

## 1.6 Organisation of the study

This study consists of eight chapters and it is organised as follows. The next chapter provides background information on ASEAN-EU agricultural trade relations. It examines and explains the recent pattern, composition and trends in ASEAN-EU agricultural trade. The chapters

three and four lay out the general theoretical framework used in this study for analysing agricultural commodity trade and trade policies. The third chapter examines some of the essential features that need to be considered in the characterisation of international commodity trade, one being the conditions that give rise to imperfect competition. The fourth chapter examines the effects of various trade policies on trade volumes and prices, and presents some ideas about the effects of individual trade policies on general economic welfare.

The chapter five presents the econometric methodology employed by the study for modelling the dynamic relationships of commodity trade. It derives the general dynamic model, which is based on the theory of co-integral processes and the error correction mechanism, and which is used to characterise the demand and

supply relationship in the bilateral trade flows. The validity of the model is tested in chapter six by applying it to the bilateral trade of certain commodities between the EU and the ASEAN. Empirical results of the estimated models for the commodity trade are then presented.

The chapter seven utilises the model to examine the effects of alternative trade policies on the trade flows between the EU and ASEAN countries in the case of selected commodities. More specifically, the model is used to examine the impacts of tariff reductions, export subsidies, and export taxes on the trade volumes and prices. The analyses provide important insights into the dynamic adjustment processes in commodity trade. The study ends with a summary of the findings, main conclusions and suggestions for future research.

## 2 ASEAN agricultural trade with the EU

This chapter provides background information on ASEAN-EU agricultural trade relations. It analyses the development and structure of ASEAN agricultural trade with the EU between 1961 and 2000. Some comparisons with third countries and regions will also be made in order to highlight the significance of ASEAN's agricultural trade with the EU in the context of global farm trade. Furthermore, the chapter attempts to investigate the major ASEAN and EU trade policies and practices influencing agricultural trade flows from the ASEAN region to the EU. The main thrust of the discussion will be on factors distorting trade, specifically interventions on exports or imports – such as export taxes, export subsidies, trade quotas, tariffs and non-tariff barriers.

The trade data, in general, is taken from the Statistical Office of the EU (EUROSTAT), supplemented with individual country sources as required to fill gaps. This data is based on the

Standard International Trade Classification (SITC). For the purpose of this study, the agricultural product heading is defined to include food and live animals (SITC 0), beverages and tobacco (SITC 1), animal and vegetable oils (SITC 4), hides, skins and fur skins (SITC 21), oil seeds and oleaginous fruits (SITC 22), natural rubber (SITC 231), and textile fibres (SITC 26).

In the analysis, the trade data has been expressed in the euros [and before 1999 in the European Units of Account (ecus)<sup>10</sup>]. Table 1 shows

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<sup>10</sup> The ecu was a “basket” currency unit, based on a certain quantity of each Community currency, weighted on the basis of a five year average of the gross national product (GNP) and intra-Community trade balance of each member state. To avoid too much confusion when discussing times before and after the launch of the Monetary Union, the euro will be used throughout, even when referring to the period before 1999.



Table 1. The conversion rate of the euro into the US dollars during 1971–2000.

Year	Value	Year	Value	Year	Value	Year	Value	Year	Value
1971	1.048	1977	1.141	1983	0.890	1989	1.102	1995	1.308
1972	1.122	1978	1.274	1984	0.789	1990	1.273	1996	1.267
1973	1.232	1979	1.371	1985	0.763	1991	1.239	1997	1.134
1974	1.193	1980	1.392	1986	0.984	1992	1.298	1998	1.121
1975	1.241	1981	1.116	1987	1.154	1993	1.171	1999	1.065
1976	1.118	1982	0.980	1988	1.182	1994	1.190	2000	0.923

the conversion rate for the US dollars. These rates will allow the data to be expressed in US dollars, if required. They also show that the choice of the euro amplifies the apparent growth in trade between 1977 and 1985 in comparison with an evaluation in US dollars, but it lowers the apparent growth in trade between 1985 and 1995, due to the fall in the value of the dollar. The choice of the US dollar as numeraire would obviously have the opposite effect on these figures.

## 2.1 The nature of ASEAN-EU agricultural trade

ASEAN's two-way agricultural trade with the EU has more than sixfolded since 1961. The trend rate of growth per year over the period 1961–2000 was 8.7%. During the ten-year period between 1990 to 2000, the total ASEAN-EU agricultural trade rose from € 4.3 billion to € 7.7 billion (USD 7.1 billion), showing an average annual growth rate of 5.8%. The agricultural trade balance has clearly tilted in favour of ASEAN, with a trade surplus of € 3.3 billion in 2000.

The EU is a more significant agricultural trading partner for ASEAN than ASEAN is for the EU. Overall, the EU ranks second (after Japan) among ASEAN's trading partners in agricultural products. Two-way trade with the EU now accounts for 14% of total ASEAN agricultural trade. By comparison, trade with Japan and

the US account for 18% (€ 10 billion) and 13% (€ 7 billion) of ASEAN agricultural trade, respectively.

On the EU side, trade with ASEAN accounts for 6.4% of total agricultural trade: a jump from the 5.3% share in 1990. The EU's two-way agricultural trade with the US was worth € 18.2 billion (USD 16.8 billion) in 2000. Its agricultural trade with Russia for the same year was € 3.4 billion (USD 3.1 billion). Between 1990 and 2000, trade with the US and Russia increased at trend rates of 5.3% and 0.1%, respectively.

ASEAN's agricultural exports to the EU grew particularly strongly during the period of 1977–85 (Figure 1). However, in the period from 1985 to 1990, the value of these exports declined by 23%. Over the ten years to 2000, these exports rose again steadily from € 3.4 billion to € 5.5 billion (about USD 5.1 billion). Major agricultural exports from ASEAN to the EU in order of export value include vegetable oils, vegetables and fruits, fish and crustaceans, and crude rubber. In 2000 these four product groups together accounted for almost 70% of total ASEAN agricultural exports to the EU.

Despite the remarkable growth in ASEAN agricultural exports to the EU, exports grew at a much slower rate than total ASEAN exports to the EU over period 1990–2000. Agricultural exports grew at an average annual rate of only 4.7%, compared to 14.4% for the part of the total exports.

Nevertheless, the EU remains an important destination for ASEAN agricultural products, accounting for about 14% of total ASEAN agricultural exports. Japan is the largest export mar-

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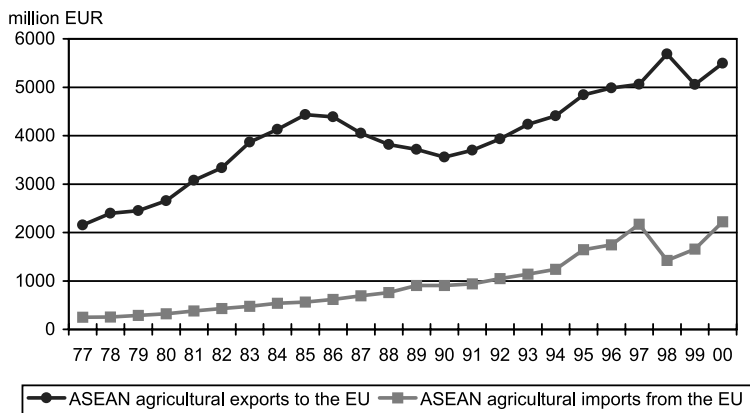


Figure 1. ASEAN agricultural trade with the EU from 1977 to 2000, exports and imports in millions of euros.

ket for ASEAN farm products, accounting for about 27% of ASEAN farm exports. Exports to Japan reached € 10.6 billion (USD 9.8 billion) in 2000. ASEAN agricultural exports to the US totalled € 4.6 billion (USD 4.2 billion) in the same year. Over the years, ASEAN countries have also managed to increase their market share in the EU quite substantially. By 2000, ASEAN countries represented 8.5% of extra-EU agricultural imports, compared to 5.9% in 1977.

By the same token, ASEAN countries have become rapidly expanding markets for EU farm exports because of their large populations, buoyant economic performance, and per capita in-

comes at levels where food is still an important component in the consumption.

Figure 1 shows that, during the ten-year period between 1990 and 2000, ASEAN agricultural imports from the EU rose from € 0.9 billion to € 2.2 billion (about USD 2.1 billion), showing an average annual growth rate of 9.0%. The four leading commodity groups imported to ASEAN from the EU are alcoholic beverages, dairy products, meat and meat preparations, and cereals. Allowing for fluctuations, they account for more than 50% of all ASEAN farm imports to the ASEAN market since 1990.

ASEAN agricultural imports from the EU grew at a much faster rate than agricultural exports to the EU. This higher growth rate is perhaps not surprising, taking into account the initial smallness of ASEAN's imports from the EU. The value of ASEAN agricultural imports from the EU was less than a third of the value of ASEAN agricultural exports to the EU in 2000. Overall, ASEAN imports from the EU account for 4.0% of total EU farm exports: a jump from the 2.7% share of 1990.

The overall trend of ASEAN-EU agricultural trade relations as discussed above hides important variations in the trade performance of individual countries. Among the ASEAN countries, Thailand, Indonesia and Malaysia are the largest agricultural exporters to the EU markets; together they account for about 80% of total ASEAN farm exports to the EU (Figure 2). Ag-

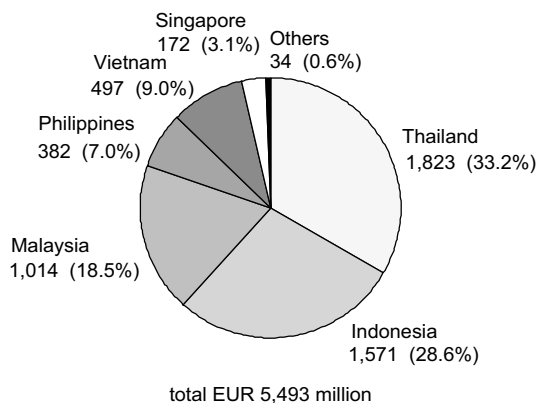


Figure 2. ASEAN member countries' agricultural exports to the EU in 2000 in millions of euros (as a % share of ASEAN total agricultural exports to the EU).

gricultural exports to the EU markets are significant for all seven economies, ranging from about 5% of all agricultural exports in the case of Singapore to over 19% for the Philippines in 2000. Among the fifteen EU countries, Germany, the Netherlands, and the UK have been the most important destinations for ASEAN agricultural exports, absorbing almost 60% of the total ASEAN farm exports to the EU.

Recently, a great deal of attention has been focused on the fall of the Southeast Asian currencies, and the impacts of these currency devaluations on the region's agricultural output and exports. The year 1997 in Southeast Asia saw mayhem in the stock markets, falling currencies and a loss of confidence (over uncertainties over the region's economies). This financial crisis started in Thailand and spread throughout Southeast Asia. As a result, the currencies of ASEAN countries fell between 20% to 70%.

The devalued ASEAN currencies have stimulated export-oriented, resource-based sectors and thus increased ASEAN agricultural commodity exports. In addition, the very large devaluations that some ASEAN currencies suffered against the European currencies prompted some substitution effect. Agricultural exports to the EU from competing countries, whose currencies did not depreciate quite so significantly, were substituted by ASEAN produce. The impacts of the sharp exchange rate depreciations on agricultural output and agricultural exports have barely been studied so far, however.

## 2.2 A detailed examination of ASEAN agricultural exports to the EU

### 2.2.1 Trends and intensities of ASEAN agricultural exports

ASEAN agricultural exports to the EU reached € 5.5 billion (about USD 5.1 billion) in 2000.

The trend rate of growth per year over the period 1961–2000 was 4.7%. As the world's largest importer of agricultural products, with 2000 imports of more than € 65 billion, the EU as a whole is an attractive and very sought-after market for exporters throughout the world. The EU internal market provides agricultural products from the other 14 member states of the EU a competitive advantage in each individual member country. It is an advantage, which cannot be easily overcome by competing third countries.

ASEAN agricultural exports to the EU face competition not only from EU food suppliers but also from many exporters within the Greater Europe and other third countries. Some of the competitors have access to a wide range of sophisticated marketing and promotional programs enabling them to compete effectively on the EU market. Furthermore, the EU provides certain trade concessions to products from its former colonies in Africa, the Caribbean, and the Pacific (the so-called ACP countries), which compete directly with ASEAN goods, particularly tropical products, such as cocoa, palm oil, fruits, tobacco, and coffee (for more details see chapter 2.3.1).

Nevertheless, ASEAN countries have been very successful in penetrating the EU market. Over the years, ASEAN countries have steadily increased their share of extra-EU agricultural imports despite tough competition. The ASEAN share of the EU imports increased from 5.9% in 1977 to 7.4% in 1990, and in 1995 the share climbed to 8.0%. By 2000, ASEAN countries had managed to extend their foothold on the EU market to account for 8.5% of extra-EU agricultural imports. It is interesting to note that all countries of ASEAN, except the Philippines, contributed to this increase – clearly the fruits of the export drive by the region as a whole, rather than one particular country.

Over the years, there has been some variation in the export performance of individual ASEAN countries. Of the ASEAN-10, Thailand and Indonesia are the largest agricultural exporters to the EU market (Table 2). Thailand holds a 33.2% share and Indonesia 28.6% share of total

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Table 2. ASEAN member countries' agricultural exports to the EU.

	Value in millions of euros				Percentage of country's total agricultural exports		Percentage of total extra- EU imports	
	1977	1985	1990	2000	1990	2000	1990	2000
Thailand	491	1,417	1,344	1,823	21.6	14.5	2.7	2.8
Indonesia	511	1,147	958	1,571	33.4	19.2	1.8	2.4
Malaysia	742	1,321	819	1,014	13.9	11.8	1.5	1.6
Vietnam	5	25	40	497	4.3	16.0	0.1	0.8
Philippines	332	403	335	382	26.4	18.6	0.7	0.6
Singapore	75	120	97	172	3.0	4.4	0.2	0.3
The rest	–	–	7	34	–	5.0	–	0.1
ASEAN	2,156	4,433	3,600	5,493	20.7	14.0	7.4	8.5

ASEAN agricultural exports to the EU. These two countries are followed in descending order by Malaysia (18.5%), Vietnam (9.1%), the Philippines (7.0%), Singapore (3.1%), and the rest (0.6%). Malaysia has lost ground in comparison to other ASEAN states since 1977, when it still accounted for 34% of ASEAN total agricultural exports. Over the same period, Thailand's share of total ASEAN agricultural exports to the EU rose from less than 20% to over 30%.

If judged by the share of their agricultural exports directed to the EU markets, these are the most important to Indonesia and the Philippines. Over the period 1990–2000, the exports to the EU markets represented about 23% of total Indonesian agricultural exports. For the Philippines, the respective figure was 25%. For Singapore, the EU was least important in this sense, taking only some 4% of her total agricultural exports.

Over the period 1977–2000, Thailand's agricultural exports to the EU grew by an average of 5.7% per year, whereas the annual growth of the global agricultural exports to the EU was only 3.3%. This has resulted in a rise in Thailand's market share. It was only 1.3% in 1977, and it reached 2.8% in 2000. Major agricultural exports from Thailand to the EU in order of export value include cassava products, rubber, canned tuna, fruits, rice, and frozen prawns and shrimps.

Indonesia and Malaysia recorded average annual growth rates of 4.9% and 1.4%, respectively, for their agricultural exports to the EU during 1977–2000. Palm oil, coffee, spices, tea, and rubber dominate the Indonesia exports, while Malaysia has concentrated almost solely on the products originating from perennial crops – such as palm oil and rubber. Indonesia's share of the extra-EU imports rose from approximately 1.4% in 1977 to 2.6% in 1996. By 2000, the share dropped to 2.4%.

Of the ASEAN-10, Vietnam registered the fastest average growth rate of 19.7% (from a small base) for its agricultural exports to the EU between 1977 and 2000. By 2000, Vietnam represented 0.8% of extra-EU agricultural imports, compared to 0.01% in 1977, and 0.1% in 1990. Rice, coffee, frozen shrimps, and rubber are Vietnam's leading commodity exports to the EU market. Because the Philippines' agricultural exports grew at an average of only 0.6% per year from 1977 to 2000, the country's relative importance in the EU market has declined. The Philippines' agricultural exports to the EU are dominated by copra and coconut oil exports.

Singapore has played and still plays an insignificant role in agricultural exports to the EU, attaining import market share of only 0.3%. Correspondingly, exports from the rest of the ASEAN-4 (Brunei, Cambodia, Lao and Myanmar) are still of little importance to the EU, with

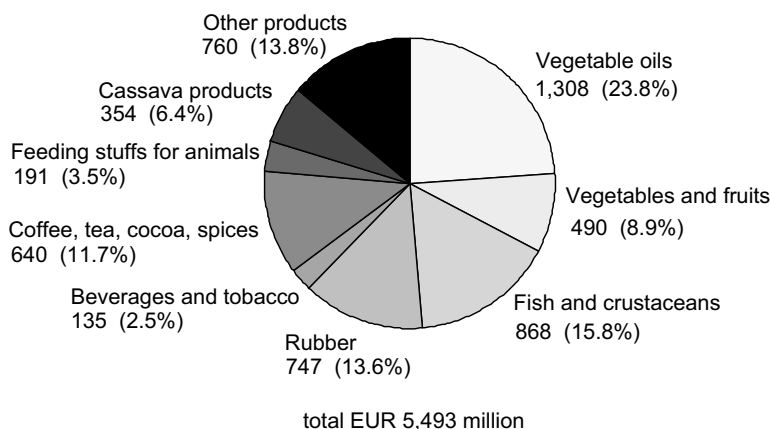


Figure 3. Commodity composition of ASEAN agricultural exports to the EU in 2000 (in million of euros) (as a % share of total ASEAN agricultural exports to the EU).

the import market share of less than 0.1%. Among the fifteen EU member states, Germany and the Netherlands are the largest agricultural importers from ASEAN, together accounting for more than 40% of ASEAN exports to the EU. They are followed by United Kingdom, France, and Italy.

## 2.2.2 A commodity composition of ASEAN agricultural exports

An analysis of the commodity structure of ASEAN agricultural exports by major subgroups can provide further insights into ASEAN-EU agricultural trade relations. Figure 3 shows the commodity composition of ASEAN exports to the EU in 2000. The commodity composition strongly reflects the structure of the ASEAN agriculture. The exports are concentrated in five product groups: (i) vegetable oils and fats, (ii) natural rubber, (iii) fish and crustaceans, (iv) prepared and preserved fruits and vegetables, and (v) cassava products. In 2000 these product groups together accounted for almost 70% of ASEAN agricultural exports to the EU. The commodity composition has stayed more or less the same during the 1977–2000 period. However, ASEAN exports of unprocessed primary commodities have fallen in relative importance in favour of processed products. The pressure com-

ing from the price instability and the gradual deterioration in terms of trade of traditional primary commodities has encouraged the ASEAN countries to add more value to a number of products before shipment to the EU market.

Almost one fifth (23.8%) of the total agricultural exports from ASEAN to the EU were made up of vegetable oils and fats (SITC 42 + SITC 43), of which 51% were exported by Indonesia, 35% by Malaysia, and 13% by the Philippines. Exports of these products rose from € 335 million in 1977 to € 1,308 million in 2000, showing an average annual growth rate of 5.9%. Vegetable oil exports from ASEAN mainly consist of crude palm oil and coconut oil. Malaysia and Indonesia are the largest exporters of the former and the Philippines of the latter. EU countries prefer to buy crude vegetable oils, mainly because of the lower tariffs on unprocessed products and the need to further reprocess the oil due to quality deterioration during long voyages. Only 16% of ASEAN vegetable oil exports to the EU markets are in processed form.

Malaysia, being an exporter of mainly processed palm oil, has lost its market share to other ASEAN countries. In 1977 Malaysia accounted for 68% of total ASEAN exports of vegetable oils and fats to the EU, but in 2000 for only 35%. On the other hand, Indonesia's share of ASEAN exports to the EU increased from 16% to 51%. It is important to note, however, that Malaysia's

exports to the EU only account for less than 12% of country's total vegetable oils exports. For Indonesia, the corresponding figure is 35%.

The EU has a special significance for the ASEAN vegetable oil sector. As a single entity, it is the world's biggest importer of palm oil as well as coconut oil. ASEAN countries also continue to hold a commanding import market share for vegetable oils and fats in the EU market (Figure 4). In 2000, imports from ASEAN represented about 55% of total EU imports of these products, up from about a 37% share in 1990. As a proportion of the total consumption of oils and fats in the EU, vegetable oil exports by ASEAN increased from 8% in 1985 to 12% in 2000. Germany and the Netherlands are the largest importers of ASEAN vegetable oils, accounting for more than half of total EU imports. The UK and Italy are the next largest importers.

Coconut oil competes with palm oil and other oils on the European market because the different oils are interchangeable to a certain extent. EU coconut oil imports have increased sharply since 1977. The Philippines supplies the bulk. Exports of coconut oil from the Philippines to the EU rose from 390 million tonnes in 1990 to more than 500 million tonnes in 1998. By 2000, exports declined to 285 million tonnes. With the strong competition from other vegetable oils, the share of coconut oil on the total EU market for vegetable oils is gradually declining. However, it is expected that the demand for coconut oil in the EU will remain relatively strong in the early 2000s, provided that its price remains competitive.

Natural rubber (SITC 231) accounts for about 14% of ASEAN agricultural exports to the EU, valued at € 910 million in 1995, and € 747 million in 2000. The ASEAN countries are EU's principal suppliers of natural rubber, providing about 79% of total EU crude rubber imports. The top three consumers in the EU are Germany (26%), France (22%), and Italy (15%). In the 1970s, Malaysia was the main supplier of the EU imports. However, over the years, Malaysia's rubber exports to the EU have decreased both in volume terms and in comparison to the other

ASEAN countries (Figure 4). Malaysia's share of ASEAN rubber exports to the EU diminished from about 80% (€ 520 million) in 1980 to 35% (€ 259 million) in 2000. In comparison, Indonesia's share increased from 10% (€ 67 million) to 18% (€ 137 million), and Thailand's share from 2% (€ 16 million) to 38% (€ 282 million).

Cassava (also called tapioca and manioc) accounts for about 6% (€ 354 million in 2000) of ASEAN agricultural exports to the EU. Most of cassava exports to the EU, which is the world's largest export market for these products, goes in the form of pellets for the production of compound animal feed stuffs<sup>11</sup>. The bulk is supplied by Thailand, with a growing supply also being provided by Indonesia (Figure 4). Between 1980 and 1990 more than half of Thai cassava production was exported to the EU. Thai exports of cassava pellets began to penetrate into the EU market in a major way in the late 1970s. The competitiveness of cassava pellets has been mainly due to the Common Agricultural Policy of keeping the EU price of grain at a high level, thus raising the competitiveness of grain substitutes for animal feed.

Over the years, EU's cassava imports have drastically fallen, however. The imports decreased from a record level of 10 million tons (€ 1,323 million) in 1982 to 5.7 million tons (€ 708 million) in 1990, and in 1998 the imports were only 2.5 million tons (€ 272 million). Contributing factors to this sharp fall included lower cereal prices in the EU, high freight rates and tight domestic supplies. In 1999 EU cassava imports reversed the downward trend seen in the last few years, rising in 1999 by an estimated 57% over the previous year's volume. Nevertheless, export volumes are still smaller than in the late 1980s and early 1990s.

Import prices of cassava pellets have also fallen sharply, following the implementation of the reform of the CAP from July 1993. The 2000

<sup>11</sup> The value of cassava in compound animal feeds lies in its high starch content. It is easily digestible, high energy feed. A mixture of cassava and soybeans, in the ratio of about 4:1, is used as a cereal substitute.

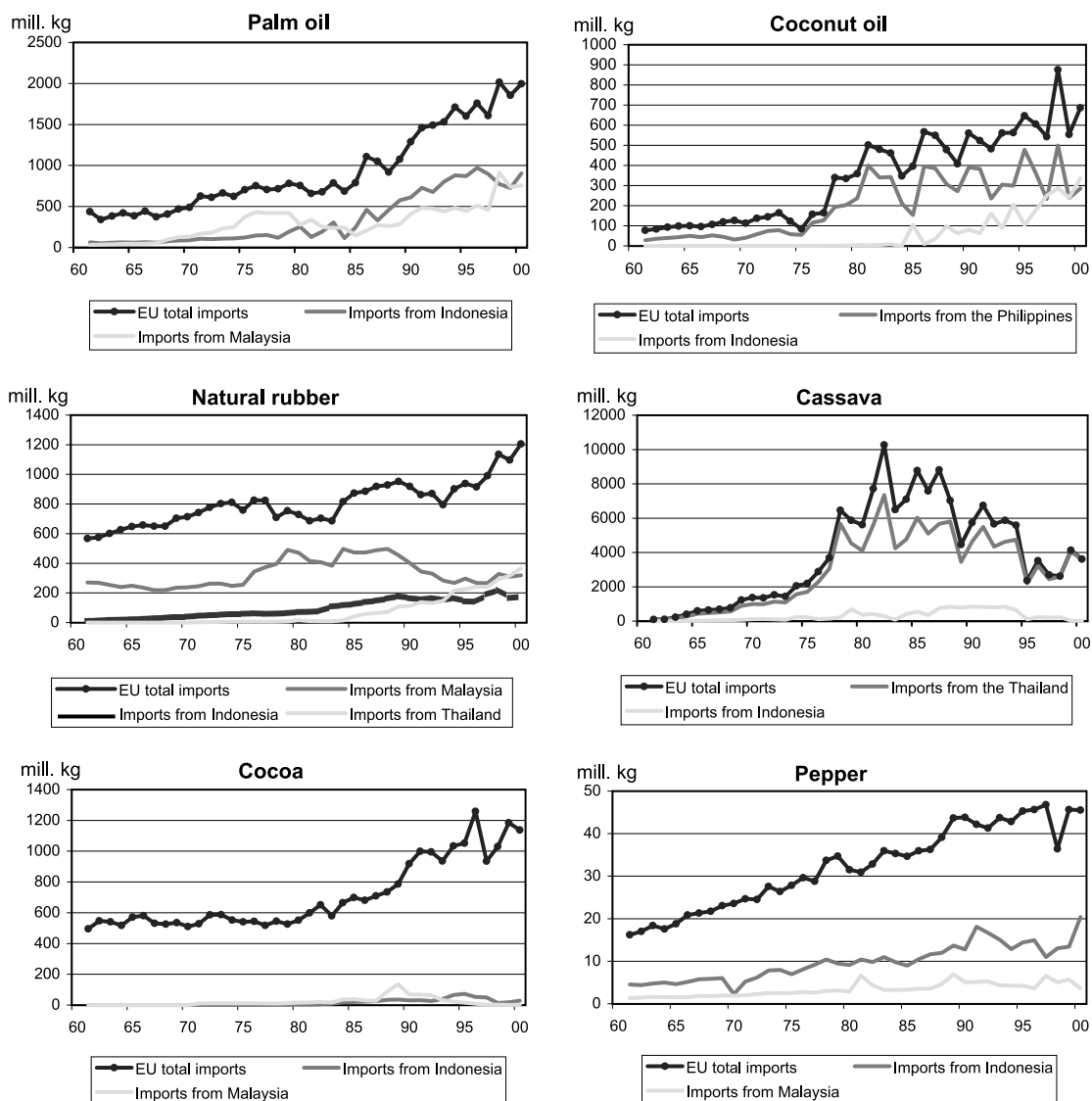


Figure 4. The development of EU total imports and imports from ASEAN countries in selected agricultural commodities from 1961 to 2000, mill. kg.

import price averaged at € 82 per ton, compared to € 128 per ton in 1992. The factors behind the drop in cassava prices included: steadily declining domestic EU grain prices; higher soybean meal import prices; and high domestic prices in several exporting countries. However, cassava has continued to be an attractive feed ingredient in the Community. Despite the increases in soy-

bean meal prices during the last two years, the prices of cassava/soybean mixtures in the EU were still substantially lower than quotations for barley, the main feed stuff.

The size of cassava exports in the early 2000s will depend on various factors, primarily price developments for grains and oil meals in the EU, which will be influenced in part by the reduc-

tion of the set-aside area for grains in the EU and the availability of supplies from other major exporters. Increased grain production in the EU could lead to lower domestic prices, thus making cassava less competitive in feed rations.

The product group SITC 07 – which includes coffee, tea, cocoa, spices – accounts for about 12% of ASEAN agricultural exports to the EU. In 2000 ASEAN exports of these items to the EU countries were approximately € 640 million, of which 45% came from Indonesia and 45% from Vietnam. Imports of this product group represented 16% and 59% of EU agricultural imports from Indonesia and Vietnam, respectively. In 2000 ASEAN exported to the EU a total of 370,000 metric tons of coffee, which was about 17% of the EU's total coffee imports. Vietnam accounts for nearly 75% of all ASEAN coffee exports to the EU. Vietnam's coffee exports to the EU increased drastically from a 1% market share in 1990 to approximately 13% in 2000.

Indonesia, which is the largest ASEAN tea exporter, experienced an increase in sales to the EU from only about 6% of total EU imports in 1990 to more than 12% in 2000. The EU cocoa imports – including cocoa beans, cocoa paste, cocoa butter, and cocoa powder – from ASEAN countries decreased from about 10% of total imports in 1990 to just below 2% in 2000. The largest cocoa exporters in ASEAN are Indonesia and Malaysia.

ASEAN exports of spices to the EU increased rapidly in both volume and value between 1990 and 2000. Indonesia is clearly the biggest spice exporter in ASEAN. Furthermore, Indonesia is globally the leading pepper supplier to the EU, with 21% (35%) of the total EU market by volume<sup>12</sup>. The pepper market is usually highly cyclical, with high prices encouraging new plantings, and the resulting overproduction leading to low prices (Market Asia 1997). Indonesia is also the top supplier of cinnamon to the EU, ac-

counting for more than 70% of all EU imports. In addition, Indonesia provides about 60% of total EU nutmeg imports. Germany is the biggest spice importer from ASEAN, accounting for 30% of total value of in 2000. The Netherlands and the United Kingdom are the next-largest spice importers in the EU.

## 2.3 Agricultural trade policies in ASEAN and the EU

The pattern, composition, and trends of ASEAN agricultural commodity exports to the EU, as examined in the previous section, are the product of various factors, of which trade policies are important ones. Import and export controls, which take various forms, are the primary instruments of trade policies in ASEAN and the EU countries. The EU, in particular, has been the target of the criticism that its highly protectionist agricultural policies and its export subsidies for EU agricultural products are harmful to the hopes of economic development of many countries, including the ASEAN agricultural exporting countries.

Despite the fact that Southeast Asian countries have seen most of the EU's tariffs and quantitative restrictions on their imports fall during the 1990s, they remain deeply anxious about the proportionately high number of EU anti-dumping duties and surveillance measures that they attract. Moreover, the EU's tariff escalation regime ensures that ASEAN countries face progressively higher tariff rates as they move towards downstream value-added production (Chee Peng Lim 1997).

In the ASEAN countries, both imports and exports have been subject to duties and non-tariff barriers. In case of exportable crops, the ASEAN countries have generally imposed a tax on prices received by farmers. Taxes on exports are typically levied to raise revenues, promote agricultural processing and stabilise prices. Some ASEAN countries have also restricted ag-

<sup>12</sup> One third of the EU pepper market is for white pepper, the rest for black. Black and white peppercorns are produced from the same plant, but they are processed differently to yield the different colours.



gricultural exports through state-directed marketing boards for such commodities as rice, sugar, and cotton.

## 2.3.1 Elements of the EU trade policy

The EU's agricultural trade relations with ASEAN countries have to be seen in the context of overall EU trade policies vis-à-vis the rest of the world, and the developing countries in particular. Trade policy in the EU belongs to those policy domains in which policies on the Community level as opposed to national policies of the member countries play an important role. Since 1968 the responsibility for trade policy has been vested in the EU Commission located in Brussels, the executive organ of the EU. In that year, all tariffs on intra-EEC trade were removed and Common External Tariffs (CET) were introduced. The new member countries, which have joined the EU after 1968, had to adjust to the common external tariffs and abolish their tariffs against the other members (Langhammer 1987).

The access of agricultural exports to the EU has generally been determined by two basic elements of trade policy. The first element consists of de-linking the EU agriculture from international competition and fluctuations in prices. This is reflected in the Common Agricultural Policy (CAP) of the EU as internal price and purchase guarantees, on the one hand, and adjustments of import prices to the EU price level, on the other. The second element relates to the fact that EU trade policy favours certain non-member countries and trading blocs such as the African, Caribbean, and Pacific countries (the so called ACP countries) and the countries of the Mediterranean rim. This is reflected in the complex network of discriminatory tariffs through generalised and country-specific or region-specific trade preferences (Langhammer 1987, Viinikka 1990). These two elements affect the access to the EU's agricultural markets by both the privileged and non-privileged countries in absolute as well as relative terms.

The CAP of the EU is itself a complex mechanism. The initial intention of the CAP was to promote European integration. The main objective of the CAP is, however, to protect farmers in the member states from too high a pressure to adjust in the process of economic change. In practical terms this means that the CAP is orientated towards supporting European farmers' incomes. This domestic objective is to be pursued with instruments, which have decisive external effects on the international level. While regulations differ according to commodities, the basic philosophy of the Common Agricultural Policy regarding internal price support and external protection has evolved out of the 1962 regulations for the marketing of grains. This system, which now covers more than 90% of total EU agricultural output, involves a mass of marketing regulations, including schemes for internal price support, external protection measures (e.g. tariffs and levies), and production and export subsidies.

While the CAP in general exhibits a high degree of protectionism, the EU has granted developing countries a whole array of trade concessions. The EU has established a complex system of trade preferences known as the Generalised System of Preferences (GSP), which, however, have not been shaped according to the global needs of the developing countries. Instead, the trade concessions of the EU reflect rather the structure of the EU's interests with respect to domestic output composition and foreign policy relations (Tangermann 1979). In the area of agricultural trade, the preferences are restricted to duty concessions for certain agricultural goods, which either cannot be produced in the EU for climatic reasons (such as tea, cocoa, some fruits, and vegetables) or which could be produced only at prohibitively high costs (as in the case of soybeans).

Although the list of agricultural goods covered under GSP has been successively extended to include more products (of specific interest for single developing countries), it still applies mainly to products, which have low significance for EU producers and processors. Such commodi-

ties, finally, which are used in the EU agriculture only as inputs and do not compete with domestic production, as in the case of feeding stuffs like oilseeds, enter the EU with low or zero tariffs (WTO 2002).

A complex hierarchy of trade arrangements between the EU and specific groups of developing countries parallels the product-wise hierarchy of EU trade concessions. Since its creation, the EU has entered into a number of different kinds of trade agreements with a number of countries, by virtue of which EU imports from the latter receive preferential treatment. Thus, the EU has deviated widely from the non-discrimination principle of the General Agreement of Tariffs and Trade (GATT), and it applies different policies to different regions and trading blocs. These country-specific trade concessions in part reflect the multiplicity of the EU's foreign policy interests, ranging from old colonial responsibilities to military-strategic considerations (Tangermann 1979).

By ranking the groups of the trading partners of the EU according to increasing degrees of preferential treatment, the following rough classification emerges. Non-beneficiaries are those developed countries, mainly non-European, who, being contracting members to WTO, enjoy nothing more than most-favoured nation (MFN) tariff treatment. Next to these categories come already those developing countries, which are subject to treatment under the EU's GSP scheme. For the ASEAN countries, the main preferences offered by the EU are embodied in the GSP (Viinikka 1990). More than one third of ASEAN exports to the EC enjoy tariff concessions under the GSP scheme.

By far more intense are trade preferences granted to the African, Caribbean and Pacific countries (ACP countries) under the Lome Convention. The ACP countries is the only single group, which is afforded concessions for central CAP products like beef and sugar. The privileged treatment of the ACP countries has far-reaching historical roots. Most of the ACP countries are former colonies of the EU member countries (Tangermann 1979). When the Community was

formed, the overseas dependencies of Belgium, France, Italy, and the Netherlands were given associated status. These dependencies gained independence in the 1960s, but continued to maintain close economic links with the Community through the Yaounde Conventions and the Arusha Agreement.

When Denmark, Ireland, and the United Kingdom joined to the EEC in 1973, it was agreed that the developing countries of the British Commonwealth, except those in Asia, should receive similar associated status. The interests of Asian Commonwealth countries were provided separately in the Joint Declaration annexed to the Accession Treaty. In 1975, the EU entered into a new contractual agreement known as the Lome Convention, with its 46 former dependencies in Africa, the Caribbean, and the Pacific. Lome Convention became a centrepiece of the EU's relations with the developing countries.

All the ASEAN countries are excluded from special EU trade preferences. Although the EU has established commercial co-operation agreement with ASEAN (1980), this agreement offers no opportunity for access to markets, but merely provides for consultation in trade policy disputes (Langhammer 1987). ASEAN countries, therefore, receive benefits only from the Generalised System of Preferences (GSP). As mentioned earlier, the GSP treatment is mainly provided for those agricultural products which play only a minor role in EU agricultural policy and which are not close substitutes for domestic products.

## 2.3.2 EU protection against agricultural export of ASEAN countries

The EU places restrictions on trade in most of the major agricultural commodity exports of the ASEAN region. The EU protection has generally taken three forms. First, there has been discrimination in tropical products, such as cocoa, palm oil, fruits, tobacco, and coffee, exported to the EU by ACP countries. Second, quantitative restrictions have been imposed on imports of

Table 3. Average pre- and post-Uruguay Round tariff rates on selected commodities in the EU.

Commodity	Pre-Uruguay MFN <sup>a</sup> rate	Post-Uruguay MFN <sup>a</sup> rate	Pre-Uruguay GSP <sup>b</sup> rate	Post-Uruguay GSP <sup>b</sup> rate
Cassava	10.00	6.40	6.00	6.00
Cocoa	3.00	0.00	3.00	0.00
Coconut oil	17.20	11.00	11.00	10.40
Palm oil	15.60	10.00	12.00	9.20
Pepper	10.60	2.70	3.20	1.40
Rubber	3.00	3.00	3.00	3.00
Tea	5.00	3.20	5.00	3.20

<sup>a</sup> Most-favoured nation (MFN) principle requires that all imports, regardless of source, must be treated uniformly with respect to tariffs and any non-tariff provisions

<sup>b</sup> Generalised System of Preferences (GSP) is a mechanism for granting tariff preferences to developing countries

animal feed, such as cassava, which are substitutes for grain. Third, domestic suppliers have been protected through variable levies and other interventions on products such as sugar and rice (Langhammer 1987, Akrasanee 1988).

Most agricultural commodities imported from ASEAN are tropical products, which do not compete directly with EU products. However, tropical products from ASEAN compete with imports from ACP countries and some Mediterranean countries. Discriminatory measures against ASEAN agricultural products that compete with the products from ACP countries have, to some extent, restrained the growth of export revenues in some ASEAN countries. GSP provisions for these products have usually included tariff quotas and ceilings to protect ACP exporters (Table 3).

For example, until 1997 the EU maintained tariffs on coffee and cocoa beans, though not on tea, to protect the preference margin of the ACP states. Finally, in 1997 the EU abolished its tariff on most coffee and cocoa beans imports. Under the new EU GSP scheme, all green, non-decaffeinated coffee from virtually all producing countries, except Brazil, will enter the EU duty free. The new GSP of the EU has meant duty-free coffee imports from Indonesia and Vietnam, among others. The ACP countries, which include most African coffee producers, already had duty-free access.

The EU protection against imports of palm oil products from Malaysia and Indonesia and coconut oil products from the Philippines has taken the form of import duties. Related to these import duties is the problem of tariff escalation. The EU has imposed a 4% duty on crude palm oil and coconut oil, and a 12–16% duty on processed palm oil and coconut oil. Thus, the EU protects domestic palm oil refineries and gives an unfair advantage to other producing countries to export the commodity in crude form (Chee Peng Lim 1997). This kind of policy tends to discourage agro-processing, which is now vigorously pursued in ASEAN region.

Another area of concern to the ASEAN countries has been the system of price subsidies to Union growers<sup>13</sup>, because such policies will continue to prevent fair trade in oils and fats (Chee

<sup>13</sup> The oil and fat regime of the EU was originally based on a system of price subsidies to Union growers. This system enabled oilseeds and the products from crushing to be traded within the Union at close to world price levels. To ensure that Community grower can still sell their produce despite competition from cheaper imports, the processing industry received a subsidy if they used Community-grown products. The aim was to make up for the gap between the Union price set by the Council and the price of imports coming in. During the 1990s, support for growing oilseeds has been incorporated in the arable area payment scheme, leaving olive oil sector as the only regime still operating a price subsidy or production aid support system.

Peng Lim 1997). The EU's production subsidies for rapeseed, sunflower seed, soybeans, and linseed have resulted in a rapid increase in the EU's oilseeds production and self-sufficiency rate regarding vegetable oils. Oilseed production in the EU increased from the average of 2.5 million tonnes in the late 1970s to well over 12 million tonnes prior to the CAP reform in the early 1990s (OECD 1994). Surpluses of these products have been released on the world markets resulting in unstable and depressed prices, in certain markets, in particular, in India, Pakistan, China, and Japan (Salih et al. 1988). Therefore, vegetable oil exported from ASEAN has to contend with competition from the surplus production of vegetable oils in the EU, which are exported to third countries.

ASEAN is also concerned with the health and safety legislation concerning the cargo restrictions on palm oil that will be imposed by member states of the EU. Most sea-born cargoes of edible oils and fats into the EU are carried under FOSFA contracts, and they have now come within the scope of the EU food hygiene directive of 1993. This directive stipulates that all foodstuffs, including edible oils and fats, should be transported in vessels or containers reserved only for the transport of foodstuffs and marked as such. This would mean that edible oils and fats can be transported only in dedicated tanks. However, at the end of 1995, following consultation with ASEAN representatives, the EU approved a derogation to the directive for the transport of oils and fats in ocean-going vessels<sup>14</sup>.

The restrictions on cassava, which has affected Thailand and Indonesia, highlights the two major elements of EU protectionism, i.e. the protection of local producers and discrimination

between non-EU producers of close substitute products. Thai exports of cassava (also called tapioca or manioc) began to penetrate onto the EU market in a major way in the late 1970s. The competitiveness of cassava was mainly due to the CAP policy of keeping the EU price of cereals at high level, thus raising the competitiveness of grain substitutes for animal feed. Therefore, the mixture of cassava pellets with soybean meal, which was not subject to variable import levies, had the competitive edge on grains and would disturb the EU-regulated grain market unless imports of cassava were also restricted<sup>15</sup>.

In 1980, the EC-Thailand agreement was signed, and voluntary export restraint (VER) were instituted. These measures were, however, introduced in a discriminatory manner. While the imports of cassava from Thailand and Indonesia were regulated, another substitute, i.e. corn gluten feed, could be imported unrestricted from the United States. This preference given to the US over imports originating in Asian countries was regarded as compensation for losses incurred by the US in world markets for agricultural products arising from the CAP (Langhammer 1987).

As a result of "voluntary" restraint on exports, the volume of cassava exports from Thailand to the EU declined by 40% after 1982. This entailed a loss of about USD 330 million, representing 11% of Thailand's total earnings from exports to the EU (Langhammer 1987). The annex of Spain and Portugal to the EU in 1983 further reduces the demand for cassava pellets from Thailand. Even thus constrained, the trade in cassava remains beneficial to the Thai economy (Siamwalla et al. 1992).

Furthermore, the EU conducts its trade relations in a context that links specific concerns

<sup>14</sup> The terms of the derogation specify cargo provisions for oils and fats, depending on whether the materials are to be further processed or not. Oils and fats that are to be further processed and are intended to be used for human consumption, can be transported in non-dedicated tanks, provided that the tanks are of stainless steel or epoxy lined, and provided the immediate previous three cargoes have been foodstuff.

<sup>15</sup> Combining cassava imported at 6% tariff with soybeans at zero tariff essentially allowed European feed compounders to create artificial maize at much lower costs than sold in the EU. The boom in the cassava trade that followed surprised Europeans and by 1980 affected their sensitivities sufficiently for them to request Thailand's co-operation in limiting its exports. Since the early 1980s, imports from Thailand were subjected to a quota of 5.0 million tons (Siamwalla et al. 1992).

with larger policy issues. This has often had adverse implications for the country concerned. For example, the request of Thailand to maintain cassava exports at the reduced level was accepted by the EU only when Thailand was willing to sign the bilateral MFA agreement, thereby deviating from the initial stand of ASEAN to oppose such agreements (Langhammer 1987).

The sugar market policy of the EU has discriminated against sugar imports from ASEAN, namely imports from Thailand and the Philippines. This question is of special relevance, since on the one hand, the EU's sugar market is its most protected agricultural market and, on the other hand, a special preference in the form of EU sugar quota is given to ACP countries.

### 2.3.3 Changes in agricultural protection in ASEAN countries

The ASEAN economies have expanded very rapidly during the past three decades. Associated with this rapid growth are considerable changes in the structure of these economies. One manifestation of this structural transformation has been the rapid decline in the relative importance of the agricultural sector: its contributions to GDP, employment, and exports have declined rapidly in these economies, as have the rates of self-sufficiency in basic foods. Between the late 1960s and early 1980s, there was a strong policy response designed to slow down this relative decline in food sector by raising steadily the level of agricultural protection (Tyers and Anderson 1985, David 1986). As a result, agricultural protection measured by nominal protection rates (NPR)<sup>16</sup> rose in ASEAN countries from slightly negative levels in the early 1960s to relatively high levels by the late 1980s.

Traditionally, in case of exportable crops, ASEAN countries have imposed a tax on prices received by farmers. For the period 1980–1985,

<sup>16</sup> The nominal protection rate (NPR) is measured as the percentage difference between domestic and border prices at the same point in the marketing chain.

penalties to traditional major exports were as high as 20 to 40 per cent for rubber, rice, coffee and copra. About 20 to 30 per cent of the implicit tax on rubber, however, have been a cess for research and replanting. Taxes on exports were typically first implemented as a source of government revenue. In the later years, they have been used as an instrument to promote local processing and to stabilise prices. The aim of high export taxes on rubber in Malaysia, rice in Thailand, and copra in the Philippines has been partly to extract perceived monopoly rents from the world market (David 1986), since exports of ASEAN countries account for a significant share of international trade in these commodities.

Yet, many scholars (Booth 1980, Tan 1984, Jenkins and Lai 1989) have shown that domestic farmers do in fact shoulder most of the export taxes<sup>17</sup>. Studies by Tan (1984), and Jenkins and Lai (1989) have shown that the export tax on natural rubber in Malaysia reduced the producer prices and in turn the producer income of both estate and smallholders. Further, the tax also resulted in reduced supply and export levels. In case of cassava, Indonesian government intervention took the form of export tax on cassava chips and licensing, which pushed down sharply the domestic cassava price and discouraged investments in export facilities (Bautista 1998).

ASEAN's switch from taxing to assisting agriculture, in the course of economic development, is not without a precedent. Indeed, it has often been observed that poor countries tend to tax agriculture relative to other tradable sectors, while industrially advanced countries tend to provide farmers with more assistance than other sectors receive (Bale and Lutz 1981, Andersson and Hyami 1986). Table 4 summarises NPRs for the major agricultural commodities from 1960

<sup>17</sup> For example, in case of cassava, Indonesian government intervention took the form of export tax (5% on cassava chips until 1982) and licensing, which artificially lowered the producer price. Most notably, the ban on cassava exports in 1973 pushed down sharply the domestic cassava price and discouraged investments in export facilities (Bautista 1998).

# AGRICULTURAL AND FOOD SCIENCE IN FINLAND

*Niemi, J. Cointegration and error correction modelling of agricultural commodity trade*

Table 4. Trends in nominal protection rates for selected agricultural commodities in four ASEAN countries from 1970–74 to 1990–1996.

Country Period	Rubber	Sugar	Corn	Rice	As specified
Indonesia					
1970–74	-28	42	-18	-1	-33 <sup>a</sup>
1975–79	-29	22	23	-6	-18 <sup>a</sup>
1980–89	-10	74	35	2	-12 <sup>a</sup>
1990–96	-4	70	41	4	-10 <sup>a</sup>
Malaysia					
1970–74	-28	17	19	20	-12 <sup>b</sup>
1975–79	-33	20	17	19	-6 <sup>b</sup>
1980–89	-19	19	13	17	-11 <sup>b</sup>
1990–96	-10	14	6	40	-9 <sup>b</sup>
Philippines					
1970–74	-4	36	20	7	-12 <sup>c</sup>
1975–79	-4	-16	20	1	-22 <sup>c</sup>
1980–89	-2	8	18	-1	-25 <sup>c</sup>
1990–96	0	15	17	0	-10 <sup>c</sup>
Thailand					
1970–74	-28	-11	0	-28	0 <sup>d</sup>
1975–79	-24	6	0	-24	0 <sup>d</sup>
1980–89	-9	6	0	-17	0 <sup>d</sup>
1990–96	-2	7	0	-12	0 <sup>d</sup>

Nominal protection rates are defined as the percentage by which domestic price exceeds border price. Domestic price is represented by domestic wholesale prices. Border price is c.i.f import unit values for importables and f.o.b export unit values for exportables.

<sup>a</sup> Coffee

<sup>b</sup> Palm oil

<sup>c</sup> Coconut oil

<sup>d</sup> Cassava

Source: David 1986, Author's own calculations

to 2000. The average NPR for the region is still generally low because of the large share of exportable and non-traded agricultural commodities particularly in Malaysia and Thailand.

In Indonesia, the domestic-to-border price ratio rose steadily for virtually all agricultural products between the late 1960s and late 1980s. Since then, periodic deregulation packages have eliminated or reduced trade barriers on agricultural products. Yet, despite the significant trade policy reforms in 1991, price and trade policies continued to isolate domestic prices of major crops from the world markets until 1997. In the mid 1990s about 60% of agricultural products were still covered by exports prohibitions, re-

strictions, licensing or taxes. These policies provided relatively low protection to the farm sector as a whole, but there was variation across commodities. In general, domestic prices of import-substituting commodities were above the world prices, and those of export-oriented commodities were at or below the world prices (Hjort and Landes 1993).

Furthermore, the State Logistics Agency (BULOG)<sup>18</sup>, which has lost some of its domes-

<sup>18</sup> Bulog was set up in 1967, when the country's economy collapsed, inflation was soaring and even rice was in short supply. By buying over-supply and importing in times of shortage, Bulog ensured supply and price stability and

tic monopolies over the years, still controlled rice trade and imports of staple foods such as wheat, soy beans and sugar. BULOG sold licences to importers, distributors and producers, often limiting the number of companies that get started.

Finally, in late 1997 and early 1998, due to the Asian financial crisis, domestic and international agricultural trade was deregulated in a major way<sup>19</sup>. Imports have been the most affected by the deregulation, with a large reduction in tariffs and the removal of BULOG's monopoly rights<sup>20</sup> concerning all commodities under its control (except rice, for social reasons). Obstacles to domestic trade are also being removed and export controls substantially relaxed (WTO 1998). There are difficulties, however, in liberalising agriculture under the present difficult economic and social conditions. With the devaluation of the rupiah increasing the cost of imported food, it has been socially important that the deregulation does not trigger further price increases. Large subsidies has been necessary to stabilise domestic prices of essential food items (including rice and cooking oil).

In addition, with the devaluation of the rupiah, a number of agricultural items, in which Indonesia is self-sufficient, such as palm oil, became very competitive in the world market. It was thought that this could lead to domestic shortages, if exports materialised, and add to inflationary pressure. To deal with these difficulties, the Government introduced temporary export bans on rice, wheat, wheat flour and other basic commodities; these bans were converted into export taxes in September 1998. In case

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helped the government, once the world's largest rice importer, reach self-sufficiency in 1984.

<sup>19</sup> The deregulation took place as a part of the the financial rescue package of USD 37 billion put together by the International Monetary Fund and the World Bank for Indonesia in November 1997. It was the biggest international bail-out organised since Mexico's USD 50 billion in 1995.

<sup>20</sup> According to the World Bank, BULOG's monopolies over imports of rice, sugar, wheat and soybeans have raised average prices and 'tax' consumers. World Bank has calculated, for example, that domestic sugar prices were 20 per cent higher than world prices through the 1980s.

of crude palm oil, export duty was 10% during 1998–2000. In September 2000, however, Indonesia slashed its export tax on crude palm oil from 10% to 5% in order to help its palm oil exporters to keep market share in India.

In Malaysia, food producers have received only small increases in government assistance directly via input subsidies/grants or indirectly via import control since the early 1970s<sup>21</sup>, and have benefited only from the supply of low-skilled immigrant labour. In fact, the Government provides support and accords protection only to two main subsectors in agriculture, i.e. rice (for food security and poverty reasons) and tobacco (for poverty reasons). The financing of a minimum price for rice is the largest outlay in connection with Malaysia's domestic support programme involves. Malaysia has used administered prices, both to support domestic rice producers and to allocate rice (and wheat) to consumers. No investment incentives, such as concessional access to credit, are accorded to the agriculture sector. Malaysia does not provide direct export subsidies, either, and, therefore, the country has no export subsidy programmes subject to reduction commitments in the WTO. However, incentives are provided to exporters of selected products in the form of tax exemptions.

Overall, Malaysia maintains liberal agricultural trade policies, especially as far as tariff and non-tariff border measures are concerned. Malaysia made substantial offers in the Uruguay Round contributing to a greater market access for imports of agricultural goods. Import tariffs on agricultural products (HS chapters 01–24) are low, averaging 3.5% in 2001, if non-ad valorem duties are excluded. A wide range of products are subject to import licensing as well as sanitary and phytosanitary (SPS) measures. Although

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<sup>21</sup> By contrast, relatively high tariffs, combined with an import quota on imported automobiles and sales tax reduction applicable to the national car, directly favour manufacturers of the latter, not just to the detriment of other domestically-manufactured or imported cars, but also at the expense of other sectors, such as agriculture, that receive lower protection.

Malaysia included selected agricultural products in its WTO Schedule XXXIX, for tariff quota purposes, these quotas do not appear to be used in practice<sup>22</sup>; the authorities grant tariff quotas to applicants on request, according to the amount demanded.

Exporters of palm oil and selected palm products, natural rubber, pepper, pineapple, and selected timber are subject to an export registration requirement. In addition, crude palm oil, rubber, pepper, and some timber products are subject to export taxes. In case of palm oil products, export duties are levied at rates that vary directly with the value per tonne of the exported products.<sup>23</sup> The overall average of the ad valorem export duties was 11.7 in 2001<sup>24</sup>. In September 2000, Malaysia responded to the difficult market situation by allowing sales without duty as Indonesia slashed its export tax from 10% to 5%. Rubber produced in Malaysia is subject to a research cess at the rate of RM 26.5 per tonne, and a development/replanting cess at the rate of RM 9.92 per tonne. Promoting the use of locally produced commodities in domestic downstream industries is one of the main objectives of export duties<sup>25</sup>. Certain agricultural products, including selected fish products, birds' eggs, avocados, citrus fruits, and semi-processed palm oil are subject to both import and export duties.

The Philippines is also gradually liberalising its agricultural pricing and trade policies. The Philippine policies, which reduced agricultural protection after 1970, limited the country's ability to benefit from the extraordinary growth in world trade brought about by the commodity boom in ASEAN's major exports in the 1970s. As a result, annual growth of agricultural exports in the Philippines was only 9% compared to 20% per year in other ASEAN countries during the 1970s and 1980s. Tariffication and reductions in

tariff rates over the past ten years have gone a long way towards offsetting the traditional anti-export bias in the Philippine import regime, which pushed up exporters' costs through competition from the protected import-competing sectors. The government has also sought to remove infrastructural constraints by liberalising regulated industries, particularly those providing basic business inputs. Nevertheless, remnants of earlier import substitution and "picking winners" strategies remain, combined with a complex system of concessions to help export-oriented industries, many located in special economic zones, to take advantage of imported inputs (WTO 1999a).

The effect of current sectoral policies is to favour agriculture and related processing industries over most other activities, a significant reversal of the situation before the time of 1990. However, in the view of existing budget constraints, support for agriculture relies predominantly on border protection. The import regimes for most foods and beverages, most notably meats and domestically produced vegetables, are still highly restricted in the Philippines. Furthermore, very high out-of-quota duties, administered through a complex system, protect sensitive products, such as rice and corn. Complying with WTO commitments to tariffy quantitative import restrictions, tariff quotas were implemented in 1995 for 15 groups of agricultural products, including coffee, corn, meat, potatoes, and sugar. Producer incentives for rice and corn include also price supports in the form of procurement prices and, fertiliser and other input subsidies. Though legal provisions were introduced in 1997 to enhance food production and lower prices, the domestic price of some agricultural commodities exceeds world prices by a wide margin.

Thailand does not provide significant export subsidies to the agricultural sector. Thailand has also shown restraint in the use of domestic subsidies likely to affect trade, particularly during the recent depreciation of the baht. Production and trade of several key agri-food products in the country are organised through marketing boards and other government-supervised organ-

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<sup>22</sup> Poultry and poultry products, swine and swine products, fresh milk, and round cabbage.

<sup>23</sup> See WTO (1997), p. 58 for details.

<sup>24</sup> In 1997, the average was 7.8% (WTO, 1997, p. 58).

<sup>25</sup> Export taxes were first implemented as a source of government revenue. In the later years, they have been used as an instrument to promote local processing.



isations. Furthermore, high tariffs protect the domestic meat and dairy, fruit and vegetable, sugar, beverage and tobacco manufacturing industries. In fact, Thailand has particularly high tariffs, which are in stark contrast to the extremely low tariff structure that already exists in the nearby and economically similar countries of Malaysia and Indonesia. This remains as a critical constraint to higher growth in the consumer demand for imported food products.

Tariffs on food items rose substantially particularly in the late 1970s, largely in response to severe current account deficits incurred in the wake of oil price shocks in 1972 and 1979 (Giordano and Raney 1993). Currently, the trend in tariffs is downwards although rates have fluctuated considerably since 1995. In 1999 applied MFN tariffs averaged 18%, compared with 23% in 1995. For agri-food products the simple average of bound tariff lines will be 34%, once the Uruguay Round of tariff reductions is fully implemented. But tariff peaks can be as high a 60%, down from 100% in 1995. Thailand does not apply quantitative restrictions on agri-food imports, and many of the tariff quotas established under the Uruguay Round are not used in practice to restrict imports; instead, lower or zero duties are frequently applied when imports of the products concerned are needed for the domestic processing industry (WTO 1999b).

## 2.4 Summary

In this chapter, the development and structure of ASEAN agricultural commodity exports to the

EU have been explored. It is noted that over the years ASEAN countries have steadily increased their share of extra-EU agricultural imports despite tough competition. ASEAN agricultural exports to the EU reached € 5.5 billion in 2000. The trend rate of growth per year over the period 1961–2000 was 4.7%. An analysis of the commodity structure of ASEAN agricultural exports by major subgroups has provided further insights into ASEAN agricultural trade relations with the EU. The commodity composition of ASEAN exports strongly reflects the structure of the ASEAN agriculture. Major agricultural exports from ASEAN to the EU in order of export value include vegetable oils and fats, natural rubber, fish and crustaceans, prepared and preserved fruits and vegetables, and cassava products. In 2000 these product groups together accounted for almost 70% of ASEAN agricultural exports to the EU.

The pattern, composition, and trends of ASEAN agricultural commodity exports to the EU, as examined in the chapter, are the product of various factors, of which trade policies are important ones. The EU places restrictions on trade in most of the major agricultural commodity exports of the ASEAN region. The EU protection has generally taken three forms. First, there has been discrimination in tropical products, such as cocoa, palm oil, fruits, tobacco, and coffee, exported to the EU by ACP countries. Second, quantitative restrictions have been imposed on imports of animal feed, such as cassava, which are substitutes for grain. Third, domestic suppliers have been protected through variable levies and other interventions on products such as sugar and rice.

### 3 Theoretical framework of the study

#### 3.1 The demand for traded commodity

The postulate of rationality is the customary point of departure in the theory of importer's behaviour. The importer is assumed to choose among the available alternatives in such a manner that the satisfaction derived from consuming commodities (in the broadest sense) is as large as possible (Henderson and Quandt 1980). Several factors affect an importing country's purchasing decisions. The price of the product is an obvious and often the most important factor. However, as it was observed in the previous chapter, the EU does not necessarily purchase all of its agricultural commodity imports from the least expensive supplier. There are other factors such as qualitative characteristics affecting trade flows of commodities. This leads to a presumption that EU consumers differentiate between commodities by place of production. In dealing with EU's demand for agricultural products, it therefore seems appropriate to adopt a theoretical framework, in which products are distinguished by their place of production and are not considered perfect substitutes for each other (product differentiation).

This subchapter derives the importer's demand schedule as well as the export demand schedules of its foreign suppliers. The ultimate purpose of the chapter is to show how to go from a formulation of the importer's preferences to the export demand curves faced by exporters. The first part of the chapter explains why commodity differentiation may arise and lead to a negatively sloped export demand schedule for exporting countries. In the second part of the chapter, the importer's preference structure for a differentiated commodity is specified and conventional demand schedules are derived from the formulated preferences. The rest-of-world consumption schedule is also specified, which al-

lows the world market for a commodity to be analysed.

##### 3.1.1 Types of product differentiation

Imperfect competition arising from product differentiation underlies the modelling framework of this study. Most commodities in the international trade are available in a range of varieties (or product-differentiates). These varieties may differ only in respect of brand names or packaging or they may differ in more substantial ways. In addition, the product differentiation may be horizontal or vertical. Horizontal product differentiation refers to product types, which differ in specifications but are of the same "quality" in the sense that they embody the same value of resources. Vertical product differentiation exists when the product varieties differ in quality, a good embodying a higher value of resources being ranked above another good (Vousden 1990).

There are many reasons why primary commodities can become horizontally differentiated in international trade. Horizontal differences between exporters of a commodity can relate either to the conditions surrounding the sale (delivery time, reliability of supplies, credit terms) or to established relationships between trading partners (e.g. cultural, historical or political ties between trading partners). As a result, there is a natural tendency for products to remain imperfect substitutes for one another even though the characteristics of a commodity originating from one supply source are very similar to those of another supplier (Lord 1991). Deardorff (1984) and Thursby et al. (1986) have suggested that even differences in the harvest periods of the countries can affect trade patterns.

The reliability of supply sources often plays a very dominant role for buyers of primary commodities. Adjustment costs are involved in

switching from one supplier to another, for example. These costs include loss of 'loyalty' preferences given by exporters to established buyers and loss of reliability of supply sources. Traditions of language and custom may also limit an importing country's willingness to switch between suppliers. In the sale of a commodity, exporters can also establish consumer preferences for their product that lead to brand loyalties (Lord 1991). Finally, there are learning costs involved in purchases made from new foreign suppliers. The learning required to use one brand may not be transferable to other brands of the same commodity even though all brands are functionally identical (Kallio 1998). Imperfect information may also reduce the degree of substitutability of a particular commodity from alternative supplier.

Models of trade in differentiated products have tended to assume horizontal differentiation, even though vertical differentiation is an important determinant of the pattern of international trade in primary commodities. Vertical product differentiation exists when the product varieties differ in quality (size, condition, grade, uniformity, colour, and variety). Exports of pepper, for instance, are divided by pepper type into white and black pepper. Moreover, each of two types of pepper is graded accordingly to its source, nature, and quality. The origin of the pepper is a critical determinant of the quality, both because of climatic and soil condition and inherent characteristics of the pepper in producing country. The important point here is that physical differences are taken into account by the importer (Lord 1989).

The topic of product differentiation has been treated extensively in the trade literature and a common framework has emerged for its analysis. Helpman and Krugman (1985) have provided a synthesis of this research, although they have not attempted to unify all the recent developments in international trade theory, since the results depend on the particular type of market structure being considered (Lord 1991). Much effort has gone into the precise formulation of product differentiation.

The literature distinguishes two distinct approaches to product differentiation. The case in which consumers derive utility from simultaneously consuming number of differentiates of a given product was developed by Spence (1976) and Dixit and Stiglitz (1977). Their approach is sometime termed the "love of variety" model and it treats the product-differentiates in a commodity group as symmetric substitutes with consumption of more varieties yielding higher utility to consumers (Vousden 1990). According to this approach, a consumer's desire for diversity of supply sources arises from the convexity of the indifference curve for imperfectly substitutable products that constitute a commodity. A number of authors have adapted this approach to explore the effects of international trade in the presence of product differentiation (see Dixit and Norman 1980, Krugman 1979, 1980, 1981, and Venables 1987).

On the other hand, Lancaster (1979, 1980) has emphasised the case in which each consumer has a preferred product specification and consumes the available product which comes closest to her ideal<sup>26</sup>. This so-called "commodity characteristics" approach to consumer behaviour takes the characteristics of a commodity as the fundamental concept. Hence commodity differentiation can arise in international trade because exports are perceived by importers to contain different proportions of characteristics. In this model, not all goods are equally good substitutes for each other. Diversification of supply sources in the Lancasterian view arises solely from aggregation of demand curves of individuals having different most preferred products. In contrast, in the "love of variety" approach the desire for supplier diversification exists at the level of the individual consumer (Lord 1991).

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<sup>26</sup> Imperfect substitutability of the same commodity originating from different countries is interpreted as the importer's desire for characteristics that distinguish a product exported by one country from those of other (Lancaster 1979, 1980). This interpretation is based on the characteristic approach to commodity differentiation in international trade.

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In both cases, the innate complexity of the problem makes it necessary to resort to special assumptions, but it is reassuring that the two approaches yield broadly similar results (Vousden 1990). The Hotelling-Lancaster formulation has the advantage of greater realism, and leads to somewhat more plausible formulation of the nature of the gains from trade. However, it is quite difficult to work with. The Spence-Dixit-Stiglitz approach, by contrast, while less convincing, lends itself quite easily to modelling (Krugman 1990).

### 3.1.2 Specification of importer's preference function

The appropriate means of describing the importer's preference ordering for commodities differentiated by country of origin is the utility tree approach. Leontief (1947) and Sono (1960) introduced the utility tree approach to preference ordering. According to this approach, the importing decision is split into two stages. At the first stage, the importer decides how much to consume of commodity  $Q$  and all other goods, whose composite forms the numeraire  $N_o$ . The decision is based on total expenditures and prices of the goods. At the next stage, a choice is made about how much to consume of the products from different sources ( $Q_j, \dots, Q_n$ ). Imports of a commodity from different sources, such as Indonesia and Malaysia, are considered to be distinct products, say  $Q_{IN}$  and  $Q_{MA}$ .

The necessary and sufficient condition for the second-stage budget allocation is that the goods in a group are weakly separable from goods in any other group in importer's utility function (see, for example, Strotz 1957, Pearce 1961, and Barten 1977). A utility function is weakly separable if the goods can be partitioned in two (or more) groups ( $q_1, \dots, q_k$ ) and ( $q_{k+1}, \dots, q_n$ ) such that

$$U = F[f_1((q_1, \dots, q_k), f_2(q_{k+1}, \dots, q_n))].$$

Following Krugman (1982) and Lord (1991) the aggregate utility function is assumed to take a constant elasticity of substitution (CES) specification. The importer's overall utility schedule is thus given by

$$U(M_j, N_{0j}) = \left[ \pi_j M_j^\alpha + (1 - \pi_j) N_{0j}^\alpha \right]^{1/\alpha}$$

where  $U$  is the total utility of the importer,  $M_j$  is the quantity of good  $Q$  imported by country  $j$ , and  $N_o$  is the numeraire, i.e. the income relative to which all other goods are measured. The parameter  $\pi$  (the distribution parameter), therefore, has here no economic interpretation because it relates different units of accounts, namely quantities of imports to relative income. The parameter  $\alpha$  (the substitution parameter) is what determines the value of the constant elasticity of intersectoral substitution. It is assumed that the parameters  $\alpha < 1$  and  $0 < \pi < 1$ .

The CES specification, which implies weak separability between different import sources, has the important advantage of parsimony in terms of the number of parameters to be estimated. However, to set against this gain there is a cost in terms of the implicit restrictions imposed on the underlying utility function (Winters 1984, Alston et al. 1990, MacLaren 1991). Weak separability in utility function means that the marginal rate of substitution between any two varieties is assumed to be independent of the decision of how much of the total product to consume and of the consumption of other goods. Furthermore, the CES specification assumes that market shares are independent of total product expenditure and that income elasticities for each type of the product are all equal to unity. This restriction, typically referred to as homotheticity, implies that market shares change only in response to relative price changes (Haley 1995).

The restrictions of CES specifications make the model simple and tractable. For example, all the cross-price elasticities between trade flows are calculated from the single elasticity of substitution and trade shares. Furthermore, the system of import demand satisfies the symmetry and

adding-up conditions under these restrictions. However, such assumptions for simplification must be tested for validity before being applied (Winters 1984). There is no objective method for judging the relevance of a certain separability structure. However, afterwards it is possible to evaluate whether the separability assumptions hold.

3.1.2.1 Import demand

Now that the assumptions are in place, it is straightforward to derive the importer's demand schedule as well as the export demand schedules of its foreign suppliers. The utility maximisation problem for the first level of decision by geographic market  $j$ , given a commodity import price  $P$  and a level of nominal income  $Y^n$ , is

$$\max U(M_j, N_{0,j}) = \max [\pi_j M_j^\alpha + (1-\pi_j) N_{0,j}^\alpha]^{1/\alpha}$$

subject to  $P_j M_j + N_{0,j} = Y_j^n$

The solution to the foregoing problem yields the overall demand schedules for commodity imports  $M$  and the numeraire  $N_o$  of importer  $j$  (see Appendix A for the derivation):

$$M_j^d = \hat{a}_1 Y_j \left( \frac{P_j}{D_j} \right)^{\epsilon_m^p} \tag{1}$$

$$\text{and } N_{0,j} = (1 - \hat{a}_1) Y_j^n \left( \frac{P_j}{D_j} \right)^{\epsilon_n^p} \tag{2}$$

where  $\hat{a}_1 = [(1-\pi_j)/\pi_j]^{1/(1-\alpha)}$  is a constant with expected sign  $\hat{a}_1 > 0$ ;  $Y = Y^n/D$  is real income in importing country  $j$ ;  $P_j$  is the price of the good imported by country  $j$ ;  $D = (1 + \hat{a}_1 P_j^{\alpha/(\alpha-1)})^{(\alpha-1)/\alpha}$  is the deflator; and  $\epsilon_m^p = 1/(\alpha-1)$  is the price elasticity of import demand for good  $M$  and  $\epsilon_n^p = \alpha/(\alpha-1)$  is the price elasticity of import demand for numeraire  $N_o$ ;

The demand schedules have two important properties. First, the income elasticities are equal to unity, a hypotheses that will later be tested. Second, the price elasticity of demand for com-

modity imports ( $\epsilon_m^p$ ) can take any value between 0 and  $-\infty$  (Lord 1991).

3.1.2.2 Export demand

Once the level of expenditures  $Y_m^n$  for the imported commodity  $M$  has been determined, the utility maximisation problem of how much of the commodity to purchase from alternative suppliers – let say an exporter of interest  $i$  and its competitors  $k$ , which refer to the rest of the  $n-1$  other foreign supplying countries, to market  $j$  whose corresponding export prices are  $P_i$  and  $P_k$  – may be expressed as

$$\max U_m(X_1, \dots, X_n) = \max [\pi_{ij} X_{ij}^\beta + (1-\pi_{ij}) X_{kj}^\beta]^{1/\beta}$$

subject to  $P_{ij} X_{ij} + P_{kj} X_{kj} = Y_{m,j}^n$

where  $X_{ij}$  is the quantity of the good exported from country  $i$  to country  $j$ . The parameter  $\pi_{ij}$  has to do with the relative market shares of the exporter  $i$ . And the parameter  $\beta$  measures the constant rate at which intrasectoral substitution takes place. It is defined as the proportionate rate of change of the of the product ratio divided by the proportionate rate of change of the marginal rate of commodity substitution. It is assumed that the values of the parameters are constrained such that

$$\beta < 1 \text{ and } \sum_{i=1}^n \pi_{ij} = 1$$

The export demand schedules for the country of interest  $i$  and its competitors  $k$  are (see Appendix A for the derivation)

$$X_{ij}^d = \hat{a}_2 M_j \left( \frac{P_{ij}}{P_j} \right)^{\epsilon_x^p} \tag{3}$$

$$\text{and } X_{kj}^d = (1 - \hat{a}_2) M_j \left( \frac{P_{kj}}{P_j} \right)^{\epsilon_x^p} \tag{4}$$

where  $\hat{a}_1 = [(1-\pi_{ij})/\pi_{ij}]^{1/(1-\beta)}$  is a constant;  $P_{ij}$  is the price of the good imported from country  $i$  to

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country  $j$ ;  $P_j = (P_{ij}^{b/(b-1)} + P_{kj}^{b/(b-1)})^{(b-1)/b}$  is the average price of the good imported to country  $j$ ; and  $\epsilon_x^p = 1/(\beta-1)$  is the price elasticity of export demand.

The export demand schedules above have the following properties. First, export demand has a unitary elasticity with respect to the level of import demand in the geographic market, which is theoretically consistent. In other words, a change in the level of import demand in the foreign market will, *ceteris paribus*, cause a proportionate change in the demand for the exports of all supplying countries to that market. Second, the price elasticity of export demand ( $\epsilon_x^p$ ) has a value that lies between 0 and  $-\infty$ . Third, the constant  $\hat{a}_2$ , which has the value  $0 < \hat{a}_2 < 1$ , measures the exporter's market share.

The rate at which the importer is willing to substitute exports from a supplier of interest  $i$  for those from other suppliers  $k$ , where  $k = 1, \dots, n-1$ , in order to maintain a given amount of total commodity imports  $M$ , is equal to the marginal rate of substitution:

$$\frac{\partial X_{kj}}{\partial X_{ij}} = \left( \frac{\pi_{ij}}{1 - \pi_{ij}} \right) \left( \frac{X_{ij}}{X_{kj}} \right)^{\beta-1} \quad (5)$$

### 3.1.2.3 World demand

Rest-of-world consumption, denoted  $C_{row}$ , comprises all consumption other than that for imports by foreign markets  $j$ . It is, therefore, made up of consumption of domestically produced commodity in foreign markets  $j$ , domestic consumption in the exporting countries  $i$ , and the import demand of markets other than  $j$ .

Since it has been assumed that substitution of goods by all consumers takes place in the constant elasticity form, the schedule for rest-of-world consumption is analogous to that derived for import demand schedule. Accordingly, rest-of-world consumption  $C_{row}$  depends on the commodity's real price  $P/D$  in the market, and real income  $Y$  of the economic agents:

$$C_{row} = \hat{a}_3 Y_{ROW} \left( \frac{P_{ROW}}{D_{ROW}} \right)^{\epsilon^p}, \quad (6)$$

The total world consumption of the commodity is then simply the sum of the quantities demanded by the importers of interest and rest-of-world consumption:

$$C = \sum_{j=1}^m M_j + C_{row}, \quad (7)$$

where import demand  $M_j$  is obtained from (1) and rest-of-world consumption  $C_{ROW}$  is obtained from (6).

## 3.2 The supply of traded commodity

This part of the chapter derives the import supply schedule to a geographic market  $j$  as well as the export supply schedules of its foreign suppliers. The rest-of-world production schedule is also specified, which allows the world market for a commodity to be analysed. The bulk of the economic literature demonstrates that supply is generally responsive to economic incentives. Accordingly, the theory underlying the supply side here is the traditional supply response to change in price and to changes in some non-price factors. The price variable used is usually a measure of relative prices: prices paid relative to prices received or output prices relative to input prices. The issue in the supply specification is therefore the choice of the relevant deflator. Apart from incentives captured by price, there are factors such as weather conditions, resource endowments, technology, GDP growth, and population growth that are important in explaining agricultural supply.

### 3.2.1 Import supply

The total supply of commodity imports to a geographic market  $j$  depends on circumstances in both the foreign supplying countries and the import market itself. Foreign supplying countries

encompass all possible producers except those in the importing country. The amount that foreign producers are willing to supply is influenced primarily by the world market price of the commodity  $P_w$  relative to general price level  $D_w$ . In addition, the amount of the commodity that producers will supply to the importing country  $j$  is influenced by the importer's foreign exchange availability  $FEX_j$ , and the ratio between the import price  $P_j$  and the world market price  $P_w$ , since any change in relative price will induce a change in import supply. According to Lord (1991) the schedule for import supply  $M^s$  to a geographic market  $j$  can be expressed as

$$M_j^s = A(P_w/D_w)^{\delta_1} (P_j/P_w)^{\delta_2} FEX_j^{\delta_3} \quad (8)$$

Thus, the import supply of the country  $j$  depends on the world market price of the commodity, which influences supply availability in the world, and on the relative import price of the commodity and foreign exchange holdings (see Appendix B). However, individual commodity imports are unlikely to be affected by the overall foreign exchange position of the country because changes in international reserves would have negligible influence on the supply of a single imported good. The elasticity of import supply with respect to foreign exchange reserves is therefore considered to approach zero, i.e.  $\delta_3 \cong 0$ , so that  $FEX_j^{\delta_3} \cong 1$ .

The second feature of the equation (8) is that the relative price elasticity of import supply approaches infinity, i.e.  $\delta_2 \cong \infty$ , since the importer has little or no influence on the market price of a commodity. The importing country takes price as given. In other words, when production in the importing country can reasonably be considered to represent a very small proportion of the world output, it can be shown that its import supply schedule has a price elasticity that approaches infinity. The supposition of an infinite price elasticity of import supply is conventionally used in empirical studies of demand for imports (e.g. Turnovsky 1968, Houthakker and Magee 1969, Hickman and Lau 1973, Khan and Ross 1975, Murray and Ginman 1976, and Roussland and

Parker 1981, Lord 1991). The import price can be obtained from the inverse of the import supply schedules. The inverse supply schedules shows that import price  $P_j$  has a proportional response to movements in the world market price of the commodity:

$$P_j = \hat{a}_4 P_w \quad (9)$$

where constant  $\hat{a}_4$  accounts for the differences between the two prices. In the competitive markets, prices of identical goods, expressed in common currency, should be equalised in international trade in the long-run, implying  $\hat{a}_4 = 1$ . However, transportation costs, tariffs, varying methods of valuation, customer-seller relationships, purchase agreements under long-term contracts<sup>27</sup>, imperfect information, inertia in consumer habits etc., may cause deviations from "the law of one price" (Chu and Krishnamurty 1978, Vataja 1998).

### 3.2.2 Export supply

The starting point for an analysis of the exporter's supply decision is the problem of identifying the market structure, in which the exporter operates. Given the assumption that importers view commodities from different sources as being distinct to some degree means that each exporting country possess some market power with respect to its own product (which is imperfectly substitutable for those produced by other exporters in the market). However, when individual producers in the exporting country take the market price of output as being given and outside of their control, the market structure can be described competitive. In a competitive market with many price-taking producers, each producer takes the price as being independent of its own actions, although it is the actions of all producers taken together that determine the market

<sup>27</sup> Most foreign trade take place under 30- and 90-day contracts (Vataja 1998).

price. The point is that the exporting country as a whole may have some monopoly power in trade, but it is for the government to exploit it by suitable use of trade policy.

The international market structure for most agricultural commodities exported from ASEAN to the EU appears to be one, in which there is a large number of producers in each exporting country, and in which the actions of individual producers in each country have a negligible impact on the market price of the product. There are typically thousands of commodity producers in each exporting country, and even the largest of them produces only an infinitesimal fraction of the total. Therefore, each producer faces a demand curve that is essentially flat. The producers compete for customers in terms of both price and the kinds of products they sell. Furthermore, there are no restrictions against new producers/exporters entering into the market. Therefore, it seems legitimate to treat the export supply of agricultural commodities under the assumption of competitive market.

The exporter's supply decision is derived from the exporter's ultimate objective of maximising net foreign exchange earnings by means of a cost-minimising combination of the factor inputs used to produce the commodity. Net foreign exchange earnings are defined as total revenue minus total cost. Total revenue of an exporter is given by the quantity exported, denoted  $X$ , multiplied by the unit export price,  $P$ . Total cost depends on the quantity exported, i.e. on the quantity of inputs used. The exporter naturally desires to minimise the cost of producing a certain level of exports.

The exporter transforms inputs into outputs of exports, subject to the technical rules specified by the production function. The production function therefore gives mathematical expression to the relationship between quantities of inputs employed and the quantities of outputs produced. This production schedule needs to be expressed in a specific functional form if a market supply that lends itself to empirical estimation is to be obtained. The particular functional form adopted in this study is the restricted form of the gen-

eralised CES function. It is here generalised to cover any degree of homogeneity. Following Lord (1991) the production schedule relating to the amount of capital  $K$  and labour  $L$  needed to produce a given level of commodity export  $X$  is

$$X_i^s = B(K^\rho + L^\rho)^{\tau/\rho} \quad (10)$$

where  $\rho < 1$  and  $\tau > 0$ .  $X_i^s$  is the quantity of the good exported from country  $i$ ;  $B = \exp(\theta_0 + \theta_1 T + \theta_2 \Psi)$  is a constant term, which serves as an indicator of the state of technology ( $e^{\theta_1 T}$ ), and major disturbances ( $e^{\theta_2 \Psi}$ ) in the production of commodity export. The value of  $\rho$  determines the value of the constant elasticity of substitution. And the parameter  $\tau$  is what determines returns to scale.

The CES production function has two principal features. First, the elasticity of substitution between the two inputs can be any number between zero and infinity. Second, for a given set of parameters, the elasticity of substitution is the same on any point along the isoquant, regardless of the ratio of input use at the point.

The problem of maximising the foreign exchange earnings must be divided up into two steps. At the first step, the problem of how to minimise the costs of producing any given level of export will be examined. At the second step, the most profitable level of export quantity will be chosen.

The problem of finding the least-cost combination of inputs can be constructed as a problem of minimising cost subject to the constraint that quantity to exported be some fixed amount  $X$ . Therefore, the objective function is to minimise cost  $C = P_K K + P_L L$  subject to the constraint that revenue be some fixed amount  $X$ . The cost minimisation problem is

$$\begin{aligned} \min C &= \min P_K K + P_L L \\ \text{subject to } &B^{\rho/\tau} K^\rho + B^{\rho/\tau} L^\rho = X^{\rho\tau} \end{aligned}$$

where  $P_K$  and  $P_L$  denote the prices of labour service (wage rate) and capital service (rental charge for capital goods), respectively. The solution to



this problem yields the following cost schedule (see Appendix B for the derivation):

$$C = B^{1/\tau} X^{1/\tau} (P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)})^{(\rho-1)/\rho} \quad (11)$$

where  $\rho < 1$  and  $0 < \tau < 1$ . It is an explicit function of the commodity output level and the input prices of capital and labour.

The exporter is free to vary the levels of both cost and output and his ultimate aim is the maximisation of foreign exchange earnings. The quantity of the product that the exporting country will supply is determined by the first-order condition of the profit maximisation objective of the exporter. The profit maximisation problem is

$$\max PX - C(X).$$

The first-order condition yields the following export supply schedule (see Appendix B):

$$X_i^s = \hat{a}_5 \left( \frac{P_i}{D_i} \right)^\gamma \exp(\varphi_1 T + \varphi_2 \Psi) \quad (12)$$

where  $X_i^s$  is the quantity of the good exported from country  $i$ ;  $(P_i/D)$  is the real domestic price of the good exported from country  $i$ ;  $P_i$  is the nominal export price of the good exported from country  $i$  in the currency of country  $i$ ,

$D = (P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)})^{(\rho-1)/\rho}$  is the deflator

and  $\hat{a}_5 = \exp[\theta_0/(\tau-1)] \tau^{\tau/(1-\tau)}$  is a constant.

Equation (12) embodies the notion that exporters increase their supply of exports as the price of exports rises relatively to domestic prices. In addition, technological development as well as exogenous shocks such as weather, civil strife or wars are important in explaining export supply. The size of the supply response is informative, in particular, about whether a policy of taxing agriculture through export levies or through overvalued exchange rates will retard agricultural trade flows or whether such

policies will generate additional export revenues.

The price elasticity of export supply is given by  $\gamma = \tau/(1-\tau)$ , which defines the percentage change in export supply brought by a 1 per cent change in the real price of the commodity. The value of  $\tau$ , which measures returns to scale, must satisfy the constraint  $0 < \tau < 1$ , implying  $\gamma > 0$ . This means that the exporter is assumed to experience decreasing returns to scale, and accordingly, the export supply schedule is upward sloping. The variable  $T$  is a trend variable, which measures technological changes in the production and export processes;  $\Psi$  represents a shift variable that measures major random disturbances in export supply. The other parameters have the following definitions:  $\varphi_1 = \theta_1/(1-\tau)$ ;  $\varphi_2 = \theta_2/(1-\tau)$ .

### 3.2.3 World supply

Rest-of-world production, denoted  $Q_{row}$ , comprises all production other than that for export by countries of interest. It is made up of production for domestic consumption in exporting countries of interest plus production in all other countries. Since it has been assumed that production function always takes a CES form, the schedule for rest-of-world supply is analogous to the export supply schedule. Accordingly, rest-of-world production  $Q_{row}$  depends on the commodity's real price  $P/D$ , as well as on a secular trend  $T$  and major disturbance  $W$ :

$$Q_{row} = \hat{a}_6 \left( \frac{P}{D} \right)^\gamma \exp(\sigma_1 T + \sigma_2 W), \quad (13)$$

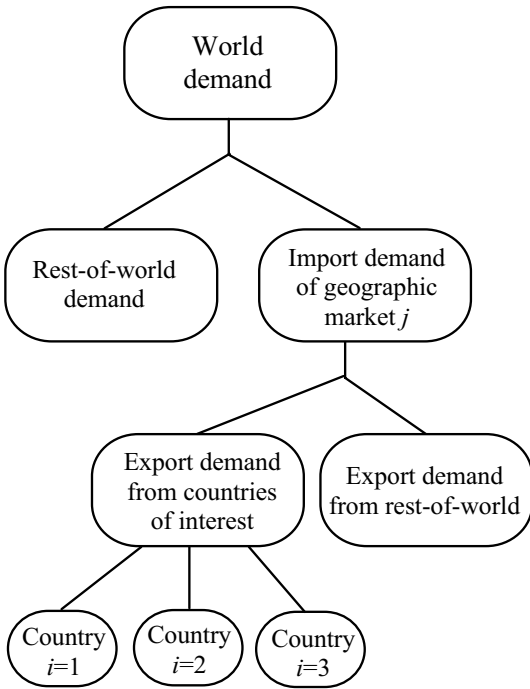
where  $\gamma > 0$  and  $\sigma_1, \sigma_2 \neq 0$ .

Summation of the supply of exporters of interest  $X_i$  and rest-of-world production  $Q_{row}$  yields the aggregate supply schedule

$$Q = \sum_i X_i^s + Q_{row}, \quad (14)$$

where export supply  $X_i^s$  is obtained from (12) and rest-of-world output  $Q_{row}$  is obtained from (13).

DEMAND



SUPPLY

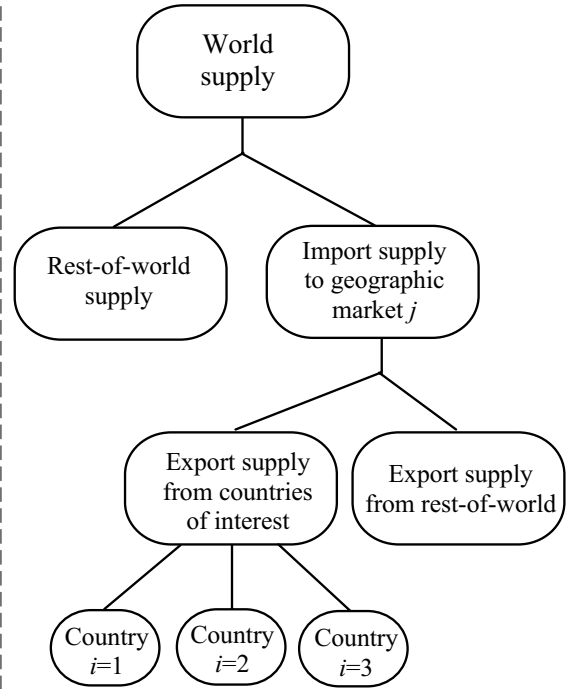


Figure 5. A visual representation of the equations of the system used to describe agricultural commodity trade.

### 3.3 Summary

This chapter has described demand and supply for traded commodities in terms of a representative importer and a representative exporter of a commodity. Figure 5 provides a visual representation of the equations of the system used to describe the underlying features of international agricultural commodity trade. Armington's (1969) model, which allows each exporting country to exert some influence on the demand for its exports through relative price changes, is used to specify the demand equations for traded commodities. The model recognises that the same commodities of different origins are imperfect substitutes within an importing country's commodity market. Following the model, the importing decision is split into two stages. At the first stage, the importer decides how much of the

imported commodity to consume against all other goods. At the second stage, once the level of expenditures for the imported commodity is determined, the utility maximisation problem is of how much of the commodity to purchase from alternative suppliers. In order to reduce to number of parameters to be estimated, the model further assumes a constant elasticity of substitution (CES) for each product pair.

The supply analysis aimed at determining the importance of price factors in export responsiveness is based on the exporter's objective of maximising net foreign exchange earnings by means of a cost-minimising combination of the factor inputs used to produce the commodity. The production function is specified as CES. The key behavioural assumption in the determination of export supply is that no monopoly power is given to the exporter, since the export supply really stands for the collection of several small pro-

ducers. The point is that each producer takes the price as being independent of its own actions in a competitive market with several price-taking producers. The exporting country as a whole may

have some monopoly power in trade, but it is for the government to exploit it by suitable use of trade policy.

## 4 Measuring the effects of agricultural trade policies

Agricultural trade policies encompass a variety of measures intended to affect the flow of agricultural commodities between countries. These measures frequently include controls on imports as well as on exports. Import tariffs, trade quotas, price controls and marketing operations of national marketing agencies are typical commodity-specific policies driving a wedge between domestic and border prices. Government intervention in agriculture has been intended to achieve many different and sometimes conflicting objectives: cheap food and raw materials to promote industrialisation, greater government revenue, the accumulation of foreign exchange earnings, food self-sufficiency, stable prices, and higher farm income etc.

Trade measures have many different effects. These include price and quantity effects on trade and production, as well as employment and welfare effects. These occur both in the country applying them as well as in other countries directly and indirectly affected by them. In this chapter the impact of the effects of alternative trade policies on commodity trade are examined. The economics of fixed tariffs will be considered in the first part of the chapter. In the second part of the chapter, the attention is turned from importer's trade policy to exporter's trade policy.

The major analytical tool in empirical trade policy analysis is a partial equilibrium model. In partial equilibrium analysis, we limit our view to a specific sector of the domestic and international economy, as we hold other things constant, at least conceptually. Our main emphasis will be on price, production, income, and trade effects

of policy decisions as applied to individual agricultural commodities. For the analysis of trade policy principles, the partial equilibrium regime has numerous advantages. It is simple to understand and manipulate. For specific trade policy schemes and interventions, partial equilibrium analysis provides results that highlight important differences among policy measures. A disadvantage of this approach is that it suppresses interactions between commodities that are actually linked together by substitution and competition (Houck 1986).

By definition, partial equilibrium models take into account only part of the factors emphasised in general equilibrium trade theory. While this is the root of the practical limitation of applied partial equilibrium modelling, it is also the source of its basic advantage. By focusing on a very limited set of factors, such as a few prices and policy variables, applied partial equilibrium models allow for relatively rapid and transparent analysis of a wide range of commercial issues. Furthermore, in many situations, such as econometric exercises, it may be impossible to introduce general equilibrium constraints to the relevant market equations. As long as the limitations of the approach are kept in mind, useful insights can often be drawn under time and data constraints that preclude more complex forms of analysis. (Francois and Reinert 1997).

The theory behind partial equilibrium models is the textbook treatment of supply and demand curves. Partial equilibrium models use economic theory to organise data and economic assumptions about markets in a systematic way.

## 4.1 Protection by importers

Tariffs, which are taxes on imports, are the most transparent forms of trade protection. They exist largely to protect domestic firms that compete with imports, though tariffs are sometimes levied for purposes of raising government revenues. They come in numerous forms: they may be specific, as fixed or ad valorem payments made on the volumes imported. Even though governments have shown ingenuity in fashioning intricate tariff schemes to protect domestic producers, the basic economics is relatively straightforward. By raising the domestic price of imported good, tariffs punish consumers. The losses sustained by consumers are partially offset by gains to owners of domestic production facilities who earn higher prices and expand their output. The government treasure also achieves gains with tariffs. (Houck 1986).

Consider the import demand equation (1) derived in chapter 3.1.2.1 (page 38).

$$M_j^d = \hat{a}_1 Y_j \left( \frac{P_j}{D_j} \right)^{\epsilon_m^p}$$

and add a fixed tariff, denoted  $T$ , to this equation. The term “fixed-rate” means that the same import tax per unit is applied no matter how much is imported or what the international or domestic prices of the commodity are. The tariff raises the price of the commodity to  $(1+t)P$  in the geographic market  $j$ . Hence, the demand function for the traded commodity in the long-run dynamic equilibrium relationship implicit in equation (1) is

$$M_j^d = \hat{a}_1 Y_j \left( \frac{(1+t)P_j}{D_j} \right)^{\epsilon_m^p} \quad (15)$$

Note that the deflator  $[D_j = (1 + \hat{a}_1 (1+t) P_j^{\alpha(\alpha-1)} )^{(\alpha-1)/\alpha}]$  in (15) is also influenced by the tariff increase on the commodity imported by country  $j$ . However, the overall inflation of the coun-

try is unlikely to be greatly affected by individual commodity imports because changes in the tariff of a single imported good would have negligible influence on the deflator.

The relative prices of foreign suppliers to the market remain unaltered: that of the country of interest  $i$  and its competitor  $k$  is  $(1+t)P_i / (1+t)P_k$ . Thus, the export demand schedules for the country  $i$  and its competitors  $k$  in the long-run dynamic equilibrium relationship implicit in equation (3) in page 38 are

$$X_{ij}^d = \hat{a}_2^* M_j \left( \frac{(1+t)P_{ij}}{(1+t)P_j} \right)^{\epsilon_x^i} \quad (16)$$

$$\text{and } X_{kj}^d = (1 - \hat{a}_2^*) M_j \left( \frac{(1+t)P_{kj}}{(1+t)P_j} \right)^{\epsilon_x^k} \quad (17)$$

Hence, a change in the quantity demanded of the commodity because of protectionist measures would cause a proportional change in the demand for the commodity.

Consider now graphically the effects of a fixed tariff applied by a country  $j$  on imports of the product  $Q$  in a partial equilibrium framework. This situation is depicted in Figure 6. If no tariffs or other trade distortions are applied in the geographic market  $j$ , the international and domestic prices are equal to  $p_j$ . Domestic producers supply an amount equivalent to  $ab$ , and  $bc$  is imported (Fig 6a). This brings total consumption to  $ac$ . Figure 6b shows imports of  $Q$  equal to  $df (= bc)$ . This is where country’s  $j$  excess demand curve<sup>28</sup> ED intersects the excess supply curve<sup>29</sup> ES(R) facing country  $j$ . Since the coun-

<sup>28</sup> For prices below  $p_j$ , which is the price in country  $j$  in the absence of trade, consumers in country  $j$  demand more than domestic producers supply. As price falls, this difference grows, tracing out an excess demand curve (ED) facing the rest-of-world.

<sup>29</sup> For prices above  $p_{row}$ , which is the price in the rest-of-world in the absence of trade with country  $j$ , producers in the rest-of-world supply more than producers supply. As price rise, this difference grows, tracing out an excess supply curve (ED) facing country  $j$ .

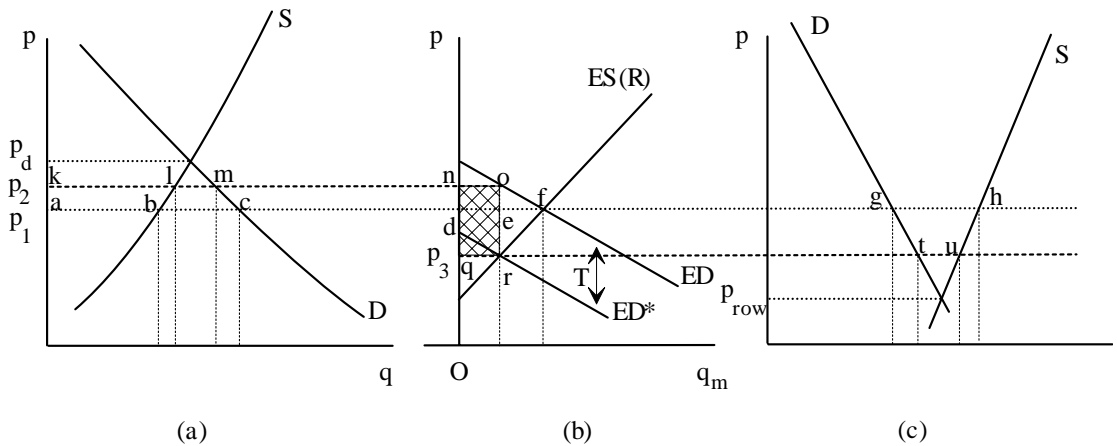


Figure 6. Effects of a fixed-rate tariff in a partial equilibrium framework, large-nation case.

try is considered “large” in relation to the total traded volume of the product in question, it faces a positively sloping excess supply (ES) function for the rest of the world.

The imposition of the tariff will have a price-increasing effect on the domestic market. At the higher price  $p_2$ , domestic production increases to  $kl$  and consumption decreases to  $km$ , which reduces excess demand to  $de$  in the world market. The lower excess demand  $ED^*$  (the tariff-burdened  $ED$  function) drives the world market prices to  $p_3$ , so that, in the rest of the world, the quantity of excess supply is reduced from  $gh$  to  $tu$  (Figure 6c).

Whether or not domestic consumption expenditures are higher or lower with the tariff depends on the price elasticity  $\epsilon_m^p$  of the domestic import demand function. If  $\epsilon_m^p$  is absolutely larger than  $-1.0$ , buyers spend less after the tariff. If  $\epsilon_m^p$  is absolutely less than  $-1.0$ , buyers spend more. In either case, they pay higher price and purchase less  $Q$  than they did without the tariff.

With the ideas of producer and consumer surplus, an analysis of the welfare implications of tariffs can be developed<sup>30</sup>. The trade-limiting

policy lowers consumer surplus from the free trade position by the area  $kmca$ . This is the partial equilibrium economic cost of this change to consumers. In other words, the area is an approximate measure of the willingness to pay by consumers to forego the tariff policy. Some of it, area  $klba$ , is picked up as an increase in producer surplus. This value goes to owners of fixed assets that produce the product. Some of it, area  $norq$ , goes to the government as tariff revenue. The area  $ofe$  is the sum of the tariff-induced domestic production inefficiency and deadweight consumer loss<sup>31</sup>.

Net social losses occur in the economy, if the additional tariff revenues generated by pressing down the world price, area  $derq$ , do not offset the welfare losses measured by  $ofe$ . However, if the area  $derq$  is larger than  $ofe$ , the government could, in principle, use the funds from area  $derq$  to compensate for the welfare losses measured

net value that consumers as a group obtain by being able to purchase as much as they wish at the going market price rather than having to pay, successively the highest price they would be prepared to offer for each additional unit (Houck 1986).

<sup>31</sup> One can view these losses as the implicit price an economy pays for (1) the privilege of protecting the producers of with a tariff, and (2) the accumulation of tariff revenues.

<sup>30</sup> Producer surplus is fundamentally the gross return obtained by owners of productive assets in the sector after variable costs are accounted for. Consumer surplus is the

by *ofe* and perhaps have something left over. The more inelastic ES(R) is relative to the absolute price elasticity of ED, the more likely it is that such an optimal tariff policy can be pursued successfully. If the ES(R) function is completely elastic, as with the small-nation assumption, the importing country cannot press down the world price (Houck 1986).

The standard trade theory reveals that tariff is always welfare-reducing in the ‘small country’ case because of the loss of real income due to substitution in production and the by-product effect of substitution in consumption. In the ‘large country’ case, a tariff is welfare-improving provided that the import supply curve is elastic. However, when trade policies are analysed by using intra-industry trade models, an introduction of tariff, though it decreases competition, does not necessarily bring about losses similar to those that occur in perfect competition. Therefore, a small country does not necessarily suffer welfare loss as a result of tariff, and there exists a possibility that she may be obtain welfare gains.

## 4.2 Protection by exporters

### 4.2.1 Export expansion policies

Turning from importables to exports, the principal instruments in use are export subsidies or measures having similar effect, such as subsidised credit, production subsidies etc. Export expansion is a powerful theme in the agricultural and trade policies of many nations. Often the underlying goal of export expansion over the long run is to seek overseas outlets for growing farm production. In other words, the objective is to support activities by public officials, trade association, or private organisations that expand the demand for a nation’s food and agricultural commodity exports. Successful demand expansion will then translate into larger export volumes, more foreign exchange earnings, and pos-

sibly higher domestic prices than otherwise would occur (Houck 1986).

The intervention measures usually adopted by an exporting country are an export subsidy, an output subsidy or a research and development subsidy. These measures may be specific, as fixed or ad valorem payments made on the volumes exported. An interesting and important phenomenon occurs when governments are observed to act as agents in support of large domestic firms in the international market place. In this case, certain government actions are designed to give domestic firms strong advantage over foreign rivals in competing for international business. These actions often involve some direct or indirect form of subsidy that lowers the production costs of the domestic firms relative to their competitors’ costs.

Consider the introduction of an export subsidy whose per-unit value is a specified amount into the export supply equation (12) formulated in chapter 3.2.2 (page 43). The export subsidy reduces the marginal cost of the exported commodity and, as a result, increases country’s exports. This effect can be shown in the first-order condition for foreign exchange earnings, in which country *i* exports the amount at which its marginal cost equals to its marginal revenue. The resulting export supply schedule is (see Appendix C for derivation)

$$X_i^s = \hat{a}_5^i \left( \frac{(P_i + S) * ER_i}{D_i} \right)^\gamma \exp(\phi_1 T + \phi_2 \Psi) \quad (18)$$

where  $\hat{a}_5^i = \exp[\theta_0(\tau-1)/\tau]^{(1-\tau)}$  is the constant,  $P_i$  is the price of the good exported from country *i* in the currency of the importing country,  $ER_i$  is the exchange rate of currency of the exporting country (in per unit of currency of the importing country),  $D_i = (P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)})^{(\rho-1)/\rho}$  is the deflator, and  $\gamma = \tau/(1-\tau)$  is the price elasticity parameter of export supply.

The economics of a fixed export subsidy, denoted *S*, is illustrated in a partial equilibrium framework in Figure 7. The exporting country *i* faces a downward sloping excess demand ED(R)

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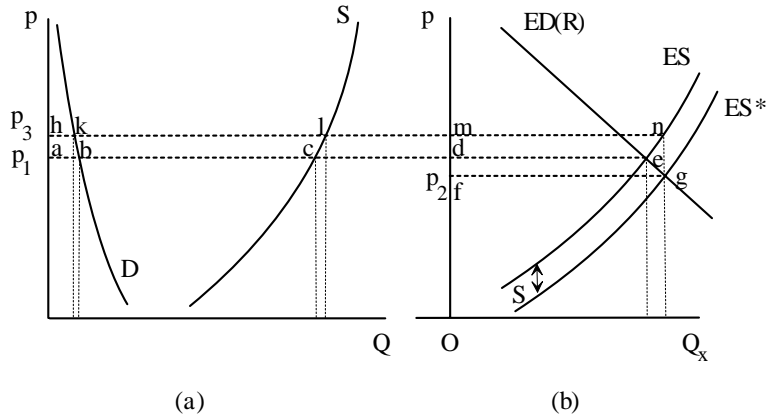


Figure 7. Effects of a fixed export subsidy in a partial equilibrium framework.

curve for the product in question. This implies that the country's product differs systematically from those of other sellers and/or the exporter is large enough in the world market so that its exports are sizeable enough to cause the relevant world price to change. In a free trade situation, total exports from country  $i$  equal  $de (= bc)$ . This is where country's  $i$  excess supply curve  $ES$  intersects the  $ED(R)$  curve (Figure 7b). The international and domestic prices are equal to  $p_1$ .

Trade intervention in the form of export subsidy lowers the supply price of exports by the value of  $S$  per unit, generating a new excess supply curve  $ES^*$  faced by foreign buyers. The new intersection of  $ES^*$  with  $ED(R)$  indicates an expansion of export volume from  $de$  to  $fg$ . The lower  $ES^*$  curve then drives world prices down to  $p_2$ . On the other hand, an increase in domestic price to  $p_3$  occurs as exporters, eager to earn subsidy payments, expand export sales and bid up prices paid for export goods.

As with most trade policy intervention schemes, there are net social losses and redistribution of economic value within any society providing export-expanding subsidies. The new policy increases producer surplus by the area  $hlca$ , and decreases consumer surplus by  $hkba$ . In addition, taxpayers distribute  $mngf$  in export subsidy outlays.

Whether or not export revenues of the country are higher or lower with the subsidy depends on the price elasticity  $\epsilon_x^p$  of the ED function. If

$\epsilon_x^p$  is absolutely larger than  $-1.0$ , an increase in the subsidy will generate both higher export revenues and larger market share. If  $\epsilon_x^p$  is absolutely less than  $-1.0$ , foreign buyers spend less on the product after the subsidy. In either case, foreign buyers pay lower price and purchase more  $Q_i$  than they did without the subsidy.

Although export subsidies or other forms of support increase profits for the national firms and may also generate higher export revenues, traditional trade policy analysis based on perfect competition and constant returns to scale shows that these subsidies are not welfare-improving for the country (Markusen et al. 1995).

However, some unconventional propositions emerge when imperfect competition is inherent in a market, for instance as a result of product differentiation or oligopolistic competition in many industries. In this case, welfare analysis in terms of producer and consumer surplus reveals that a country does not necessarily suffer welfare loss as a result of export subsidy, and that there exists a fair degree of possibility that she may obtain welfare gains (Borkakoti 1998).

#### 4.2.2 Export subsidies as strategic trade instruments

Whenever a country  $i$  uses an export subsidy, specific or variable, foreign nations with agricultural interests are bound to sense intrusion and

damage. Competing producers around the world in other exporting countries will be damaged to the extent that subsidised exports drive down international prices and replace non-subsidised production and sales. Therefore, the types of strategic trade policy decisions that can be taken by a country  $i$  depend on the nature of competition, and on the particular type of market structure being considered. In particular, it pays a country to know which are its closest competitors and what their most likely responses would be to possible policy initiatives on its part (Lord 1991).

Game theory has recently been widely used in this type of strategic trade policy problems. For the problem to be well defined, it is necessary to know what sort of game the countries are engaged in (e.g. Cournot, Bertrand, or a dominant country with competitive fringe). From a game theoretical viewpoint, these models are distinguished by the definition of the strategy space (prices or quantities) and by the information sets: whether one country knows the other's choice when it makes its move (Varian 1992). A number of interesting studies, which apply the tools of game theory in order to capture strategic interactions between players in the market, have been written (see for example, Karp and MacCalla 1983, Johnson et al. 1993, Kennedy et al. 1996, Abbott and Kallio 1996, Kallio 1998).

In Cournot competition, Brander and Spencer (1985) have explained in detail why export subsidies might be attractive policies for countries that have price-elastic export demand functions. They have formulated trade policy decisions as non-cooperative games involving a large number of countries exporting differentiated products. Each exporter possesses some market power with respect to its own product (which is imperfectly substitutable for those produced by other exporters in the industry), but exporters in other countries do not react to decisions taken by their competitors about the quantity to be exported. This type of competition encompasses most commodity markets that contain a large number of exporters and in which the actions of

exporters in each country have a negligible impact on a market.

The Brander-Spencer (1985) results for export subsidy can be illustrated by assuming that unilateral action is taken by the government of the exporting country  $i$ , while no action is taken by its competitors  $k$ , which refer each of the  $n-1$  other foreign supplying countries. Hence, consider the equation (18), which represents the export supply function for country  $i$  with a subsidy. The corresponding export supply function without a subsidy for its competitors  $k$  is given by (12) in page 43. The export demand functions for all exporting countries are described by (3) in page 38. In order to find the effect of a change in a subsidy on export volume and price, the export supply function of a country with a subsidy in (18) is set equal to its export demand function in (3),

$$\begin{aligned} \hat{a}_5' \left( \frac{(P_i + S) * ER_1}{D_i} \right)^{\gamma} \exp(\varphi_1 T + \varphi_2 \Psi) & \quad (19) \\ = \hat{a}_2 M \left( \frac{P_i}{P} \right)^{\varepsilon_i'} & \end{aligned}$$

and solve for  $P_i$ . The solution for  $P_i$  is then substituted into the export demand or supply function to obtain the amount exported.

The central idea in the Brander-Spencer case is that it is to the advantage of a country to capture a larger share of the production of profit-earning imperfectly competitive industries. Export subsidies can be used to carry out such 'profit-shifting' policies, since the expansion in exports will increase both the market share and the export revenues of the country provided its price elasticity of export demand is greater than unity. The essential assumption to the outcome in their analysis is that the government uses subsidy for strategic purposes and that export industry takes the subsidy as given. By acting first, the government can move the domestic firm to the so called Stackelberg leader position in the output space. As a result, the government has unilateral incentive to offer an export subsidy.



Ultimately, Brander and Spencer (1985) have argued that the promotion of exports will cause the country's national income to expand. This occurs not only because of the shift in production of a good from competing exporters to the domestic economy, but also because of the domestic multiplier effect that accompanies an increase in the real exports of the country. Thus, a small subsidy at the non-cooperative equilibrium always increases domestic welfare through an expansion of profitable exports.

Brander and Spencer (1985) have, however, been quick to point out that any policy involving subsidies should be viewed with suspicion because the marginal opportunity cost of government revenue may be much higher than the value of unity assumed in simple surplus analysis. Secondly, in a world of imperfect information and imperfect governments, any arguments indicating a plausible national motive for subsidies may be open door for various kind of socially wasteful rent-seeking.

More fundamentally, Eaton and Grossman (1986) have argued forcefully that the argument for strategic trade policy is of limited use because the particular policy recommendation depends critically on details of the model. In particular, they show that the Brander-Spencer case for export subsidies depends on the assumption of Cournot competition. With other assumptions the result may go away or even be reversed. They have demonstrated, for example, that an export subsidy with price competition, rather than quantity competition, may cause the amount of the exporter's revenues to increase by less than a subsidy. Nogués (1990) has provided an illustration of the insignificance of export subsidies designed to improve export performance of the economies in Latin America.

Furthermore, Dixit and Grossman (1986) have shown that when several industries are linked together by factor endowment constraints, the optimal rent-extraction policies are generally less beneficial than a partial-equilibrium analysis would suggest, and very demanding of information. Rent-extraction in one industry will work at least in part by reducing the rents cap-

tured by other industries. In addition, the prospects for correct implementation of such policies in practice are not good at all.

Grossman (1986) has also argued that the Brander-Spencer model is based on too simple representation of an economy. In particular, he has pointed out that the model assumes that all output is exported, so that there is no need to consider domestic consumer interests, and that each exporter has only one firm, so the effect of resource redistribution does not need to be considered. Furthermore, Krugman (1987) has provided an illustration of the insignificance of a strategic trade policy designed to capture the economic rents of an industry for an economy such as that of the USA. The potential gains to large countries from strategic trade policy measures are likely to be too small to warrant the efforts associated with the identification of strategic sectors.

Finally, Brainart and Martimort (1996) have pointed out that the Brander-Spencer model assumes that policymakers have complete information about targeted market. They argue that since real governments are unlikely to meet the informational requirements assumed by the theory, there is concern that strategic trade models may be largely overstating the case for rent-shifting trade interventions. However, contrary to the intuition that policymakers' lack of information should reduce their incentives to engage in strategic trade intervention, Maggi (1999) has shown that the information asymmetries may increase trade policy distortions in equilibrium and ultimately worsen the "prisoner's dilemma" between governments.

Whether governments should provide assistance to their exporters to help them overcome informational entry barriers is a question that has also given rise to some controversy. Papers by Mayer (1984), Bagwell and Staiger (1989), Bagwell (1991) come out in favour of export subsidies. Grossman and Horn (1988), on the other hand, argue that exports should not be promoted. More recently, Raff and Kim (1999) have shown that the drawback of an export subsidy is that, by inducing the exporter to lower his price,

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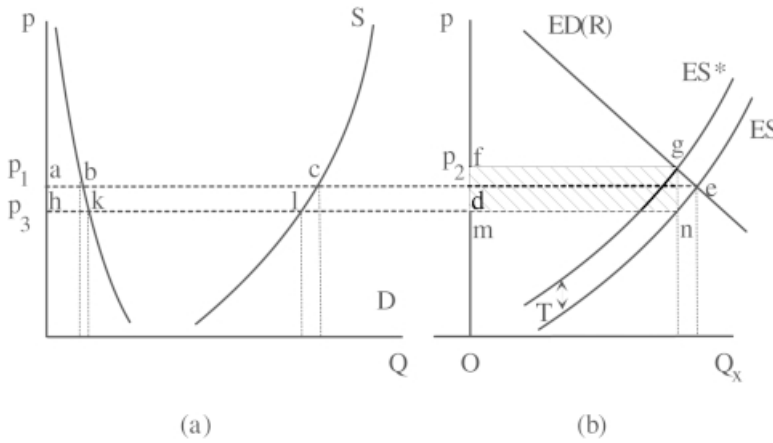


Figure 8. Effects of a fixed export tax in a partial equilibrium framework.

it may increase price competition between exporter and the foreign incumbent. For strategic reasons, it may hence be better to impose export tax. However, according to Raff and Kim (1999), an export subsidy could be selected if the difference between high and low quality is large, the associated difference in production costs is small, the degree of product differentiation between exporter and incumbent is large, and the foreign import tariff is high.

Nevertheless, for small, open economies that rely on a few primary commodity exports for the bulk of their export earnings, the potential gains from export policy measures may be considerable (Lord 1991). Hence, in accordance with the Brander-Spencer approach, export policies for countries that have price-elastic export demand functions are examined here as non-cooperative games involving a large number of countries exporting differentiated products, with each country establishing its export quantity separately. A market structure of this type is appropriate for the analysis of trade in most primary commodities, since there are usually a large number of countries that export a given commodity and the actions of those countries have a negligible effect on the world market. This approach also allows consideration of policies aimed at expanding exports without fear of retaliation by the competing exporters.

### 4.2.3 The role of export taxes

Export trade policy is not always devoted to the expansion of international sales or the protection of domestic producers. Government may levy export taxes to deliberately depress domestic prices to protect consumers from having to pay higher international prices of the exported product or to generate government revenue for the central authority. Export taxes have a long history of use, in particular, by primary-product or raw-material exporting countries as a way to secure revenue for the central government. In nations where there are long-standing political and organisational impediments to collecting income, excise, and other taxes, export levies are an attractive taxation mechanism (Houck 1986). Like tariffs, they place an economic wedge between international and domestic prices.

To illustrate, consider a small exporting country  $i$  facing a downward sloping excess demand ED(R) curve for the product in question (Figure 8). The free trade equilibrium is determined by the intersection of excess supply curve ES with the ED(R) curve. In this setting,  $de$  or its equivalent  $bc$  is exported. Now suppose country  $i$  decides to levy an export tax on the product in question. This decision creates the tax-burden excess supply curve ES\*, pushes up international prices to  $p_2$ , and depresses domestic prices to  $p_3$ . The

impacts on domestic production and exports are negative.

Generally, the direct losers with the export taxes are domestic producers and possibly foreign buyers. Gainers are domestic consumers and the tax-levying government. Whether or not export revenues (area  $fgnm$ ) of the country are higher or lower with the export tariff depends on the price elasticity  $\epsilon_x^p$  of the export demand function. If the excess demand function for the taxed export is price inelastic, the foreign exchange revenues for the country will be higher than otherwise. In addition, the steeper is the domestic supply function, the higher the foreign exchange earnings gain.

Eaton and Grossman (1986) have considered export tax policy alternatives for small countries when trade is characterised by monopolistic competition and non-retaliation by close rivals in the market. They have shown that if the competition is Bertrand type and a country has a price-inelastic demand function, a government seeking to maximise export revenue and domestic income should tax its export industry. Therefore, the strategic steps for the exporting country would be to select an appropriately higher price, and raise prices through policies designed to shift the country's export supply curve back along the demand curve. The idea here is that the exporter, by driving up international prices, can obtain tax revenues sufficient to offset its social losses – and possibly have something left over.

Furthermore, Dixit (1987) has pointed out that if the competition is Bertrand type, the small country is in a better strategic position by remaining a small exporter and charging higher price for its exports. In this way, the country does not subject itself to the possibility of retaliation by its competitors, which might feel threatened if the country expands its market share. Finally, Raff and Kim (1999) have argued that it may be optimal for the government to impose export tax to help exporters overcome informational barriers to entry into the foreign markets. Indeed, as their paper shows, it may be best initially to impose a low export tax and raise the tax rate over time.

Consider the introduction of an export tax, denoted  $\Gamma$ , into the export supply equation (12) formulated in chapter 3.2.2 (page 43). The tax increases the per-unit cost of the commodity export by  $\Gamma$ , so that the marginal cost of exports is  $MC'(X_i) + \Gamma$ . Therefore, an export tax has exactly the opposite effect than an export subsidy [shown in (18) in page 50]. The resulting export supply schedule is

$$X_i^s = \hat{a}_5 \left( \frac{(P_i - \Gamma) * ER_i}{D_i} \right)^{\gamma} \exp(\phi_1 T + \phi_2 \Psi) \quad (20)$$

The effect of a change in the tax rate, denoted  $t (= \Gamma/P_i)$ , on export volume and price, can be found by the same procedure used to find the effect of a change in a subsidy on exports. Hence, the export supply function of a country with a tax in (20) is set equal to its export demand function in (3) in page 38, and solved for price and quantity.

If a given revenue is to be raised from export taxes, the question of what structure of export taxes will minimise the distortion costs of raising revenue is of interest. Corden (1997) has shown that in general the marginal cost of raising revenue from different export taxes must be equalised. It follows then that the optimum revenue-tax structure will therefore involve high rates of tax on goods where elasticity of export demand is low, and low rates on goods where elasticity of export demand is high.

### 4.3 Summary

This chapter has laid out the basic partial equilibrium framework to be used for the economic analysis of various import and export trade policy schemes. First, the economics of tariffs applied by an importing nation has been considered. Tariffs are shown to raise internal prices and, as a result, to push imports down from their non-tariff volume. Furthermore, it is shown that

the effect of tariffs depend on the price elasticity of import demand and the tariff-equivalent rate adopted in the importing country. Next, the effects of export policy measures – export subsidy and export tax – adopted by an exporting country have been examined. The key behavioural assumption in the determination of the price and quantity of exporters is that each exporting country ignores the actions of their competitors and is, therefore, not concerned about the reactions of competing exporters to their own actions. The formulation of export policies as non-cooperative games involving a large number of countries exporting differentiated products, with each country establishing its export quantity separately, allows consideration of policies aimed at

changing export without fear of retaliation by the competing exporters. A market structure of this type is considered appropriate for the analysis of commodity trade covered by the study, since there are usually a large number of countries that export a given commodity and the actions of those countries have a negligible effect on the world market. The analysis suggest that, provided the price elasticity of export demand is greater than unity, an increase in the subsidy will generate higher export revenues for an exporter. On the other hand, in the cases, in which exporters have an inelastic export demand an increase in the tax rate will generate greater export revenues.

## 5 The econometric methodology and data

Econometric models are the most efficient and convenient way to summarise the theory relevant to the system under study for empirical measurement and testing. In this chapter, the econometric methodology employed by the study in modelling the dynamic relationships of commodity trade is specified. The term dynamic refers here to the type of analysis in which the object is to consider the long periods of adjustment in agricultural commodity markets that account for oscillations in the adjustment processes. The dynamic modelling, in turn, denotes the problem of appropriately matching the lag reactions of postulated theoretical model to the auto-correlation structure of the associated observed time-series data, i.e. the dynamic specification is based on the introduction of appropriate lags in the explanatory variables (Lord 1991).

The starting point in the dynamic specification is that economic theory postulates a long-run equilibrium relationship between the dependent variable and explanatory variables. A modelling strategy, which takes into account both the information provided by economic theory and

that provided by the time series properties of the data is needed. Nevertheless, it is often difficult to offer a framework, which is at once simple and unambiguous and encompasses a comprehensive range of phenomena, yet allows economic theory to play a substantive role (Hendry et al. 1984). Furthermore, time series data used in many econometric studies present some special problems for econometricians, since most empirical work based on time series data assumes that the underlying series are stationary. If this is not the case, the conventional hypotheses-testing procedure based either on small sample or asymptotic distributions of the estimates are no longer valid.

Several distinct methodologies for econometric analysis have been developed in recent years. In this study, a relatively unrestricted modelling approach based on the error correction mechanism (ECM) advocated by Hendry (1986), Hendry and Richard (1982, 1983), Hendry et al. (1990), and Banerjee et al. (1993), is utilised in order to emphasise the importance of dynamics of trade functions. The aim of this chapter is to

describe the derivation of dynamic specification with the ECM approach. However, before moving to a specific formulation of dynamic relationships, a definition of stationary time series is explained and tests to find out whether time series is stationary are described. In this connection, some related concepts such as a unit root and an integrated time series are introduced. In addition, the notion of cointegration (Engle and Granger 1987) of a set of variables is explained, and its relationship with the error correction model is explored. Finally, the chapter characterises basic statistical properties of the data, and illustrates how the data are obtained.

## 5.1 Cointegration and error correction model

### 5.1.1 Stationarity and unit roots

Time series data have become so frequently and intensively used in empirical research that econometricians have begun to pay very careful attention to such data. A significant re-evaluation of the statistical basis of time series econometrics took place during 1980s, when theoretical and applied econometricians became aware of certain difficulties associated with the analysis of nonstationary data. The classical regression analysis based on time series data implicitly assumes that the underlying time series are stationary. The small sample *t* tests, *F* tests, chi-square tests, and the like are based on this assumption.

Any time series data is said to be covariance stationary if its mean and variance are constant over time and the value of covariance between the two time periods depends only on the distance or lag between the two time periods, and not on the actual time at which the covariance is computed (Gujarati 1995). In other words, the error structure is time invariant. If a time series is not stationary in the sense defined above, it is

called a nonstationary time series. However, studies in empirical economics almost always involve nonstationary and/or trending variables, such as income, consumption, money demand, the price level, trade flows, and exchange rates. In other words, economic time series tend to exhibit non-stationary stochastic processes of the form

$$Y_t = \delta_1 + \xi Y_{t-1} + u_t \quad (21)$$

where  $\delta_1$  is a constant drift,  $\xi = 1$ , and  $u_t$  is an error term. Thus,  $Y_t$  is said to have unit root if the coefficient  $\xi$  is in fact equal to 1. More precisely,  $Y_t$  in (21) could be characterised as having a unit root and a drift (random walk with a drift). A random walk is an example of a nonstationary time series, even if  $\delta_1$  equals zero.

When a time series is nonstationary, it has important asymptotic consequences: regression estimates do not converge in probability with increased sample size; R-square values have non-degenerate distributions; and divergence in *t*-value distributions often exists such that asymptotically correct critical values do not exist. Regressions involving nonstationary variables in levels often display first-order serial correlation. In other words, econometric estimates and their distributions are not guaranteed to have desirable statistical properties when stationary assumption is violated (Hendry 1986). Therefore, regressions involving time series data include the possibility of obtaining spurious or dubious results in the sense that the results look good but on further probing they look suspect.

The problem of spurious regression arises because if the time series involved exhibit strong trends (sustained upward or downward movements), the regression is virtually certain to produce significant relationships, even if the time series are, in fact, independent. The high  $R^2$  observed is due to the presence of the trend, not to a true relationship between them. It is therefore very important to find out if the relationship between economic variables is true or spurious (Gujarati 1995). Among the conclusions in their seminal paper, Granger and Newbold (1974) ar-

gued forcefully that a regression equation is misspecified, whatever the value of  $R^2$  observed, if it is found to have strongly autocorrelated residuals, equivalent to a low Durbin-Watson value.

Granger and Newbold (1974) also showed just how easily one may produce a spurious model if sufficient care is not taken over an appropriate formulation for autocorrelation structure of the errors from the regression equation. Since economic data as a rule are integrated, the standard significance tests are, therefore, usually misleading in regressions involving the levels of such data. The conventional  $t$  test,  $F$  test, etc. would tend to reject the hypotheses of no relationship when, in fact, there might be none (Greene 1997). The fact that most variables used in traditional trade functions display a powerful trend in time series has seldom been explicitly taken into account.

In order to avoid the problem of spurious correlation, the trend, or time, variable  $t$  is often included as one of the regressors in regressions involving time series data. However, a number of time series econometricians (Nelson and Plosser 1982, Stock and Watson 1988) have challenged this common practice. According to them, the standard practice may be acceptable only if the trend variable is deterministic and not stochastic. The trend is considered deterministic if it is perfectly predictable and not variable. However, economic time series such as (5.1) tend to exhibit a stochastic trend. In case of a stochastic trend, fluctuations in a time series are the result of shocks not only to the transitory or cyclical component but also to the trend component (Balke 1991). Therefore, the common practice of detrending the data by a single time trend would be misleading.

In many cases, stationarity can be achieved by first-order differencing or other mathematical transformations (such as seasonal adjustment), i.e. to estimate the model in first differences. Yet this approach of differencing nonstationary economic series into stationary series has been criticised for throwing out and ignoring valuable long-run equilibrium information. Thereby, the model explains only short-run ef-

fects (Bentzen and Engsted 1992). However, for the purpose of policy planning and forecasting agricultural commodity trade, long-run properties of the model are usually of particular interest. International trade theory is stated as a long-term relationship between variables in level form and not first-difference form. Engle and Granger (1987) have shown that modelling with differencing data can raise serious mis-specification problems through ignoring of theoretically relevant long-run components in the level data.

Since time series data used in international trade analysis are often non-stationary unit root processes, econometric modelling of trade should be based on methods, which explicitly take this feature of the data into account. In other words, it should be ensured that the final model reflects the co-movement of variables due to the underlying equilibrating tendencies of economic forces, rather than those due to common, but unrelated, time trends in the data (Harris 1995). By the same token, the long-run information should be retained in modelling time series data.

Recent developments and a growing literature in time series econometrics have shown that there are interesting and appropriate ways to estimate equations in the manner that allow the relevant economic theory to enter the formulation of long-run equilibrium in levels while the short-run dynamics of the equation are determined by growth rates. The innovation of an error correction mechanism (ECM) and advances in cointegration, in particular, have provided the tools to apply dynamic models that account explicitly for the dynamics of short-run adjustment toward long-run equilibrium.

The ECM approach employs a specification that uses a combination of growth rates and levels simultaneously while attempting not to violate the basic set of assumption in regression analysis (Malley 1990). The idea of incorporating the dynamic adjustment to steady-state targets in the form of error correction terms, suggested by Sargan (1964) and developed by Hendry and Anderson (1977) and Davidson et al. (1978), among others, therefore offers the pos-

sibility of revealing information about both short-run and long-run relationships. Furthermore, ECM-models can be estimated consistently by ordinary least squares, and appear to perform well empirically (Hallam and Zanoli 1993, Banerjee et al. 1993).

While the foundations of the ECM specification rest heavily on the seminal work of Sargan (1964), it was really only in 1986 (following the March special issues of the Oxford Bulletin of Economics and Statistics) that cointegration became a familiar concept in the literature (Harris 1995). The concept is fundamental to the understanding of long-run relationships among economic time series. Intuitively, cointegration among a set of variables implies that there exist fundamental economic forces, which make the variables move stochastically together over time (Urbain 1992). These movements in variables are related in a predictable way to the discrepancy between observed and equilibrium states. The ECM then corrects for any disequilibrium between variables that are cointegrated, because the sequence of the discrepancy between observed and equilibrium states tends to decay to its mean, which is zero (Engle and Granger 1987).

### 5.1.2 Derivation of dynamic specification with an error correction model

The ECM specification can be derived as a simple reparameterisation of a general autoregressive distributed lag (ADL) model<sup>32</sup>. The starting point in the specification is that economic theory postulates a long-run equilibrium relationship between the dependent variable, say  $X$  (country's exports), and explanatory variable, say  $Y$  (eco-

nomic activity of its trading partner). This relationship is summarised as

$$X = k Y^\gamma \text{ or in log-linear form as} \quad (22)$$

$$\ln X = \ln k + \gamma \ln Y$$

Models such as equation (22) are usually specified in log-linear form by assuming that standard trade theory relates exports and imports to explanatory variables through multiplicative form that can be derived within a cost minimisation framework (Urbain 1992). Empirical studies using Box-Cox-type power function to discriminate between the log-linear and the simple linear form have also strongly favoured the log-linear specification (Khan and Ross 1977, Boylan et al. 1980).

The long-term relationship postulated in (22) takes, of course, time to achieve. As a result, the dynamic specification of any postulated theoretical relationship should be based on the introduction of appropriate lags in the explanatory variables. Economic theory is usually silent on what a lag distribution should look like and provides little guidance for the modelling of the short-run dynamic of functions. The data themselves often provide most of the guidance. Rigidities and transaction costs imply that the observed data adjust slowly to exogenous shocks. A modelling strategy, which takes into account both the information provided by economic theory and that provided by the time series properties of the data is needed.

In this study the so-called 'general to specific' approach advocated by Hendry (1986) is applied. The Hendry's approach to economic modelling starts with a model with several regressors and then whittles it down to model containing only the important variables (Gujarati 1995). The main feature of this 'general to specific' methodology is the abandonment of any attempt to identify a suitable parsimonious model at the outset. Instead, there is deliberate 'over fitting'. The decision as to whether or not a particular explanatory variable should be included in the model can only really be made if it is included in the model in the first place (Harvey 1981).

<sup>32</sup> In regression analysis involving time series data, if the regression model includes not only current but also the lagged (past) values of the explanatory variables, it is called a distributed-lag model. If the model includes one or more lagged values of dependent variable among its explanatory variables, it is called an autoregressive model (Gujarati 1995).

The starting point is, therefore, an unrestricted general ADL model. The ‘general to specific’ approach proposes the following type of dynamic procedure in order to reach (22):

$$\ln X_t = \psi_1 \ln X_{t-1} + \dots + \psi_m \ln X_{t-m} + \lambda_0 \ln Y_t + \lambda_1 \ln Y_{t-1} + \dots + \lambda_m \ln Y_{t-m} + v_t \quad (23)$$

A specification analysis by Thursby and Thursby (1984) shows that this type of dynamic specification outperforms static ones. The lagged dependent variable can be introduced in the model by assuming some type of adjustment costs (see Goldstein and Khan 1985). Furthermore, Mizon (1983) has noted that, given sufficient lags in the dependent variable and explanatory variables, the stochastic difference equation can be so defined as to have a white noise process in its disturbance term. As a result, the ordinary least squares estimator for the coefficient will be fully efficient.

The general ADL model (23), which contains several lag values ( $m$ ) of the regressors, is then considered as the maintained hypothesis. However, such a model is too general because the value of  $m$  remains to be specified. At the outset all the explanatory variables postulated by economic theory and the lags of relatively high order are deliberately included. In choosing a simplified model, several specifications (i.e. different values of  $m$ ) must be tested before settling down on the “final” model (Gujarati 1995). In addition, data-acceptable reductions and/or transformations need to be performed in order to get more parsimonious reparametrization (Urban 1992). Whether or not a particular explanatory variable should be retained and which lags are important are decided by the results obtained.

According to Hendry and Richard (1983), the simplified (or final) model should satisfy the following six criteria: 1) Be data admissible. That is, predictions made from the model must be logically possible. 2) Be consistent with theory. That is, it must make good economic sense. 3) Have exogenous or at least weakly exogenous regressors. That is, the regressors to be

uncorrelated with the error term. 4) Exhibit parameter constancy. That is, the value of the parameters should be stable. Otherwise forecasting will be difficult. 5) Exhibit data coherency. That is, the residuals estimated from the model must be purely random (technically white noise). If that is not the case, there will be some specification error in the model. 6) Be encompassing. That is, the model should encompass or include all the rival models in the sense that it is capable of explaining their results. Finally, the empirical model must reproduce the theoretical model under the conditions assumed by the theory.

The ECM specification of the postulated relationship in (22) can now be derived by an appropriate transformation of the finite-dimensional autoregressive distributed lag (ADL) model. A simple ADL (1,1) representation of the theoretical relationship in (22) is expressed as

$$\ln X_t = \psi_0 + \psi_1 \ln X_{t-1} + \lambda_0 \ln Y_t + \lambda_1 \ln Y_{t-1} + v_t \quad (24)$$

where  $v_t \sim \text{IID}(0, \sigma_2)$ , and  $0 < |\psi_1| < 1$  for the system to be stable.

Since economic time series typically change rather slowly, including a large number of lags in a model, it may lead to numerical instability because of the resulting multicollinearity. A solution to the problem of multicollinearity is the transformation of the equation in such a way that “differences” formulation of the variables are nested in the levels form of the equation (Harvey 1981). The first step in rewriting equation (24) is to subtract  $\ln X_{t-1}$  from both sides, then subtract  $\ln \lambda_0 Y_t$  from the third term and add it to the fourth term:

$$\Delta \ln X_t = \psi_0 + (\psi_1 - 1) \ln X_{t-1} + \lambda_0 \Delta \ln Y_t + (\lambda_0 + \lambda_1) \ln Y_{t-1} + v_t \quad (25)$$

By casting the model in levels and differences, a formulation of this kind separates out long-run and short-run effects. Further rearrangement gives:



$$\Delta \ln X_t = \psi_0 + \lambda_0 \Delta \ln Y_t + (\psi_1 - 1) \left( \ln X_{t-1} - \frac{\lambda_0 + \lambda_1}{1 - \psi_1} \ln Y_{t-1} \right) + v_t \quad (26)$$

If the response of dependent trade variable  $X$  to its determinant  $Y$  in steady-state growth is proportional, then  $(\psi_1 + \lambda_0 + \lambda_1) = 1$  in (26), the result of which yields

$$\Delta \ln X_t = \psi_0 + \lambda_0 \Delta \ln Y_t + (\psi_1 - 1) (\ln X_{t-1} - \ln Y_{t-1}) + v_t \quad (27a)$$

This is the simplest example of an ECM. Models such as equation (27a) are known as single-equation error correction models (ECMs), the changes in  $\ln X_t$  being proportional to changes in  $Y_t$  and to departures from the long-run solution.

Where the long-run response of  $\ln X_t$  is not necessarily proportional to changes in  $Y_t$ , an additional term is introduced<sup>33</sup>. In this term the explanatory variable is lagged one period and the coefficient  $\zeta = (\psi_1 + \lambda_0 + \lambda_1 - 1)$ :

$$\Delta \ln X_t = \psi_0 + \lambda_0 \Delta \ln Y_t + \zeta \ln Y_{t-1} + (\psi_1 - 1) (\ln X_{t-1} - \ln Y_{t-1}) + v_t \quad (27b)$$

where  $\zeta > (\psi_1 - 1)$  when  $\lambda_0, \lambda_1 > 0$  in (24). When the coefficient  $\zeta$  has non-zero significance, the steady-state response of the dependent trade variable to the explanatory variable is non-proportional.

The term  $(\ln X_{t-1} - \ln Y_{t-1})$  in (27a) and (27b) is called the error correction term, while  $(\psi_1 - 1)$  is the feedback coefficient. In this regression  $\Delta \ln Y_t$  captures the short-run disturbances in  $\Delta \ln X_t$ , whereas the error correction term captures the adjustment toward the long-run equilibrium. If  $(\psi_1 - 1)$  is statistically significant, it tells what proportion of the disequilibrium in  $\Delta \ln X_t$  in one period is corrected in the next period. In other words, the feedback coefficient  $(\psi_1 - 1)$  on  $\ln(X/$

$Y)_{t-1}$  suggests that the greater is the excess of  $(\ln X)$  over  $(\ln Y)$  for the time period lagged one period, the higher is  $(\ln Y)$  now.

Since the ECM is simply a linear transformation of the ADL model, one might ask what the distinguishing feature is. The answer is that in the ECM formulation, parameters describing the extent of short-run adjustment to equilibrium are immediately provided by the regression. The ECM will be of particular value where the extent of an adjustment to a deviation from equilibrium is especially interesting.

A major decision in the determination of the model specification is the choice of lag length (Harvey 1981). Because of the complexity of dynamic relationships, the orders of ADL structure of ECM may be complicated. However, the higher order lags will often have the smallest coefficients and it is natural to begin by testing them for significance and gradually moving down to the lower order lags<sup>34</sup>. In addition, any model, which is seriously entertained, must also satisfy various diagnostic-checking procedures. Therefore, a battery of tests is used to validate the model. Diagnostic tests for serial correlation, heteroskedasticity, and parameter stability should be provided.

### 5.1.3 Cointegration

The particular relevance of the error correction form is to modelling cointegrated series. According to Engle and Granger (1987), when variables are cointegrated there exists a valid error correction model describing their relationship, with the implication that cointegration between variables involved is a prerequisite for the error correction model. The concept of cointegration developed by Granger (1981), Granger and Weiss

<sup>33</sup> Hence this parameter does not need to be estimated at an earlier stage in order to allow us to use the ECM (Banerjee et al. 1993).

<sup>34</sup> Therefore, the specification strategy begins with the maintained hypothesis, and then tests hypotheses in increasing order of restrictiveness. Such a backward selection procedure, in contrast to one that starts from the most restrictive hypothesis, has been shown by Anderson (1971) to have optimal properties with regard to power.

(1983), and Engle and Granger (1987), therefore, provides a formal statistical support for the use of ECM. Cointegration means that despite being individually nonstationary, a linear combination of two or more time series can be stationary. The series that satisfy this requirement are said to be co-integrated.

Following Granger (1981), a time series  $x_t$  which has a stationary, invertible, non-deterministic ARMA representation after differencing  $d$  times is integrated of order  $d$  and is denoted by  $x_t \sim I(d)$ . The components of the vector  $x_t$  are said to be cointegrated of order  $d, b$ , denoted CI( $d, b$ ), if

- (i) all the components of  $x_t$  are  $I(d)$ ;
- (ii) there exists a vector  $\alpha (\neq 0)$  so that  $z_t = \alpha' x_t$  is  $I(d-b)$ ,  $b > 0$ .

The vector  $\alpha$  is then called a cointegrating vector. A necessary condition for cointegration is that the data series for each variable involved exhibit similar statistical properties, that is, to be integrated to the same order with evidence of some linear combination of the integrated series. If the evidence suggests that the variables are integrated to different orders, or not at all, then the specification of the model should be reconsidered (Greene 1997). A time series  $Y_t$  is said to be integrated of order one, denoted  $I(1)$ , if taking a first difference of the time series produces a stationary process. Similarly, if the original nonstationary series has to be differenced  $d$  times before it becomes stationary, the original series is integrated of order  $d$ , or  $I(d)$ .  $Y_t$  is integrated of order  $I(0)$ , when it is stationary in level form.

Thus, in the case where the original series, say  $x_t$  and  $y_t$ , are integrated of order one,  $I(1)$ , as is frequently the case with economic variables (Nelson and Plosser 1982), consistency in error correction model requires all of its terms to be integrated of order zero,  $I(0)$ . This will only be the case if  $y$  and  $x$  are cointegrated, i.e. if there is a linear combination of  $x$  and  $y$  such as  $x_t = \alpha y_t + u_t$  which is stationary even though  $y$  and  $y$  are non-stationary (Banerjee et al. 1993). In such a case, we are able to distinguish between a long-

run relationships between  $x_t$  and  $y_t$ , that is, the manner in which the two variables drift upward together, and the short-run dynamics, that is, the relationship between deviations of  $x_t$  from its long-run trend and deviations of  $y_t$  from its long-run trend (Greene 1997).

The idea that variables are hypothesised to be linked by some theoretical economic relationship and should not diverge from each other in the long run is a fundamental one. Economic theory often suggests that certain pairs of economic variables should be linked by a long-run equilibrium relationship. Although the variables may drift away from equilibrium for a while, economic forces may be expected to act so as to restore equilibrium. That part of the response of a variable that never decays to zero is the steady-state response, while that part that decays to zero in the long run is the transient response. Examples of such variables might include prices of similar commodities in different countries (if purchasing power parity holds in the long run), government spending and tax revenues, wages and prices, or spot and future prices of a commodity.

The link between ECM and cointegration are exploited by the two-step procedure for estimating error correction models proposed by Engle and Granger (1987). Engle and Granger have demonstrated that the ECM corrects for any disequilibrium between variables that are cointegrated, because the sequence of the discrepancy between observed and equilibrium states tends to decay to its mean, which is zero. The ECM specification thus provide the means by which the short-run observed behaviour of variables is associated with their long-run equilibrium growth paths. This begins with estimation of a static cointegrating regression such as  $X_t = \alpha Y + u_t$  and tests for cointegration.

## 5.1.4 Testing procedures for unit roots and cointegration

Since the validity of the error correction specification requires the existence of a long-run relationship or cointegration between the variables

concerned, the modelling strategy begins with tests for the existence of a cointegrating vector involving the variables of interest. A number of methods for testing for cointegration have been proposed in journal articles. However, the first step in the analysis of cointegration is to investigate stationarity of the time series involved, i.e. the integration order of univariate time series.

At the formal level stationarity can be checked by finding out if the time series contains a unit root. The recent voluminous literature on unit roots has provided a variety of possibilities of detecting these in observed time series. The Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests can be used for this purpose (Dickey and Fuller 1979, 1981). The DF test is applied to regression runs in the following forms:

$$\Delta Y_t = \xi Y_{t-1} + u_t \quad (28)$$

$$\Delta Y_t = \delta_1 + \xi Y_{t-1} + u_t \quad (29)$$

$$\Delta Y_t = \delta_1 + \delta_2 t + \xi Y_{t-1} + u_t, \quad (30)$$

where  $t$  is the time or trend variable. The next step here is to divide the estimated  $\xi$  coefficient by its standard error to compute the Dickey-Fuller  $\tau$  statistic and refer to Dickey-Fuller tables to see if the null hypotheses  $\xi = 0$  (there is a unit root) is rejected<sup>35</sup>. If the computed absolute value of the  $\tau$  statistics (i.e.,  $|\tau|$ ) is less than the absolute critical values, the time series is considered nonstationary (Gujarati 1995). However, Dickey-Fuller tables for critical values of the  $\tau$  statistic are not totally adequate<sup>36</sup>. Therefore, they have been considerably extended through

Monte Carlo simulations by MacKinnon (1991), and Davidson and MacKinnon (1993). MacKinnon (1996) provides a computer program to calculate numerically highly accurate critical values at any desired level.

In the case that the error term  $u_t$  is autocorrelated, one modifies (30) as follows:

$$\Delta Y_t = \delta_1 + \delta_2 t + \xi Y_{t-1} + \sum_1^m \Delta Y_{t-1} + e_t, \quad (31)$$

and then applies the ADF test. Thus, the ADF test is comparable to the simple DF test but it involves adding an unknown number of lagged first differences of the dependent variable to capture autocorrelated omitted variables that would otherwise enter the error term  $e_t$ . The number of lagged difference terms to be included is often determined empirically, the idea being to include enough terms so that the error term in (31) is serially independent<sup>37</sup>. The ADF test statistic has the same asymptotic distribution as the DF statistic, so the same critical values can be used.

If non-stationarity can be rejected, standard regression methods can be applied safely. Otherwise, one may choose to transform the series to stationarity, or one may investigate cointegrating relationships between the data series, which – if present – could again justify regression involving the levels of the variables (Harris 1995). Therefore, having established that all series are integrated of the same order, tests for cointegration are undertaken, and the nature of any cointegrating vectors explored. Tests for unit roots are performed on univariate (i.e. single) time series. In contrast, tests for cointegration are performed among a set of time series. Cointegration deals with the relationship among group of variables, where each has a unit root. The null hypothesis to be tested is no co-integration, i.e. spurious regression.

<sup>35</sup> There are also more recent tests that take as the null hypotheses that a series is stationary, against the alternative of non-stationarity (e.g., Kahn and Ogaki 1992, Kwiatkowski et al. 1992). Yet, these tests have not achieved widespread usage. Since the consequences of non-stationarity are so important, a conservative approach with non-stationarity is taken here as the maintained hypotheses.

<sup>36</sup> The DF test suffers from one serious disadvantage: the test statistic does not follow any standard tabulated distribution, either in finite samples or asymptotically.

<sup>37</sup> Banerjee et al. (1993) favour a generous parameterisation, since ‘...if too many lags are present ... the regression is free to set them to zero at the cost of some loss in efficiency, whereas too few lags imply some remaining autocorrelation.’

Two broad approaches for testing for cointegration have been developed. The Engle and Granger (1987) method is based on assessing whether single equation estimates of the equilibrium errors appear to be stationary. Therefore, Engle and Granger (or EG) tests are closely related to some of the tests suggested by Fuller (1976) and Dickey and Fuller (1979, 1981) to test the unit root hypothesis. The second approach, due to Johansen (1988, 1995) and Stock and Watson (1988), is based on the vector autoregression (VAR) approach.

This study applies the ECM method developed by Engle and Granger. The Engle-Granger approach to testing for cointegration is to construct a test statistics from the residuals of a cointegrating regression. Where the original series are integrated of order one,  $I(1)$ , as is frequently the case with economic variables (Nelson and Plosser 1982), cointegration requires the residual terms of two or more time series to be integrated of order zero,  $I(0)$ . With  $m$  time series  $Y_{1t}, \dots, Y_{mt}$ , each of which is  $I(1)$ , (integrated of order 1), two forms of the cointegrating regression equations are:

$$Y_{1t} = \zeta_0 + \sum_{j=2}^m \zeta_j Y_{jt} + u_t \tag{32}$$

$$Y_{1t} = \zeta_0 + \zeta_1 t + \sum_{j=2}^m \zeta_j Y_{jt} + u_t \tag{33}$$

Equation (32) is no-trend and equation (33) is with-trend. A test for no co-integration is given by a test for a unit root in the estimated residuals  $\hat{u}_t$ . The procedure is essentially the same as the DF and ADF tests. The ADF regression equation is:

$$\Delta \hat{u}_t = \eta^* \hat{u}_{t-1} + \sum_{j=1}^p \eta_j \Delta \hat{u}_{t-1} + v_t$$

Test statistics is a t-ratio test for  $\eta^* = 0$  (the  $\tau$ -test). If this null hypotheses cannot be rejected (against the alternative  $\eta^* < 0$ ), then the variables are not cointegrated. If the null hypothesis is rejected, then the conclusion would be that the estimated  $u_t$  is stationary (i.e. does not have a unit root), and, therefore, the time series  $Y_{1t}, \dots,$

$Y_{mt}$ , despite being individually nonstationary, are cointegrated.

The alternative test for the existence of a unit root in the residuals of the cointegrating regression is that suggested by Phillips (1987) and extended by Perron (1988) and Phillips and Perron (1988). Rather than taking account of extra terms in the data generating process by adding them to the regression model, a non-parametric correction to the t-test statistic is undertaken to account for the autocorrelation that will be present. That is, while the DF procedure aims to retain the validity of tests based on white-noise errors in the regression model by ensuring that those errors are indeed white noise, the Phillips-Perron (PP) procedure acts instead to modify the statistics after estimation in order to take into account the effect that autocorrelated errors will have on the results (Banerjee et al. 1993). Sources of critical values for the PP test include Phillips and Ouliaris (1990), MacKinnon (1991), and Davidson and MacKinnon (1993).

The testing procedures discussed above involve actually estimating the cointegrating vectors. If the null hypothesis of no cointegration is rejected, the second step uses the lagged residuals from the cointegrating regression as an error correction term in a dynamic, first-difference regression, as shown in equation (27a) and (27b). One can then “test down” to find a satisfactory structure (Greene 1997). Because of the complexity of dynamic relationships, the structure of ECM may be complicated. A major decision is the choice of lag length. Ordinary least squares can, however, be used throughout, and Engle and Granger (1987) show that it yields consistent estimators for all the parameters.

## 5.2 Data

### 5.2.1 Data availability and requirements

The success of any econometric analysis ultimately depends on the availability of the appro-

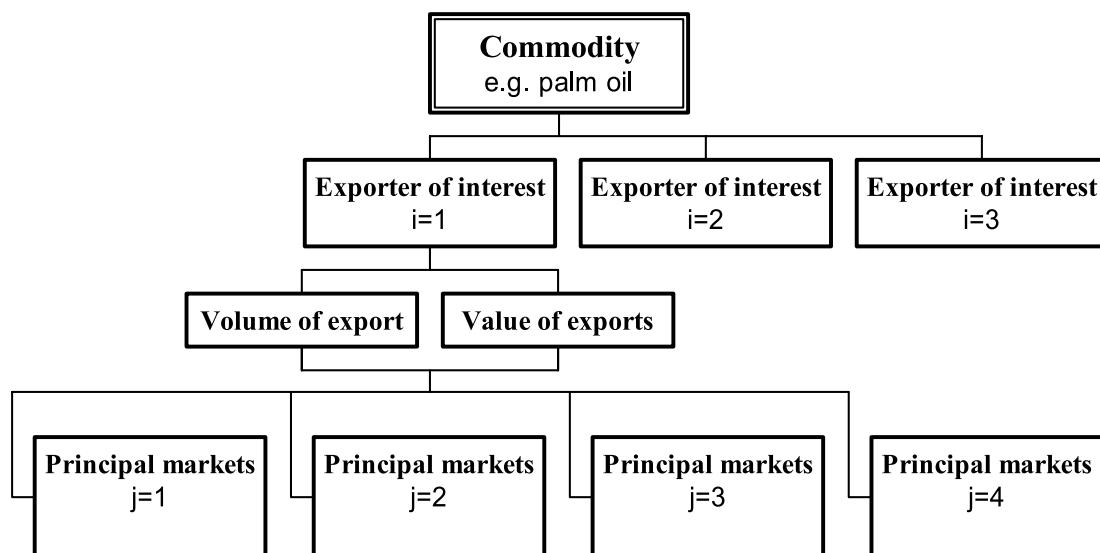


Figure 9. Structure of trade data.

appropriate data. This section discusses the nature, sources, and limitations of the data. The empirical analysis of this study will be conducted with a sample of annual data that cover ASEAN's major commodity exports to the EU from 1961 to 2000. The sample is composed of five elements: the commodity itself, the country of origin, the geographic market (EU), the economic variables, and time (Figure 9). Therefore, the first step in drawing the sample is to choose the commodities that represent the major agricultural exports of the ASEAN region to the EU. Then the countries of origin are selected and designated exporters of interest  $i = 1, \dots, n$ . Next, their principal geographic markets  $j = 1, \dots, m-1$  are chosen, and all other aggregated into a group, denoted  $m$ , and regarded as a single residual market.

To keep the task manageable, attention is restricted to seven agricultural commodities that in the period of 1961–2000 represented an average about 50 per cent of the total value of ASEAN agricultural exports to the EU. Those commodities include cassava, cocoa, coconut oil, palm oil, pepper, rubber, and tea. The countries of origin of each commodity are limited here to

those ASEAN countries, which account for an average at least 5 per cent of ASEAN total exports of that commodity in 1961–2000. The contribution of these commodities to the total agricultural exports of each ASEAN country is shown in Figure 3 in page 19. With respect to principal geographic market, the EU is taken here as one region, although there are marked differences in the development of the demand over time, especially between Northern and Southern European countries.

The variables of interest for each commodity are listed in Table 5. Volume and value data on EU total imports for the period 1961–2000 are obtained from EUROSTAT. Volume and value data on EU imports from source country  $i$  over this same period are also obtained from EUROSTAT, supplemented with individual country sources as required to fill gaps.

Volume data is compiled in metric tons, and value data in thousands of euros (before 1999 in the European Units of Account, ecus). The transaction value is the value at which the importing country bought goods and includes the cost of transportation, insurance, and freight to the frontier of the importing country (c.i.f. valuation).

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Table 5. List of variables.

Variable	Variable description	Sources
$M_{EU}^d$	total quantity of imports in the EU	EUROSTAT
$M_{EU}^{va}$	total value of imports in the EU in euros	EUROSTAT
$X_{IN}^d$	quantity of export from Indonesia to the EU	EUROSTAT
$X_{MA}^d$	quantity of export from Malaysia to the EU	EUROSTAT
$X_{PH}^d$	quantity of export from Philippines to the EU	EUROSTAT
$X_{TH}^d$	quantity of export from Thailand to the EU	EUROSTAT
$X_{IN}^{va}$	value of export from Indonesia to the EU in euros	EUROSTAT
$X_{MA}^{va}$	value of export from Malaysia to the EU in euros	EUROSTAT
$X_{PH}^{va}$	value of export from Philippines to the EU in euros	EUROSTAT
$X_{TH}^{va}$	value of export from Thailand to the EU in euros	EUROSTAT
$P_W$	world market price of the commodity	calculated
$P_{EU}$	import price of the EU, $P_{EU} = M_{EU}^{va}/M_{EU}^d$	calculated
$P_{IN}$	export price of Indonesia to the EU, $P_{IN} = X_{IN}^{va}/X_{IN}^d$	calculated
$P_{MA}$	export price of Malaysia to the EU, $P_{MA} = X_{MA}^{va}/X_{MA}^d$	calculated
$P_{PH}$	export price of Philippines to the EU, $P_{PH} = X_{PH}^{va}/X_{PH}^d$	calculated
$P_{TH}$	export price of Thailand to the EU, $P_{TH} = X_{TH}^{va}/X_{TH}^d$	calculated
$Y_{EU}$	Gross domestic product index of the EU	IMF
$D_{EU}$	Consumer price index in the EU	EUROSTAT
$D_{IN}$	Consumer price index in Indonesia	IMF
$D_{MA}$	Consumer price index in Malaysia	IMF
$D_{PH}$	Consumer price index in the Philippines	IMF
$D_{TH}$	Consumer price index in Thailand	IMF
$ER_{IN}$	Exchange rate of euro in terms of Indonesian rupiah	IMF
$ER_{MA}$	Exchange rate of euro in terms of Malaysian ringgit	IMF
$ER_{PH}$	Exchange rate of euro in terms of Philippine peso	IMF
$ER_{TH}$	Exchange rate of euro in terms of Thai baht	IMF
$P_{EU}/D_{EU}$	real import price of the EU	calculated
$P_{IN}^{\otimes}/D_{IN}$	real export price of Indonesia to the EU, $P_{IN}^{\otimes} = P_{IN} * ER_{IN}$	calculated
$P_{MA}^{\otimes}/D_{MA}$	real export price of Malaysia to the EU, $P_{MA}^{\otimes} = P_{MA} * ER_{MA}$	calculated
$P_{PH}^{\otimes}/D_{PH}$	real export price of Philippines to the EU $P_{PH}^{\otimes} = P_{PH} * ER_{PH}$	calculated
$P_{TH}^{\otimes}/D_{TH}$	real export price of Thailand to the EU $P_{TH}^{\otimes} = P_{TH} * ER_{TH}$	calculated

Dividing value by volume derives the unit prices of imports and exports. These unit values suffer from the traditional f.o.b./c.i.f. valuation problems. Elasticity estimates are based on c.i.f. prices, which, because they include changes in trade resulting from transportation and distribution costs or from tariffs, do take into account all price differences between suppliers to the ultimate consumer. Therefore, in this ‘standard’

formulation the observed real prices in exporting country  $i$  assume fixed transfer costs.

One of the principal variables determined outside the system of equations is economic activity in the EU. Specifically, the gross domestic product (GDP) index is used here as a measure of economic activity. The source of the data is the International Financial statistics database of the International Monetary fund (IMF). The

nominal GDP data of the EU is transformed into constant GDP in 1995 prices, using the consumer price index (CPI) of the EU as a deflator. The other exogenous variables are the exchange rates and deflators for commodity prices in the exporting countries. Exchange rates for each ASEAN country are calculated using data from the IMF. The CPI in each of the exporting country is used as a deflator for the price faced by exporters. Again the source of the data is the International Financial statistics database of the IMF.

### 5.2.2 Testing for unit roots

Before specifying the demand and supply equations, the order of integration of the time series for the variables, and the existence of cointegration between them need to be determined. The seventy-one variables for the test for unit roots are listed in Table 6. The data are annual for the period from 1961 to 2000<sup>38</sup>, and all variables are in logarithmic form.

Tests for unit roots are performed using the augmented Dickey-Fuller tests in version 8.0 of SHAZAM (1997). The null hypothesis is that the time series for the variables of interest have a unit root, against the alternative that they do not. Akaike's (1974) information criterion is used to determine the optimal lag length for the augmented terms. The computed test statistics are summarised in Table 6 for two regression models (a model with both trend and drift and a model with only drift).

It is found that for the economic activity variable of the EU ( $\ln Y_{EU}$ ), the null hypothesis of a unit root could not be rejected for the level of the variable but is rejected for the first difference of the variable. Similarly, for EU import volume variable ( $\ln M_{EU}$ ), with the exception of cassava, the unit root hypotheses could not be rejected for the levels of the variables, but is rejected for the first differences of the variables.

<sup>38</sup> The following variables have a shorter data range: Indonesian cocoa exports (1971–2000), Malaysian cocoa exports (1971–2000), and Thai rubber exports (1971–2000).

As far as the export volume variables from country  $i$  to the EU ( $X_i^d$ ) are concerned, only 2 of the 14 trade flows reject the unit root in level form (Indonesian cassava exports at 10%, and Thai cassava exports at 1%).

In contrast, when the EU import price variables ( $\ln P_j/D_j$ ) are concerned, the null hypotheses of a unit root is rejected in 4 out of 7 commodities at the 5 percent or less. For the relative price variable ( $\ln P_{ij}/P_j$ ), the null of a unit root is rejected in 11 out of the 14 trade flows. Four are significant at the 1% level, three at the 5% level, and four at the 10% level. Similarly, 13 trade flows reject the unit root in real export price variable ( $P_{ij}^e/D_i$ ) and, of these, one is significant at the 1% level, seven at the 5% level, and five at the 10% level.

These results suggest that changes in variables  $\ln Y_{EU}$ ,  $\ln M_{EU}$ , and  $\ln X_i^d$  are stationary, while their level forms are nonstationary. In other words, the variables in question are I(1) processes. On the other hand, most of the time series for the price variables are characterised as a stationary I(0) processes. Note that import price variables ( $\ln P_j$  and  $\ln P_j/D_j$ ) for tea retains a unit root even upon differencing, implying that they may not be fit for inclusion in the analysis.

It is important to emphasise, however, that the statistical unit root tests applied here have some limitations. For example, there are several problems related to the size and power of unit root tests, especially concerning the small sample properties of these tests. The important problem faced when applying the DF and the ADF unit root tests is their tendency to over-reject the null when it is true and under-reject the null when it is false, respectively<sup>39</sup>. This problem occurs because of the near equivalence of non-stationarity and stationary processes in finite samples,

<sup>39</sup> Blough (1992), among other, have stated that unit root tests must have either high probability of falsely rejecting the null of non-stationarity when the true data generating process is a nearly stationary process or low power against any stationary alternative. More specifically, the unit root test must have power equal to its size against a near-stationary process.

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Table 6. The augmented Dickey-Fuller unit-root testing results for the variables of interest.

Commodity	Levels			First differences	
	Variable name	Model 1	Model 2	Model 1	Model 2
<b>All commodities</b>					
	$\ln Y_{EU}$	-2.211	-1.823 (1)	-4.292***	-3.778*** (2)
<b>Cassava</b>					
	$\ln M_{EU}^d$	-4.098***	-4.935*** (0)		
	$\ln X_{IN}^d$	-0.871	-2.621* (0)		
	$\ln X_{TH}^d$	-2.066	-3.461*** (0)		
	$\ln (P_{EU}/D_{EU})$	-1.338	-2.620* (3)		
	$\ln (P_{IN}/P_{EU})$	-4.011***	-3.993*** (1)		
	$\ln (P_{TH}/P_{EU})$	-2.824	-2.801* (0)		
	$\ln P_{EU}$	-0.512	-1.336 (0)	-5.494***	-5.061*** (1)
	$\ln P_W$	-0.564	-1.383 (2)	-3.576**	-3.431*** (2)
	$\ln (P_{IN}^{\otimes}/D_{IN})$	-2.672	-2.829* (1)		
	$\ln (P_{TH}^{\otimes}/D_{TH})$	-3.402*	-3.235** (3)		
<b>Cocoa</b>					
	$\ln M_{EU}^d$	-2.215	-0.412 (0)	-3.147*	-2.692* (3)
	$\ln X_{IN}^d$	-0.823	-1.277 (0)	-3.940**	-3.883*** (0)
	$\ln X_{MA}^d$	-0.316	-0.248 (0)	-3.394*	-2.845* (1)
	$\ln (P_{EU}/D_{EU})$	-2.204	-0.835 (1)	-3.183*	-2.827** (5)
	$\ln (P_{IN}/P_{EU})$	-1.430	-2.025 (0)	-3.621**	-3.077*** (2)
	$\ln (P_{MA}/P_{EU})$	-2.607	-2.691* (0)	-3.371*	-2.787** (2)
	$\ln P_{EU}$	-2.042	-1.702 (1)	-3.835**	-3.309** (3)
	$\ln P_W$	-1.892	-1.900 (1)	-3.206*	-3.108** (2)
	$\ln (P_{IN}^{\otimes}/D_{IN})$	-2.784	-2.673* (0)		
	$\ln (P_{MA}^{\otimes}/D_{MA})$	-3.209*	-1.025 (1)		
<b>Coconut oil</b>					
	$\ln M_{EU}^d$	-2.818	-2.435 (0)	-3.780**	-3.742*** (3)
	$\ln X_{IN}^d$	-2.534	-0.829 (1)	-3.530**	-3.514*** (2)
	$\ln X_{PH}^d$	-2.572	-2.307 (0)	-4.580***	-3.589*** (2)
	$\ln (P_{EU}/D_{EU})$	-3.923**	-1.399 (1)		
	$\ln (P_{IN}/P_{EU})$	-5.313***	-5.068*** (0)		
	$\ln (P_{PH}/P_{EU})$	-3.542**	-3.073** (0)		
	$\ln P_{EU}$	-2.237	-1.936 (2)	-4.676***	-4.740*** (3)
	$\ln P_W$	-2.122	-1.660 (2)	-2.988	-2.993** (4)
	$\ln (P_{IN}^{\otimes}/D_{IN})$	-3.275*	-3.625*** (0)		
	$\ln (P_{PH}^{\otimes}/D_{PH})$	-4.053***	-3.131** (3)		
<b>Palm oil</b>					
	$\ln M_{EU}^d$	-2.994	-0.153 (0)	-4.187***	-4.212*** (2)
	$\ln X_{IN}^d$	-2.001	-0.686 (3)	-3.555**	-3.620*** (2)
	$\ln X_{MA}^d$	-1.843	-1.699 (0)	-3.960***	-3.877*** (1)
	$\ln (P_{EU}/D_{EU})$	-1.829	-0.541* (2)		
	$\ln (P_{IN}/P_{EU})$	-3.539**	-2.933** (3)		
	$\ln (P_{MA}/P_{EU})$	-1.904	-1.734 (0)	-5.032***	-4.591*** (1)
	$\ln P_{EU}$	-1.535	-1.568 (2)	-3.539**	-3.563*** (2)
	$\ln P_W$	-1.396	-1.225 (2)	-3.347*	-3.384** (2)
	$\ln (P_{IN}^{\otimes}/D_{IN})$	-3.272*	-1.547 (0)		
	$\ln (P_{MA}^{\otimes}/D_{MA})$	-3.653**	-1.688 (0)		

*continued on the next page*



Table 6. (cont.)

Commodity	Levels			First differences	
	Variable name	Model 1	Model 2	Model 1	Model 2
<b>Pepper</b>					
	$\ln M_{EU}^d$	-2.243	-1.795 (1)	-4.676***	-3.146*** (4)
	$\ln X_{IN}^d$	-2.616	-0.883 (3)	-4.805***	-4.866*** (3)
	$\ln X_{MA}^d$	-2.705	-1.738 (1)	-4.385***	-4.325*** (2)
	$\ln (P_{EU}/D_{EU})$	-3.184*	-2.572*		
	$\ln (P_{IN}/P_{EU})$	-2.617	-2.732*		
	$\ln (P_{MA}/P_{EU})$	-2.312	-2.604*		
	$\ln P_{EU}$	-2.075	-0.456 (0)	-3.683**	-3.763*** (5)
	$\ln P_W$	-1.760	-1.809 (0)	-3.089	-3.126** (0)
	$\ln (P_{IN}^\otimes/D_{IN})$	-3.125	-3.063** (1)		
	$\ln (P_{MA}^\otimes/D_{MA})$	-3.291*	-3.330** (1)		
<b>Rubber</b>					
	$\ln M_{EU}^d$	-2.195	-0.631 (0)	-4.414***	-4.446*** (1)
	$\ln X_{IN}^d$	-1.599	-2.277 (3)	-3.385*	-2.741* (2)
	$\ln X_{MA}^d$	-1.174	-1.275 (0)	-3.989***	-3.980*** (1)
	$\ln X_{TH}^d$	-2.004	-0.477 (0)	-3.019**	-3.115** (3)
	$\ln (P_{EU}/D_{EU})$	-3.894**	-1.060 (1)		
	$\ln (P_{IN}/P_{EU})$	-6.079***	-6.753*** (0)		
	$\ln (P_{MA}/P_{EU})$	-3.270*	-2.751* (1)		
	$\ln (P_{TH}/P_{EU})$	-2.969	-3.132** (4)		
	$\ln P_{EU}$	-1.524	-1.294 (2)	-2.996	-2.993** (3)
	$\ln P_W$	-1.857	-1.152 (2)	-3.483**	-3.657*** (2)
	$\ln (P_{IN}^\otimes/D_{IN})$	-2.859	-2.999** (0)		
	$\ln (P_{MA}^\otimes/D_{MA})$	-3.472**	-3.103** (1)		
	$\ln (P_{TH}^\otimes/D_{TH})$	-3.157*	-1.353 (0)		
<b>Tea</b>					
	$\ln M_{EU}^d$	-2.759	-1.350 (2)	-3.686**	-3.765*** (3)
	$\ln X_{IN}^d$	-2.546	-2.244 (0)	-4.852***	-4.887*** (1)
	$\ln (P_{EU}/D_{EU})$	-2.381	-1.379 (0)	-1.541	-1.487 (6)
	$\ln (P_{IN}/P_{EU})$	-1.698	0.222 (1)	-3.864**	-3.550*** (3)
	$\ln P_{EU}$	-1.990	-1.253 (0)	-2.497	-2.546 (5)
	$\ln P_W$	-1.734	-0.933 (0)	-4.183***	-4.246*** (1)
	$\ln (P_{IN}^\otimes/D_{IN})$	-1.176	-2.226 (0)	-3.116*	-2.528 (1)

Notes

The two forms of augmented Dickey-Fuller (ADF) regression equations for a time series  $Y_t$  are:

Model 1  $\Delta Y_t = \delta_1 + \delta_2 t + \xi Y_{t-1} + \sum_1^m \theta_j \Delta Y_{t-1} + e_t$  (with trend and drift)

Model 2  $\Delta Y_t = \delta_1 + \xi Y_{t-1} + \sum_1^m \theta_j \Delta Y_{t-1} + e_t$  (with drift)

where  $t$  is the time or trend variable.

The next step is to divide the estimated  $\xi$  coefficient by its standard error to compute the Dickey-Fuller  $\tau$  statistics and refer to Dickey-Fuller tables to see if the null hypothesis  $\xi = 0$  (there is a unit root) is rejected. If the computed absolute value of the  $\tau$  statistics (i.e.,  $|\tau|$ ) is less than the absolute critical values, the time series is considered nonstationary.

The number in parentheses denotes minimum value of  $m$  required achieving white noise errors. These numbers are the same in both of the models.

\*, \*\*, and \*\*\* indicates statistical significance at the 10 per cent, at the 5 per cent, and at the 1 per cent level, respectively. Critical values for model 1 are -3.13 (10 per cent), -3.41 (5 per cent) and -3.96 (1 per cent); and for model 2 -2.57 (10 per cent), -2.86 (5 per cent) and -3.43 (1 per cent).

which makes it difficult to distinguish between trend-stationary and difference-stationary processes (Harris 1995).

Moreover, choosing the correct form of the ADF model is problematic and using different lag-lengths often results in different outcomes with respect to rejecting the null hypothesis of nonstationarity. Therefore, unit root tests with 40 or less observation are not likely to be very powerful and failure to reject the null hypotheses of a unit root does not mean that one can accept this hypotheses. This, in turn, raises the issue of whether current procedures are sufficiently robust<sup>40</sup> to provide any substantial method of discriminating between non-stationary and trend-stationary processes. The trade-off between size and power properties of unit root tests, in particular, makes it difficult to make definite statements about (non)stationarity.

### 5.2.3 Testing for cointegration

Having established that the time series of a number of variables are integrated of order I(1), tests for cointegration are undertaken, and the nature of any cointegrating vectors explored, again using SHAZAM (1997). The augmented Dickey-Fuller and Phillips-Perron (PP) cointegration test results for demand equations are presented in Table 7. The critical values are -3.50 (10 per cent), -3.78 (5 per cent) and -4.32 (1 per cent) for model 1; and -3.04 (10 per cent), -3.34 (5 per cent) and -3.90 (1 per cent) for model 2.

The demand for imports of a commodity in a geographic market ( $\ln M_j$ ) is postulated to have a steady-state response to the domestic economic activity ( $\ln Y_j$ ), but not necessarily to the real price of imports ( $\ln P_j/D_j$ ). The life-cycle approach to consumption emphasises income as a determinant of intemporal consumption planning and provides theoretical justification for the existence of long term relationship between the

volume of imports ( $\ln M_j$ ) and the domestic economic activity ( $\ln Y_j$ ).

Looking at the t-statistics in Table 7 for coconut oil, palm oil, pepper and rubber, there is evidence of the existence of long run relationship involving the volume of EU imports ( $\ln M_{EU}$ ) and the economic activity of the EU ( $\ln Y_{EU}$ ). However, in the case of cocoa, it would appear that the price variable does enter the cointegrating vector as well, and thus has an effect in the long run.

The demand for the exports of a country ( $X_i$ ) is expected to have a steady-state response to the import demand of geographic markets ( $M_j$ ), and a transient (or long term) response to the relative export price of the country ( $P_{ij}/P_j$ ). The results reveal that in most cases, the relative price variable does not enter the cointegrating vector, and thus does not have effect in the long run. In other words, there exist a stationary linear combination only between the quantity of exports from an ASEAN country to the EU and the volume of EU imports, implying that  $X_{ij}$  and  $M_j$  are cointegrated.

However, for cocoa exports from Indonesia and Malaysia as well as palm oil exports from Malaysia, there is evidence of the existence of long run relationship involving all three variables: the quantity of exports from a country to the EU ( $X_i$ ), the volume of EU imports ( $M_j$ ), and the relative price ( $P_{ij}/P_j$ ) of the EU market. In other words, it would appear that  $X_{ij}$ ,  $M_j$ ,  $P_{ij}/P_j$  are cointegrated.

The price of an imported commodity ( $\ln P_j$ ) is expected to have a steady-state response to the world market price of that commodity ( $\ln P_w$ ), because the rates of change of the import price of a commodity and its world market price must be the same in the long run. Although the results are not clear-cut, they seem to confirm the expectation that the price of an imported commodity in the EU ( $\ln P_{EU}$ ) is cointegrated with the world market price of that commodity ( $\ln P_w$ ).

It is important to note here that, in common with the tests for unit roots, tests for co-integration may lack power to discriminate between unit roots and borderline-stationary processes (Baner-

<sup>40</sup> Robustness is defined by lack of sensitivity of the critical values to a wide range of changes to the data generating process.

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Table 7. Cointegrating regressions for demand equations, 1970–1996.

Commodity	ADF-test			Phillips test	
	Model 1	Model 2		Model 1	Model 2
<b>Cassava</b>					
$\ln P_{EU}^d, \ln P_W$	-2.026	-2.061	(0)	-2.252	-2.286
<b>Cocoa</b>					
$\ln M_{EU}^d, \ln Y_{EU}$	-1.747	-3.806***	(0)	-1.606	-3.860***
$\ln M_{EU}^d, \ln Y_{EU}, \ln (P_{EU}/D_{EU})$	-3.625**	-3.130**	(3)	-5.011*	-6.083***
$\ln X_{IN}^d, \ln M_{EU}^d$	-2.023	-0.987	(0)	-1.919	-1.226
$\ln X_{MA}^d, \ln M_{EU}^d, \ln (P_{IN}/P_{EU})$	-2.409	-2.202	(2)	-4.643**	-4.300**
$\ln X_{MA}^d, \ln M_{EU}^d$	0.545	0.553	(0)	-0.691	-0.706
$\ln X_{MA}^d, \ln M_{EU}^d, \ln (P_{MA}/P_{EU})$	-2.490	-2.718	(1)	-2.491	-2.718
$\ln P_{EU}^d, \ln P_W$	-1.954	-2.027	(0)	-2.230	-2.317
<b>Coconut oil</b>					
$\ln M_{EU}^d, \ln Y_{EU}$	-2.775	-2.882	(0)	-2.735	-2.844
$\ln X_{IN}^d, \ln M_{EU}^d$	-4.537***	-7.273***	(0)	-4.519**	-7.232***
$\ln X_{PH}^d, \ln M_{EU}^d$	-3.175*	-3.419**	(0)	-3.202*	-3.445
$\ln P_{EU}^d, \ln P_W$	-2.686	-2.463	(0)	-2.782	-2.647
<b>Palm oil</b>					
$\ln M_{EU}^d, \ln Y_{EU}$	-3.425*	-3.818*	(0)	-3.441*	-3.826*
$\ln X_{IN}^d, \ln M_{EU}^d$	-2.760	-3.244	(2)	-4.148***	-4.618***
$\ln X_{MA}^d, \ln M_{EU}^d$	-2.497	-2.095	(0)	-2.501	-2.096
$\ln X_{MA}^d, \ln M_{EU}^d, \ln (P_{MA}/P_{EU})$	-3.786**	-3.446	(0)	-3.795**	-3.420
$\ln P_{EU}^d, \ln P_W$	-2.789	-3.291	(4)	-2.444***	-2.493***
<b>Pepper</b>					
$\ln M_{EU}^d, \ln Y_{EU}$	-3.982***	-3.977***	(1)	-5.025***	-5.022***
$\ln X_{IN}^d, \ln M_{EU}^d$	-3.950***	-3.900***	(1)	-5.226***	-5.065***
$\ln X_{MA}^d, \ln M_{EU}^d$	-4.261*	-4.453**	(0)	-4.622*	-4.518**
$\ln P_{EU}^d, \ln P_W$	-3.522	-3.608	(1)	-3.657***	-3.720***
<b>Rubber</b>					
$\ln M_{EU}^d, \ln Y_{EU}$	-3.141*	-3.303*	(2)	-5.101***	-5.286***
$\ln X_{IN}^d, \ln M_{EU}^d$	-3.001	-3.523*	(3)	-4.781***	-4.907***
$\ln X_{MA}^d, \ln M_{EU}^d$	-3.521*	-3.663*	(0)	-3.607*	-3.732**
$\ln X_{TH}^d, \ln M_{EU}^d$	-1.213	-1.904	(2)	-4.003**	-3.756**
$\ln P_{EU}^d, \ln P_W$	-2.253	-2.269	(0)	-2.437	-2.480
<b>Tea</b>					
$\ln M_{EU}^d, \ln Y_{EU}$	-3.294***	-3.579***	(2)	-7.650***	-7.913***
$\ln M_{EU}^d, \ln Y_{EU}, \ln (P_{EU}/D_{EU})$	-4.533**	-4.846***	(1)	-7.531*	-7.849***
$\ln X_{IN}^d, \ln M_{EU}^d$	-2.107	-2.634	(0)	-1.963	-2.547
$\ln X_{MA}^d, \ln M_{EU}^d, \ln (P_{IN}/P_{EU})$	-3.851*	-3.889**	(0)	-3.884*	-3.880**
$\ln P_{EU}^d, \ln P_W$	-2.301	-2.361	(0)	-2.485	-2.548

Two models of the cointegrating regression equations (with  $m$  time series  $Y_{1, \dots, Y_m}$ ) are:

$$(1) Y_{t1} = \zeta_0 + \sum_{j=2}^m \zeta_j Y_{tj} + u_t, \text{ and } (2) Y_{t1} = \zeta_0 + \zeta_1 t + \sum_{j=2}^m \zeta_j Y_{tj} + u_t$$

A test for cointegration is given by a test for a unit root in the estimated residuals  $\hat{u}_t$ . The ADF regression equation is:

$$\Delta \hat{u}_t = h_0 \hat{u}_{t-1} + \sum_{j=1}^p h_j \Delta \hat{u}_{t-j} + v_t$$

\*, \*\*, and \*\*\* indicates statistical significance at the 10 per cent level, at the 5 per cent level, and at the 1 per cent level, respectively. Critical values with two variables are -3.04 (10 per cent), -3.34 (5 per cent) and -3.90 (1 per cent) for model 1; and -3.50 (10 per cent), -3.78 (5 per cent) and -4.32 (1 per cent) for model 2. Critical values with three variables are -3.45 (10 per cent), -3.74 (5 per cent) and -4.29 (1 per cent) for model 1; and -3.84 (10 per cent), -4.12 (5 per cent) and -4.66 (1 per cent) for model 2.

jee et al. 1993, Harris 1995). Moreover, there are problems associated with testing for cointegration using single equation approach, since it is only really applicable to use the single equation approach when all the right-hand-side variables are weakly exogenous and when there is a single unique cointegration vector. The problem of endogeneity may be relatively unimportant in many situations, as suggested by Inder (1993), on the basis of Monte Carlo experiments. However, there is still the important issue of how many possible  $(n-1)$  cointegration relations exist in a model, which includes  $n$  variables. The single equation approach can be misleading, particularly if more than one cointegration relationship is present.

## 5.3 Summary

In this chapter, the econometric methodology employed by the study in modelling the dynamic relationships of commodity trade has been specified. Given that economic time series often exhibit nonstationary stochastic processes, the econometric specification has been conducted in a framework that allows for nonstationary but potentially cointegrated variables. The approach adopted is to convert the dynamic model into error correction formulation, and it is shown that this formulation contains information on both the

short-run and long-run properties of the model, with disequilibrium as a process of adjustment to the long-run model. The error correction specification is derived as a reparameterisation of a general unrestricted autoregressive distributed lag model. Equations specified in this manner allow the relevant economic theory to enter the formulation of long-run equilibrium in levels while the short-run dynamics of the equation are determined by growth rates.

Since the validity of the error correction specification requires the existence of a long-run relationship or cointegration between the variables concerned, the econometric analysis begins with the tests for the existence of a cointegrating vector. The first step in the analysis of cointegration is to determine the time series properties (i.e., the order of integration) of each variable, whether they have a unit root or not. The econometric analysis has been conducted with a sample of annual data that cover ASEAN's major commodity exports to the EU from 1961 to 2000. Tests for unit roots have been performed using the augmented Dickey-Fuller univariate tests. Having established the order of integration of each variable, tests for cointegration have been undertaken, and the nature of any cointegrating vectors explored. A formal test of cointegration has been carried out following the residual-based approach proposed by Engle-Granger (1987) as well as the sequential testing procedure put forward by Perron (1988).

## 6 Empirical analysis of ASEAN-EU agricultural trade

In this chapter, it will be considered how the theoretical structures described in chapters 3 and 4 are implemented in dynamic econometric models in practice. The basic aim of the chapter is to derive the dynamic specifications of the demand and supply relationships in the system of equations used to characterise commodity trade between ASEAN and the EU. The derivations are

conducted by means of econometric concepts developed in the chapter 5. Among these, the so-called 'general to specific' approach' advocated by Hendry (1986) is applied in the context of data series whose stationary properties were investigated in the previous chapter. The approach follows closely the modelling strategy developed in a series of papers by Davidson et al. (1978),

Hendry and Richard (1983), Hendry (1986), Lord (1991), and Urbain (1992). The results of the estimations of import demand and export demand as well as import supply and export supply functions are then presented.

## 6.1 Dynamic system of demand equations

### 6.1.1 Import demand

The theory underlying the import demand side is the traditional demand response to income and price. Consider the general form of a long-run equilibrium relationship for import demand function postulated in equation (1) in page 38 and expressed as a logarithmic function

$$\ln M_j^d = \ln a_1 + \epsilon_m^y \ln Y_j + \epsilon_m^p \ln \left( \frac{P_j}{D_j} \right) \quad (34)$$

Equation (34) represents a country's  $j$  imports ( $M$ ) as a function of economic activity ( $Y$ ) and real price of the good imported ( $P/D$ ). The function is linear-in-logarithms and, therefore, consistent with the form of the equation used empirically to estimate the dependence among variables. Furthermore, it is postulated that the income elasticity  $\epsilon_m^y$  equals one under the null hypotheses. On other hand, the price elasticity  $\epsilon_m^p$  is postulated to take any value between 0 and  $-\infty$ .

Because each of the three variables in the import demand equation (34) can either be stationary or nonstationary, four possible model specifications need to be considered (Table 8). In the first case, the unit root hypothesis cannot

Table 8. The four possible model specifications for import demand equation.

Model specification	Model predictions and testing strategy. <sup>a</sup>
<p><b>1. All three variables are difference stationary (DS)</b></p> <p>We have the case, where</p> <p>a. <math>M_j</math> is DS, <math>Y_j</math> is DS, <math>(P/D)_j</math> is DS.</p>	<p>a. <math>M_j</math>, <math>Y_j</math>, and <math>(P/D)_j</math> are cointegrated.</p> <p>If a cointegration relation between these three variables does not exist, estimation of the import demand equation (34) will result in a spurious regression. Hence, to detect this potential spuriousness, a residual-based cointegration test will be performed on equation (34).</p>
<p><b>2. One of the three variables is trend stationary (TS)</b></p> <p>We have three cases, depending on which variable is TS</p> <p>b. <math>M_j</math> is TS.</p> <p>c. <math>Y_j</math> is TS.</p> <p>d. <math>(P/D)_j</math> is TS.</p>	<p>b. <math>Y_j</math> and <math>(P/D)_j</math> are cointegrated</p> <p>c. <math>M_j</math> and <math>(P/D)_j</math> are cointegrated</p> <p>d. <math>M_j</math> and <math>Y_j</math> are cointegrated</p> <p>In all three cases, if a cointegration relation between these pairs of variables does not exist, attempts to estimate the import demand equation will result in a spurious regression. Hence, to detect this potential spuriousness, a residual-based cointegration test will be performed on equation (34).</p>
<p><b>3. Two of the three variables are TS</b></p>	<p>This case can be viewed as a rejection of the model, since there is no linear combination of the three variables that yields a stationary process.</p>
<p><b>4. All three variables are TS</b></p> <p>This is the only case in which classical inference is valid.</p>	<p>The import demand equation (34) becomes a classical regression equation.</p>

<sup>a</sup> See Senhadji (1998).

<sup>b</sup> See Stock and Watson (1988).

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be rejected for all three variables, and the model is assumed to predict a cointegrating relationship between all these three I(1) variables. If a cointegration relation between these three I(1) variables does not exist, attempts to estimate the import demand equation (34) will result in a spurious regression. Hence, to detect this potential spuriousness, a residual-based cointegration tests were performed in the previous chapter.

In the second case, the unit root hypotheses can be rejected for only one of the three variables, and the model predicts a cointegrating relationship between the other two I(1) variables. There are three alternative subcases, depending on which variable is found stationary. In all three subcases, if a cointegration relation between the two I(1) variables does not exist, attempts to estimate the import demand equation (34) will result in a spurious regression.

In the third case, the unit root hypotheses can be rejected for two of the three variables. Since there is no linear combination of the three variables that yields a stationary process, this case can be viewed as a rejection of the model. In the fourth case, the unit root hypotheses can be rejected for all of the three variables, i.e. the import demand equation becomes a classical regression.

Results from the unit root and cointegration tests in Table 6 and Table 7 (pages 72–77) show that the second specification is the most common one, with four commodities (coconut oil, palm oil, pepper and rubber) falling into this category. Cocoa belongs to the first category, and cassava to the fourth category. Tea is only commodity, which falls into the third category. Hence, for the import demand equation for tea, there exist no linear combination of the three variables that yields a stationary process.

Equation (34) will be estimated in a dynamic form (that is, with the lagged dependent variable included as an explanatory variable). Following closely the modelling strategy introduced in chapter 5.1.2 (pages 61–64), the first-order stochastic difference equation of the theoretical relationship in (34) is expressed as

$$\ln M_{jt} = a_0 + a_1 \ln Y_{jt} + a_2 \ln Y_{j,t-1} + \quad (35)$$

$$a_3 \ln \left( \frac{P_j}{D_j} \right)_t + a_4 \ln \left( \frac{P_j}{D_j} \right)_{t-1} + a_5 \ln M_{j,t-1} + v_{1t}$$

where the expected signs are  $a_1, a_2 > 0$ ;  $a_3, a_4 < 0$ ; and  $0 < a_5 < 1$ .

The lags in the model are specified as the maximum to be expected in the light of the nature of import demand and the evidence of previous econometric studies. The maximum lag length for annual time-series data is usually equal to one on the hypothetical basis that economic agents are characterised by one-year planning horizons.

In the case of those four commodities (coconut oil, palm oil, pepper and rubber), which fall into the second category, the demand for imports of a commodity in the EU ( $\ln M_{EU}$ ) has a steady-state response to the domestic economic activity ( $\ln Y_{EU}$ ), but a transient response to the constant price of imports ( $\ln P_j/D_j$ ). Therefore, it is appropriate to apply ECM to the linear relationship between  $\ln M_{EU}$  and  $\ln Y_{EU}$ . This implies that price of imports does not enter the cointegrating vector, and thus has no effect on imports in the long run.

Adding an ECM<sup>41</sup> driven by  $\ln Y_{EU}$  and  $(\ln P_j/D_j)$  to the equation (35), with an additional lagged variable of  $\ln Y_{EU}$ <sup>42</sup>, results in the following import demand specification:

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<sup>41</sup> The following notation is used for these regressors: (a) ECM1 for those obtained from the cointegration regression of  $M_j$  on  $(Y, P_j/D_j)$ ; and (b) ECM2 for  $M_j$  on  $Y_j$ .

<sup>42</sup> Recall that equation (1) in page 38 states that import demand ( $M$ ) has a proportional response to a change in economic activity ( $Y$ ), which implies that  $a_1 + a_2 + a_5 = 1$  in (35). In order to test the hypothesis that income elasticity is equal to unity, an additional term ( $Y_{t-1}$ ) is introduced as a regressor (see equation (27b) in page 64 for derivation). Hence when the coefficient for ( $Y_{t-1}$ ) has non-zero significance, the steady-state response of ( $M$ ) to ( $Y$ ) is non-proportional. Note that it would also be possible to test the income elasticity coefficient from the cointegration regression. However, the parameter does not need to be estimated at an earlier stage in order to allow one to use the ECM (Banerjee et al. 1993).

$$\Delta \ln M_{jt} = \alpha_0 + \alpha_1 \Delta \ln Y_{jt} + \alpha_2 \ln Y_{j,t-1} + \quad (36)$$

$$\alpha_3 \Delta \ln \left( \frac{P_j}{D_j} \right)_t + \alpha_4 \left( \frac{P_j}{D_j} \right)_{t-1} + \alpha_5 \ln ECM1_{t-1} + v_{1t}$$

where  $\alpha_0 = a_0$ ,  $\alpha_1 = a_1$ ,  $\alpha_2 = (a_1 + a_2 + a_5 - 1)$ ,  $\alpha_3 = a_3$ ,  $\alpha_4 = (a_3 + a_4)$ , and  $\alpha_5 = (a_5 - 1)$ . The expected signs of the coefficients are  $\alpha_1 > 0$ ,  $\alpha_2 > \alpha_3$ ,  $-1 < \alpha_3 < 0$ , and  $\alpha_3, \alpha_4 < 0$ .

The price term in the foregoing specifications (36) has been so transformed as to nest the ‘differences’ formulations of the variable in the levels form of the equation. The fifth term ( $\alpha_5 \ln ECM1$ ) is the mechanism for adjusting any disequilibrium in the previous period. It corrects for previous non-proportional responses in the long-run dynamic growth of import demand. If the rate of growth of the dependent variable,  $\Delta \ln M_{jt}$ , were to fall below its steady-state path, the negative coefficient in the disequilibrium adjustment term would induce an increase in the demand for imports.

Conversely, if the rate of import growth of the country were to increase above its long-run equilibrium level, that coefficient would generate downward pressure on the import demand until the growth rate returned to its steady-state path. Short-run adjustments are therefore guided by, and consistent with, the long-run equilibrium relationship.

Since cocoa falls into the first category, the demand for cocoa imports in the EU ( $\ln M_{EU}$ ) has a steady-state response to the domestic economic activity ( $\ln Y_{EU}$ ), and to the constant price of imports ( $\ln P_j/D_j$ ). Therefore, it is appropriate to apply ECM to the linear relationship between  $\ln M_{EU}$ ,  $\ln Y_{EU}$ , and  $\ln P_j/D_j$ .

In order to derive the long-run dynamic equilibrium properties of the relationship between the dependent variable and its explanatory variable, the approach used by Currie (1981) and Lord (1991) is adopted here. Consider now the ECM specification, where  $\ln M_{EU}$  has a steady-state response to  $\ln Y_{EU}$ , but a transient response to  $\ln P_j/D_j$ . Adding an ECM driven by  $\ln Y_{EU}$  to the equation (35), and a ‘differences’ formulation of

the price term ( $\ln P_j/D_j$ ) – nested in the levels form of the equation – results in the following import demand specification:

$$\Delta \ln M_{jt} = \alpha_0 + \alpha_1 \Delta \ln Y_{jt} + \alpha_2 \ln Y_{j,t-1} +$$

$$\alpha_3 \Delta \ln \left( \frac{P_j}{D_j} \right)_t + \alpha_4 \left( \frac{P_j}{D_j} \right)_{t-1} + \alpha_5 \ln \left( \frac{M_j}{Y_j} \right)_{t-1} + v_{1t}$$

The long-run dynamic solution of a single-equation system generates a steady-state response in which growth occurs at a constant rate, say  $g$ , and all transient responses have disappeared (Lord 1991). With growth rates of domestic economic activity and import demand,  $\Delta \ln Y_{jt} = g_1$  and  $\Delta \ln M_{jt} = g_2$ , respectively, the long-run dynamic equilibrium solution of the foregoing equation is

$$g_2 = \alpha_0 + \alpha_1 g_1 + \alpha_2 \ln Y_j +$$

$$\alpha_4 \ln \left( \frac{P_j}{D_j} \right) + \alpha_5 \ln \left( \frac{M_j}{Y_j} \right)$$

Rearrangement of the terms yields (see Appendix I for the derivation)

$$\ln M_j = -\frac{\alpha_0}{\alpha_5} + \left( \frac{1 - \alpha_1}{\alpha_5} \right) g_1 + \left( 1 - \frac{\alpha_2}{\alpha_5} \right) \ln Y_j -$$

$$\left( \frac{\alpha_4}{\alpha_5} \right) \ln \left( \frac{P_j}{D_j} \right)$$

or, in terms of the original (anti-logarithmic) values of the variable,

$$M_j = \hat{a}_1^* Y_j^{1 - (\alpha_2 / \alpha_5)} \left( \frac{P_j}{D_j} \right)^{-\alpha_4 / \alpha_5} \quad (37)$$

where  $\hat{a}_1^* = \exp \{ [-\alpha_0 + (1 - \alpha_1)g_1] / \alpha_5 \}$ . Equation (37) encompasses the static equilibrium solution when  $g_j = 0$ . The income elasticity of import demand is expressed as  $\epsilon_m^y = 1 - (\alpha_2 / \alpha_5)$ . The price elasticity of import demand is  $\epsilon_m^p = -\alpha_4 /$

$\alpha_5$ . The third response is stimulated by a change in the rate of growth of economic activity. It reflects the income growth elasticity, denoted  $\varepsilon^{YG}$ , and is defined as a percentage change in import demand brought about by a 1 per cent change in the rate of growth of economic activity, and is expressed as

$$\varepsilon^{YG} = \frac{\partial M_j}{\partial g_1} \frac{1}{M_j} = \frac{1 - \alpha_1}{\alpha_5} \quad (38)$$

### 6.1.2 Export demand

On the export demand side, the equation (3) formulated in chapter 3.1.2.2 (page 38) links the demand for the exports of a country  $i$  to import demand of a geographic market  $j$  and to the relative price of that market. Therefore, the export demand schedule for the country of interest is given in the log-linear form by

$$\ln X_{ij}^d = \ln \hat{a}_2 + \varepsilon_x^m \ln M_j + \varepsilon_x^p \ln \left( \frac{P_{ij}}{P_j} \right) \quad (39)$$

where  $X_{ij}^d$  is the quantity of the good exported from country  $i$  to country  $j$ ;  $\hat{a}_2$  is a constant;  $M_j$  is the total quantity of the good imported by country  $j$ ;  $P_{ij}$  is the price of the good imported from country  $i$  to country  $j$ ;  $P_j$  is the average price of the good imported to country  $j$ ; and is the price elasticity of export demand. Furthermore, it is postulated that the import demand elasticity  $\varepsilon_x^m$  equals one under the null hypotheses. On other hand, the price elasticity  $\varepsilon_x^p$  is postulated to take any value between 0 and  $-\infty$ .

As with import demand equations, each of the three variables in the export demand equation (39) can either be stationary or nonstationary, and therefore four possible model specifications need to be considered (see Table 8 in page 81). The results of the unit root and cointegration tests in Tables 6 and 7 (pages 72–77) show that most equations – 8 of the 14 – fall into the second case (the unit root hypothesis can be re-

jected for one of the three variables in the export demand equation). Four of the remaining equations fall into the first case (the unit root hypotheses cannot be rejected for all three variables), and two into the fourth case. No equation belongs to the third case.

Export demand equation will be estimated in a dynamic form. In terms of the general stochastic difference specification, the relationship in (39) is expressed as

$$\ln X_{ijt}^d = b_0 + b_1 \ln M_{jt} + b_2 \ln M_{j,t-1} + \quad (40)$$

$$b_3 \ln \left( \frac{P_{ij}}{P_j} \right)_t + b_4 \ln \left( \frac{P_{ij}}{P_j} \right)_{t-1} + b_5 \ln X_{ijt-1}^d + v_{2t}$$

where the expected signs of the coefficients are  $b_1, b_2 > 0$ ;  $b_3, b_4 < 0$ ; and  $0 < b_5 < 1$ .

The dynamics for the export demand relationship is assumed to be of relatively small order, and can therefore be restricted to cases where the lagged values of the variables are of one year.

In the first case, demand for exports from country  $i$  to country  $j$  ( $X_{ij}$ ) has a steady-state response to the import demand ( $M_j$ ), and to the relative price ( $P_{ij}/P_j$ ) of that market. In other words,  $X_{ij}$ ,  $M_j$ ,  $P_{ij}/P_j$  are cointegrated. The following transformation of (40) incorporates an ECM<sup>43</sup> driven by  $M_j$  and  $P_{ij}/P_j$ ;

$$\Delta \ln X_{ijt}^d = \beta_0 + \beta_1 \Delta \ln M_{jt} + \beta_2 \Delta \ln \left( \frac{P_{ij}}{P_j} \right)_t + \beta_3 \ln \left( \frac{P_{ij}}{P_j} \right)_{t-1} + \beta_4 \ln ECM3_{t-1} + v_{2t} \quad (41)$$

where  $\beta_0 = b_0$ ,  $\beta_1 = b_1$ ,  $\beta_2 = b_3$ ,  $\beta_3 = (b_3 + b_4)$ , and  $\beta_4 = (b_5 - 1)$ . The expected signs of the coefficients are  $\beta_1, \beta_2 > 0$ ,  $\beta_3 < 0$ , and  $-1 < \beta_4 < 0$ .

<sup>43</sup> The following notation is used for these regressors: (a) ECM3 for those obtained from the cointegration regression of  $X_{ij}$  on  $M_j$  and  $P_{ij}/P_j$ ; and (b) ECM4 for  $X_{ij}$  on  $M_j$ .



Now, the disequilibrium adjustment mechanism in the fourth term,  $\ln ECM_{3,t-1}$ , measures ‘errors’ (divergences) from the long-run equilibrium and corrects for previous non-proportional responses in the long-run dynamic growth of export demand. Therefore, the coefficient  $\beta_4$  measures the extent of correction needed. The relative price term in the foregoing specification have been so transformed as to nest the ‘differences’ formulations of the variable in the level form of the equation.

The second case implies that demand for exports from country  $i$  to country  $j$  ( $X_{ij}$ ) has a steady-state response to the import demand ( $M_j$ ) of a geographic market  $j$  and a transient response to the relative price ( $P_{ij}/P_j$ ) of that market. In other words,  $X_{ij}$  and  $M_j$  are cointegrated. The following transformation of (40) incorporates an ECM driven by import demand  $M_j$ :

$$\Delta \ln X_{ijt}^d = \beta_0 + \beta_1 \Delta \ln M_{jt} + \beta_2 \Delta \ln \left( \frac{P_{ij}}{P_j} \right) + \beta_3 \ln \left( \frac{P_{ij}}{P_j} \right)_{t-1} + \beta_4 \ln \left( \frac{X_{ijt}^d}{M_j} \right)_{t-1} + v_{2t} \quad (42)$$

As with import demand equations, the approach used by Currie (1981) is adopted to derive the long-run dynamic equilibrium properties of the equation (Appendix I). For the dynamic specification of the relationship described by (42),  $\Delta \ln M_{jt} = g_2$ ,  $\Delta \ln X_{ijt} = g_3$  and are the growth rates of import demand and export demand, respectively. Since relative price would not be expected to have any long-run dynamic influence in (42), its effect is constrained to zero so that  $\Delta \ln (P_{ij}/P_j)_t = 0$ , the solution is

$$g_3 = \beta_0 + \beta_1 g_2 + 0 + \beta_3 \ln \left( \frac{P_{ij}}{P_j} \right) + \beta_4 \ln \left( \frac{X_{ijt}^d}{M_j} \right)$$

Rearrangement of terms yields the steady-state solution for export demand:

$$\ln X_{ij}^d = -\beta_0 / \beta_4 + \left( \frac{1 - \beta_1}{\beta_4} \right) g_2 +$$

$$\ln M_j - \left( \frac{\beta_3}{\beta_4} \right) \ln \left( \frac{P_{ij}}{P_j} \right)$$

or, in terms of the original values of the variable,

$$X_{ij}^d = \hat{a}_2^* M_j \left( \frac{P_{ij}}{P_j} \right)^{-\beta_3 / \beta_4} \quad (43)$$

where  $\hat{a}_2^* = \exp \{ [-\beta_0 + (1 - \beta_1)g_2] / \beta_4 \}$ . Export demand here has a unitary elasticity with respect to the level of import demand in the geographic market. The price elasticity of export demand is expressed as  $\epsilon_x^p = -\beta_3 / \beta_4$ . The import growth elasticity, denoted  $\epsilon^{MG}$ , is defined as a percentage change in export demand brought about by a 1 per cent change in the growth rate of import demand, and is expressed as

$$\epsilon^{MG} = \frac{\partial X_{ij}^d}{\partial g_2} \frac{1}{X_{ij}^d} = \frac{1 - \beta_1}{\beta_4} \quad (44)$$

It should be noted, however, that the response of export demand to changes in import demand is not necessarily proportional<sup>44</sup>. This is why the export demand specification should test whether or not export demand has a unitary elasticity with respect to import demand. In order to test the assumption, an additional term  $\ln (M_{j,t-1})$  is introduced as a regressor [see equation (27b) in page 64 for derivation]. The inclusion of an extra lag of  $\ln (M_j)$  into the export demand equation (40) yields:

<sup>44</sup> Recall that equation (3) in page 38 states that export demand ( $X_{ij}$ ) has a proportional response with respect to the level of import demand ( $M_j$ ), which implies that  $b_1 + b_2 + b_3 = 1$  in (40).

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$$\Delta \ln X_{ijt}^d = \beta_0 + \beta_1 \Delta \ln M_{jt} + \beta_2 \ln M_{j,t-1} \quad (45)$$

$$+ \beta_3 \Delta \ln \left( \frac{P_{ij}}{P_j} \right) + \beta_4 \ln \left( \frac{P_{ij}}{P_j} \right)_{t-1} + \beta_5 \ln ECM3_{t-1} + v_{2t}$$

where  $\beta_0 = b_0$ ,  $\beta_1 = b_1$ ,  $\beta_2 = (b_1 + b_2 + b_3 - 1)$ ,  $\beta_3 = b_3$ ,  $\beta_4 = (b_3 + b_4)$ , and  $\beta_5 = (b_5 - 1)$ . The expected signs of the coefficients are  $\beta_1 > 0$ ,  $\beta_2 > \beta_3$ ,  $\beta_3, \beta_4 < 0$ , and  $-1 < \beta_5 < 0$ . Hence when the coefficient  $\beta_2$  for  $\ln(M_{j,t-1})$  has non-zero significance, the steady-state response of  $\ln(X_{ij})$  to  $\ln(M_j)$  is non-proportional.

## 6.2 Dynamic system of supply equations

### 6.2.1 Import supply

The principal concern in examining the import supply functions in this study is the speed with which import prices in country  $j$  adjust to changes in world market prices of the commodities. The specification for import supply in equation (9) in page 41 posits that that import price  $P_j$  – which is the average import price in country  $j$  supplied from different sources  $i = 1, \dots, k$  – has a proportional response to movements in the world market price  $P_w$ :

$$\ln P_j = \ln \hat{a}_4 + \ln P_w$$

In other words, the long-run rate of change of the import price in country  $j$  is equal to that of the world market price, implying a unitary long-run elasticity. However, there could be a great deal of variation in the pattern of response of import prices to changes in the world market price between different commodities. The first-order stochastic difference equation for the relationship between the import price of a geographic market  $j$  ( $P_j$ ) and the world market price  $P_w$  is given by

$$\ln P_{jt} = d_0 + d_1 \ln P_{wt} + d_2 \ln P_{w,t-1} + d_3 \ln P_{j,t-1} + v_{3t} \quad (46)$$

where the expected signs are  $d_1, d_2 > 0$ , and  $0 < d_3 < 1$ . The proportional relationship between  $P_j$  and  $P_w$  requires that  $(d_1 + d_2 + d_3) = 1$ . Transformation of the equation (46) with an ECM driven by the world market price yields the following dynamic specification:

$$\Delta \ln P_{jt} = \delta_0 + \delta_1 \Delta \ln P_{wt} + \delta_2 \ln \left( \frac{P_j}{P_w} \right)_{t-1} + v_{3t} \quad (47)$$

where  $\delta_0 = d_0$ ,  $\delta_1 = d_1$ , and  $\delta_2 = (d_3 - 1)$ . The expected signs are  $\delta_1, \delta_2 > 0$ , and  $-1 < \delta_2 < 0$ . Since the rates of change of the import price and the world market price must be the same over the long term,  $\Delta \ln P_j = g_4 = \Delta \ln P_w$ , the steady-state solution is

$$P_j = \hat{a}_4 P_w \quad (48)$$

### 6.2.2 Export supply

The specification for export supply in equation (12) in page 43 posits that the quantity of good exported from country  $i$  to country  $j$  ( $X_{ij}^x$ ) is a log-linear function of its export price  $P$  (in the currency of the exporting country  $i$ ), relative to the general price level  $D$ , as well as of the time trend  $T$  to represent secular shifts due to technological change, and of the shift variable ( $\Psi$ ) to represent major random disturbances.

Adding an additional term  $ER_i$  in (12) to represent the exchange rate of currency of the exporting country (in per unit of currency of the importing country)<sup>45</sup> results in the following export supply equation:

<sup>45</sup> Recall that in export demand equation (39) in page 84 the price of the good imported from country  $i$  to country  $j$  ( $P_{ij}$ ) is quoted in the currency of the importing country  $j$ . Thus, exchange rates are used to translate foreign prices into domestic-currency terms for the exporting countries.

$$\ln X_{ij}^s = \ln b_{ij} + \gamma \ln \left( \frac{P_{ij}^\otimes}{D_i} \right) + \phi_1 T + \phi_2 \Psi \quad (49)$$

where  $P_{ij}^\otimes = P_{ij} * ER_i$ . Accordingly, the stochastic difference equation for export supply is given by

$$\ln X_{ijt}^s = c_0 + c_1 \ln X_{ij,t-1}^s + c_2 \ln X_{ij,t-2}^s + \sum_{k=0}^n c_{3+k} \ln \left( \frac{P_{ij}^\otimes}{D_i} \right)_{t-k} + \phi_5 T + \phi_6 \Psi_{it} + v_{4t} \quad (50)$$

where the expected signs are  $c_{3+k} > 0$ ,  $\phi_5 \neq 0$  and  $\phi_6 < 0$ . If  $c_2 = 0$ , then  $0 < c_1 < 1$ ; if  $c_2 \neq 0$ , then  $0 < c_1 < 2$ ;  $-1 < c_2 < 1$ ;  $(1 - c_1 - c_2) > 0$ ; and  $(c_1)^2 \geq -4c_2$ .

To transform the stochastic difference equation so that the differences formulation of appropriate variables is nested in the levels form of the equation results in the following dynamic specification for the export supply relationship:

$$\Delta \ln X_{ijt}^s = \phi_0 + \phi_1 \ln X_{ij,t-1}^s + \phi_2 \ln X_{ij,t-2}^s + \quad (51)$$

$$\sum_{k=0}^{n-1} \phi_{3+k} \Delta \ln \left( \frac{P_{ij}^\otimes}{D_i} \right)_{t-k} + \sum_{k=0}^n \phi_{4+k} \ln \left( \frac{P_{ij}^\otimes}{D_i} \right)_{t-k} + \phi_5 T + \phi_6 \Psi_{it} + v_{4t}$$

where  $\phi_0 = c_0$ ,  $\phi_1 = (c_1 - 1)$ ,  $\phi_2 = c_2 \sum_{k=1}^n \phi_{4+k} = \sum_{k=1}^{n-2} \phi_{3+k}$  and  $\phi_{4+n} = \phi_{3+n-1} + \phi_{3+n}$ . The expected signs of the coefficients are  $\phi_{3+k} \neq 0$ ,  $\phi_{4+k} > 0$ , such that  $(\phi_{3+k} + \phi_{4+k}) > 0$ , and for the lagged dependent variables  $-1 < \phi_1 < 1$ ;  $-1 < \phi_2 < 1$ ;  $\phi_1 + \phi_2 < 0$ ; and  $(1 + \phi_1)^2 < \phi_2$ .

The identification procedure for the export supply relationship consists in determining the shape of the lag structure and finding a suitable specification of the dynamics. The relationship between export supply and export price in primary commodity trade is often characterised by long lags, since the effects of price changes usually take many years to obtain the benefits of expanded acreage (Lord 1991). Therefore, the choice of the lag structure can be of great importance.

The shape of the lag structure can be roughly estimated from the coefficients obtained when export supply,  $X^s$ , at time  $t$  is regressed on a sequence of lagged prices,  $P_t, P_{t-1}, \dots, P_{t-m}$ , for the product (Harvey 1981). The lags in the initial model are specified as the maximum to be expected in the light of technical nature of production and the evidence of previous econometric studies. For each commodity the maximum lag was set two years greater than the last response suggested by other studies.

The ECM specification is not applied for the export supply functions, since the tests for unit root and cointegration (in Tables 6 and 7) reject the presence of a unit root in real domestic export price variable ( $P_{ij}^\otimes/D_i$ ) and show no evidence of the existence of long run relationship between the volume for the exports of a country ( $X_i$ ) and the real domestic export price of a country ( $P_{ij}^\otimes/D_i$ ). In other words, the long-run equilibrium solution of export supply seems to be independent of the rate of growth of its explanatory variables, and depends solely on the level of them.

Accordingly, the long-run solution to the dynamic specification is the same as that for the static solution. The supply of export has a transient response to the rate of change of the real domestic price of exports. Since  $\Delta \ln [(P_{ij}^\otimes ER_i)/D] = 0$  implies  $\Delta \ln X_{ij} = 0$ , the long-run equilibrium of the dynamic export supply relationship has as its solution

$$0 = \phi_0 + \phi_1 \ln X_{ij}^s + \phi_2 \ln X_{ij}^s + 0 + \sum_{k=1}^n \phi_{4+k} \ln \left( \frac{P_{ij} * ER_i}{D_i} \right) + \phi_5 T + \phi_6 \Psi_i$$

Rearrangement of terms yields

$$\ln X_{ij}^s = - \left( \frac{\phi_0}{\phi_1 + \phi_2} \right) - \left( \frac{\sum_{k=1}^n \phi_{4+k}}{\phi_1 + \phi_2} \right) \ln \left( \frac{P_{ij} * ER_i}{D_{ij}} \right) - \left( \frac{\phi_5}{\phi_1 + \phi_2} \right) T - \left( \frac{\phi_6}{\phi_1 + \phi_2} \right) \Psi_i$$

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or, in terms of the original (anti-logarithmic) values of the variable,

$$X_{ij}^s = k_4 \left( \frac{P_{ij}^* ER_i}{D_i} \right)^\gamma \exp(\varphi_1 T + \varphi_2 \Psi) \quad (52)$$

where  $k_4 = \exp [-\phi_0/(\phi_1 + \phi_2)]$ ,  $\gamma = -\sum_{k=1}^n \phi_{4+k}/(\phi_1 + \phi_2) > 0$ ,  $\varphi_1 = \phi_5/(\phi_1 + \phi_2)$ , and  $\varphi_2 = \phi_6/(\phi_1 + \phi_2)$ , the expected signs being  $\gamma > 0$ ,  $\theta_1 \neq 0$ , and  $\theta_2 < 0$ .

### 6.3 Estimation procedure and diagnostic tests

The system of equations that characterises agricultural commodity trade between ASEAN and the EU is estimated in its structural form using ordinary least squares (OLS). The results provide information about the parameters of the relationships that constitute the theoretical model derived in Chapter 3. Hypothesis testing about the individual partial regression coefficients and the overall significance of the sample regression presumes, however, that the model chosen for empirical analysis is adequate in the sense that it does not violate one of more assumptions underlying the classical normal linear regression model. Therefore, the validity of the estimated models is tested using the standard diagnostic tests – the Jarque-Bera test for normality, the Durbin-Watson test for first order serial correlation and the Ljung-Box (LB) and the Lagrange multiplier (LM) test for serial correlation of higher orders. The Breuch-Pagan-Godfrey (BGP) test is computed to detect the presence of heteroskedasticity and the ARCH test for autoregressive conditional heteroskedasticity in error processes. Tests such as Durbin-Watson d statistic and Ramsey’s RESET test are used to detect equation specification errors. The Chow test for parameter constancy and recursive residuals is also computed.

The classical normal linear regression assumes that each of the regression disturbances

$u_i$  is distributed normally, i.e. they have zero expectations, are uncorrelated, and have a constant variance. This assumption may be stated as

$$u_i \sim N(0, \sigma^2)$$

where N stands for normally and independently distributed. The Jarque-Bera (JB) test of normality is an asymptotic test based on OLS residuals and uses the following test statistic:

$$JB = n \left[ \frac{S^2}{6} + \frac{(K-3)^2}{24} \right] \quad (53)$$

where S (= square of the third moment about mean/cube of the second moment about the mean) represents skewness and K (= fourth moment about the mean/square of the second moment) represents kurtosis. Under the null hypotheses that the residuals are normally distributed, Jarque and Bera (1987) have shown that asymptotically the JB statistic given in (53) follows the chi-square distribution with 2 df. If the  $p$  value of the computed chi-square statistic in an application is reasonably high, one does not reject the normality assumption. But if the  $p$  value is sufficiently low, one can reject the hypotheses that these residuals are normally distributed.

To test whether the residual autocorrelations are jointly zero, the variant of the Box-Pierce (1970) Q statistic developed by Ljung and Box (1978) is used. The LB statistic is defined as

$$LB = n(n+2) \sum_{k=1}^m \left( \frac{\hat{c}_k^2}{n-k} \right) \quad (54)$$

where  $n$  = sample size,  $m$  = lag length, and  $\hat{c}_k$  = sample autocorrelation function at lag  $k$ . Under the null hypothesis that the series is white noise, LB is asymptotically distributed as chi-squared with  $m$  degrees of freedom.

The LM test is based on an auxiliary regression, in which the residuals from the original regression are regressed on the original explan-

atory variables augmented with a specified amount of lagged variables. Under the null hypotheses, LM has a chi-squared distribution with degrees of freedom equal to number of restrictions. The LM statistic is discussed in detail in Breusch and Pagan (1980).

The Breusch-Pagan-Godfrey (BPG) test, developed by Breusch and Pagan (1979) and Godfrey (1978), is used to detect heteroskedasticity. To illustrate this test, consider the  $n$ -variable linear regression model

$$Y_i = \beta_1 + \beta_2 X_{2i} + \dots + \beta_m X_{mi} + u_i \quad (55)$$

Assume that the error variance  $\sigma_i^2$  is described as

$$\sigma_i^2 = f(\alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_m Z_{mi})$$

that is,  $\sigma_i^2$  is some function of the nonstochastic variables  $Z$ 's; some or all of the  $X$ 's can serve as  $Z$ 's. Specifically, assume that

$$\sigma_i^2 = \alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_m Z_{mi}$$

that is,  $\sigma_i^2$  is a linear function of the  $Z$ 's. If  $\alpha_2 = \alpha_3 = \dots = \alpha_m = 0$ ,  $\sigma_i^2 = \alpha_1$ , which is a constant. Therefore, to test whether  $\sigma_i^2$  is homoskedastic, one can test the hypothesis that  $\alpha_2 = \alpha_3 = \dots = \alpha_m = 0$ . This is the basic idea behind the BPG test. According to Gujarati (1995), the actual test procedure is as follows: (i) estimate (55) by OLS and obtain the residuals  $\hat{u}_1, \hat{u}_2, \dots, \hat{u}_n$ ; (ii) Obtain  $\hat{\sigma}^2 = \sum \hat{u}_i^2/n$ ; (iii) Construct variables  $p_i$  defined as  $p_i = \hat{u}_i^2/\hat{\sigma}^2$ ; (iv) regress  $p_i$  thus constructed on the  $Z$ 's as  $p_i = \alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_m Z_{mi} + v_i$ ; (v) obtain the ESS (explained sum of squares) from this regression and define  $LM = 1/2$  ESS.

Under the null hypothesis of homoskedasticity, LM is asymptotically distributed as chi-squared with (number of estimated parameters - 1) degrees of freedom. Therefore, if in an application, the computed test statistic exceeds the critical value at the chosen level of significance, one can reject the hypotheses of homoskedasticity; otherwise one does not reject it. The test is sensitive to the assumption that the

regression disturbances  $\hat{u}_i$  are normally distributed.

The autoregressive conditional heteroskedasticity (ARCH) test is based on the regression of squared residuals on lagged squared residuals. The key idea of ARCH is that the variance of regression disturbances of  $u$  at time  $t (= \sigma_t^2)$  depend on the size of the squared error term at time  $(t-1)$ , that is, on  $(u_{t-1})^2$ . More specifically, an ARCH process can be written as

$$\text{var}(u_t) = \sigma_t^2 = \alpha_0 + \alpha_1 u_t^2 + \alpha_2 u_{t-1}^2 + \dots + \alpha_p u_{t-p}^2$$

If there is no autocorrelation in the error variance, we have  $H_0: \alpha_1 = \alpha_2 = \dots = \alpha_p = 0$ , in which case  $\text{var}(u_t) = \alpha_0$ , and we have the case of homoskedastic error variance. As Engle (1982) has shown, a test of the preceding null hypotheses can be made by running the following auxiliary regression:

$$\hat{u}_t^2 = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{u}_{t-1}^2 + \hat{\alpha}_2 \hat{u}_{t-2}^2 + \dots + \hat{\alpha}_p \hat{u}_{t-p}^2 \quad (56)$$

where  $\hat{u}_i$  denote the OLS residuals estimated from the original regression model. One can test the null hypotheses  $H_0$  by the usual F test or, alternatively, by computing  $nR^2$ , where  $R^2$  is the coefficient of determination from the auxiliary regression. It can be shown that

$$nR^2 \sim X_p^2$$

that is,  $nR^2$  follows the chi-square distribution with degree of freedom equal to the number of autoregressive terms in the auxiliary regression.

The Ramsey (1969) RESET tests (Regression Specification Error Test) tests for linearity (correct functional form) is computed by augmenting the original regression with a specified number of fitted values from the original regression (are computed by running three additional regressions of the dependent variable on the independent variable, and powers of  $Y$  (the predicted dependent variable -  $Y^2, Y^3, Y^4$ ) included in the same regression). The RESET test is an F test that tests whether the coefficient on the new regressors are zero.

It is also important to test whether the model specification is externally valid when used in policy simulations or in predictions based on post-sample data. The Chow (1960) test provides a test for structural stability (parameter constancy) of the estimated regression models. It is based on the following F-test:

$$F(k, n_1 + n_2 - 2k) = \frac{(RSS - RSS1 - RSS2)/k}{(RSS1 + RSS2)/(n_1 + n_2 - 2k)} \quad (57)$$

where RSS = residual sum of squares with  $n_1 + n_2$  observations, RSS1 = the residual sum of squares with  $n_1$ , RSS2 = residual sum of squares with  $n_2$  observations,  $k$  = number of estimated parameters,  $n_1$  = number of observations in the first sub-period of the sample,  $n_2$  = number of observations in the second sub-period of the sample.

If the test statistic computed from (57) is less than the critical value, then there is no evidence for a structural break. Alternatively, if it exceeds the critical F value at the chosen level of significance, the null hypotheses of structural stability is rejected.

## 6.4 Regression results of model equations

Based on models developed in the previous section, statistical estimations are conducted and reported in this section. The first part of the section presents the results of coefficient estimates of import demand and export demand relationships and compares them with estimates by others. The second part of the section summarises the results of the estimated import supply and export supply relationships and also compares the results with those estimated by others. The equations and summary statistics are estimated using version 8.0 of SHAZAM (1997). The format used to report the results of the regression analysis is presented in Appendix D.

### 6.4.1 The demand equations

#### 6.4.1.1 The import demand

The short-run and long-run responsiveness of agricultural commodity imports to changes in incomes and own-prices in the EU are summarised in Table 9. The analysis is based on the import demand schedule derived in Chapter 3. The detailed estimation results are presented in Appendix E. Statistically the import demand models behave well and pass all the diagnostic tests. Coefficient signs and magnitudes are acceptable in terms of a priori expectations. The models also track the sizes and the directions of changes in the volume of EU agricultural imports fairly well. Considering that the equation explains the rate of changes in the import volumes, the  $R^2$  values ranging from 0.54 to 0.88 can be considered quite good.

The results for own-prices elasticities indicate that they are statistically different from zero in six out of the seven commodities, and, of these, three are significant at the 1% level, two at the 5% level, and one at the 10% level. The estimated income elasticities have the expected positive signs and are significantly different from zero at the 10% level in the equation for all commodities, excluding tea. All the coefficient of the lagged error-correction terms appear highly significant at 1-percent level. Therefore, the deviation from the equilibrium level of the import demand due to random shocks represents a significant determinant of its short-run dynamic behaviour.

To evaluate the reliability of the estimates, Tables A1–A6 in Appendix E present test results for the assumptions of normality, serial independence, and homoskedasticity in the error term of each equation. The results from the Jarque-Bera tests indicate that the data do not violate the normality assumption for any of the six import demand equations considered here. None of the Lagrange multiplier LM tests gave evidence in favour of a two- or three-year lagged variable. According to the the Ljung and Box (LB) tests for serial correlation, it is not possible to

Table 9. Short-run and long-run elasticities of import demand in the EU for selected commodities.

Commodity	Price elasticity		Income elasticity		Income growth elasticity
	Short-run	Long-run	Short-run	Long-run	
Cassava	-0.79 <sup>a</sup>	-1.86 <sup>a</sup>	-	1.91	-1.53
Cocoa	-0.14	-0.26	0.43	0.43	-1.75
Coconut oil	-0.27	-0.77	-	1.00	-1.21
Palm oil	-0.27	-0.48	0.63	0.63	-3.64
Pepper	-0.04	-0.05	0.83	0.88	-1.26
Rubber	-	-0.28	-	0.004	-3.96
Tea	-	-	-	-	-

<sup>a</sup> In case of cassava the price elasticities are not estimated using the real import price of cassava, but relative price of cassava versus alternative feed

Note: - Not significant at the 5% level

reject the assumption of serial independence for the residuals. The results from the Breusch-Pagan-Godfrey (BPG) test indicate that heteroskedasticity does not pose problem at the 5% significance level in 5 out of the 6 commodities. Similarly, based on the evidence of first order ARCH tests it is not possible to reject the assumption of homoskedastic errors in 5 out of 6 cases. The equation failing the LB and the ARCH test is the import demand equation for rubber. Therefore the models appear to be data coherent.

To examine further the reliability of the estimates, tests for the choice of dynamic specification and parameter constancy were used. On the basis of RESET test, it is not possible to reject the restrictions associated with the proposed model specification for any of import demand equations. Finally, the results associated with the Chow test indicate that it is possible to reject the hypothesis of parameter constancy at the 5% significance level for the import demand equation for cocoa. However, at the 5% level, it is not possible to reject the hypothesis of parameter constancy in any of the other import demand equations. In summary, tests for model adequacy are satisfactory.

The coefficient estimates on the own-price terms confirm the expectation that demand for commodity imports in the EU is relatively inelastic with respect to price. The price elasticities

range from from -0.04 to -0.27 in the short-run, and from -0.05 to -0.77 in the long run. The policy implication of this fact is that exchange rate policies and commercial policy intervention measures in the form of tariff and non-tariff barriers to trade would not be very effective in changing the quantity of imports demanded. The trade-weighted average long-run price elasticity of import demand across the commodities is equal to -0.50. Among the commodities listed in Table 9, coconut oil has the largest long run price elasticity ( $\cong -0.77$ ); and the remaining four have elasticities less than 0.5 in absolute terms. Pepper has the lowest long run price elasticity ( $\cong -0.05$ ).

Cassava and tea did not show the expected sign of price elasticity, though neither was statistically significant. However, in case of cassava, the relative price of cassava versus alternative feed mix is found to be very large and statistically highly significant variable explaining volumes of EU import. The results suggest that on average a 1% decrease of cassava price relative to the price of alternative feed ingredient (mainly grain), would increase the import demand for cassava by 1.86% in the long-run. Therefore, it is the EU grain policy that has a major impact on the level of cassava imports. For example, following the implementation of the reform of the EU grain policy from July 1993 (with lower cereal prices), EU imports of cassa-

va pellets fell sharply from a level of 5.7 million tons in 1992 to 2.4 million tons in 1995.

The long-run income elasticities are in a range between 0.004 for rubber and 1.9 cassava. Coconut oil is found to have a unitary elasticity with respect to income. Pepper has income elasticity close to unity, and cocoa and palm oil have elasticities significantly less than unity. The large differences in the income elasticities have implications for sales by exporters. Cassava exports have a considerably stronger growth potential in the EU than other commodities, because of a strong response of buyers in the EU to improvements in their real income. Cassava imports have been extremely sensitive to income changes.

The high income elasticity of cassava is supported by a strong demand for its use as an ingredient in compound animal feed. The level of demand for compound feeds depends on the livestock industry, and the livestock industry depends in turn on the level of demand for meat and other livestock products. The growth of the compound industry through the 1960s and early 1980s was a result of the build-up in livestock numbers over that period, associated with rising real incomes and increased demand for meat. Imports of cassava increased by 22.2% per year during 1961–1982, a higher growth rate than any other commodity covered by this study.

Overall, the results suggest that agricultural commodity imports of the EU are not very sensitive to income changes and are considered necessary goods in the sense that demand increases slower than economic activity goes up. This means a relatively weak growth potential for the selected commodities in the EU market. At the same token, imports of these commodities are not susceptible to larger swings of demand during business cycles, either. The trade-weighted average long-run income elasticity of import demand across commodities is relatively low ( $\cong 0.71$ ). The short-run income elasticity ( $\cong 0.45$ ) is substantially lower than its long run counterpart.

The findings are consistent with the earlier studies on primary commodities. Many studies showed that income is an important factor determining the import demand for primary com-

modities. Mad Nasir et al. (1988, 1993, 1994), Mohd. Yusoff (1988, 1993), Mohd. Yusoff and Salleh (1987), Honma (1991), and Lord (1991), among others, have shown the effect of income changes of the consuming countries on the demand for primary commodities.

The dynamic specification of the import demand relationship also allows us to calculate the income growth elasticities. The coefficients of the income growth elasticities in the import demand relationships are, in general, well below zero. The estimated income growth elasticities of import demand range from  $-4.0$  for rubber to  $-1.2$  for palm oil. This elasticity has the following interpretation: if the long-term rate of growth of income of the EU were to rise by 1 per cent, e.g. from 2 to 3 per cent, the level of import demand for rubber would decrease by 4.0 per cent (and for palm oil it would decrease by  $-1.2$  per cent), holding all other factors constant.

The coefficients on the error correction terms in the import demand relationships measure adjustment towards the long-run relationship between import volumes, economic activity, and prices. In case of cocoa, coconut oil and pepper, the coefficients of the error correction terms are close to unity in absolute terms. This fact reflects the relatively quick response of EU importers to changes in income and prices, i.e. it does not take a great deal of time for import demand to resume its long-term equilibrium growth path when a short-run disequilibrium arises between import demand and income. Nevertheless, importers of palm oil and rubber adjust to income and price changes relatively slowly.

#### *6.4.1.2 The export demand*

The elasticity estimates of export demand equations for the major commodity exports of ASEAN to the EU are reported in Table 10. Details of these estimates are presented in Appendix F, together with diagnostic tests of each equation. The signs and magnitudes of the estimated coefficients are broadly in line with theoretical expectations and the diagnostic test statistics are quite satisfactory. Relative prices and error correction terms are strongly significant with an



Table 10. Dynamic equilibrium solutions of export demand functions for selected commodities from ASEAN into the EU.

Commodity	Relative price elasticity of export demand		Response to changes in the level of EU import		Import growth elasticity
	Short-run	Long-run	Short-run	Long-run	
Exporter					
Cassava					
Indonesia	-1.56	-4.07	0.29	0.77	-2.49
Thailand	-	-	0.99	1.00	-0.09
Cocoa					
Indonesia	-2.29	-6.25	-	1.00	-2.43
Malaysia	-4.68	-8.46	-	1.00	-2.80
Coconut oil					
Indonesia	-6.97	-8.26	2.05	5.15	1.55
Philippines	-0.79	-2.04	1.08	1.00	0.18
Palm oil					
Indonesia	-	-1.14	0.89	1.00	0.15
Malaysia	-3.47	-5.04	1.06	1.56	0.10
Pepper					
Indonesia	-0.95	-1.13	0.29	1.00	-1.38
Malaysia	-0.70	-1.59	0.93	1.00	-0.11
Rubber					
Indonesia	-0.97	-3.70	0.87	1.00	-1.89
Malaysia	-0.47	-2.67	0.82	1.00	-2.29
Thailand	-0.92	-3.48	0.71	1.00	-0.69
Tea					
Indonesia	-1.37	-3.73	1.47	2.80	0.98

Note: - Not significant at the 5% level

adjustment coefficients ranging from -0.07 to -0.75. Furthermore, the models explain the changes in the volume of ASEAN agricultural exports to the EU rather accurately. Goodness of fits are acceptable with an  $R^2$  in a range between 0.63 and 0.96. The models also pick up quite well the turning points and rapid rises in export demand.

As with import demand equations, all tests for model adequacy yield satisfactory results. For all the 14 equations, the Ljung and Box (LB) statistic for residual autocorrelation does not reject the null hypothesis of no autocorrelation in the residuals. According to the Breusch-Pagan-Godfrey (BPG) test, heteroskedasticity does not pose problem at the 5% significance level in 11 out of 14 trade flows. The results from the ARCH test indicate that the data violates the homoske-

lasticity assumption in only one of the 14 bilateral trade flows considered here. All higher order tests are also non-significant. In some cases, the Jarque-Bera test, however, provides evidence against normality of the residuals because of extra kurtosis and a few outliers.

Based on the evidence of the RESET test, it is not possible to reject the assumption of correct functional form in 12 out of 14 cases. The equations failing the RESET test at the 5% significance level are export demand for Malaysian cocoa, as well as export demand for Indonesian palm oil. Finally, the results associated with the Chow test indicate that it is not possible to reject the hypothesis of parameter constancy in 11 out of 14 export demand equations. This implies a good out of the sample forecasting performance for most the equations.

As expected, relative price movements affect significantly the trade flows of all commodities, implying that exporter's market share has been influenced by price competitiveness. Relative prices are statistically different from zero in 13 out of the 14 trade flows, and, of these, six are significant at the 1% level, two at the 5% level, and five at the 10% level. The only exception is the export demand for cassava from Thailand, where the relative price coefficient did not result in statistically significant estimate. This is attributed to the fact that exports of Thai cassava to the EU have been restricted by voluntary export restraint. In addition, Thailand dominates the cassava trade flows to the EU, so that the own-price of Thai cassava relative to the average import price does not fluctuate enough, resulting in an insignificant relative-price coefficient.

For the combined commodity exports of the region, the trade-weighted average relative price elasticity of export demand by the EU (which is equivalent to the elasticity of substitution for market share in the EU) is equal to  $-3.2$  in the short run and  $-5.8$  in the long run. The sizes of relative price coefficients, of course, differ by commodity as well as by source of supply in each commodity. The short-run relative price elasticity of export demand range from  $-0.5$  to  $-7.0$ , and the long-run elasticity from  $-1.1$  to  $-8.5$ . In other words there is a great deal of variation in the export performance between different commodities and among individual ASEAN countries. Therefore, care should be exercised in generalisations about the price elasticities of demand for the region's commodity exports.

The observed differences in relative-price coefficients by trade flow reflect the dynamic aspect of the EU agricultural trade, in which particular trade flows rise and fall in price competition. Among the trade flows under examination, the export demand for Indonesian pepper is the least sensitive to relative price changes, followed by Indonesian palm oil exports. Pepper and palm oil exports from Indonesia have relative-price coefficients of  $-1.13$  and  $-1.14$ , respectively. In contrast, the relative-price coef-

ficients of Malaysian cocoa exports and Indonesian coconut exports are exceptionally large,  $-8.5$  and  $-8.3$ , respectively.

The rapid expansion of Malaysian cocoa bean exports to the EU in the mid 1980s, and, in turn, the sharp decrease in market share that Malaysian exporters experienced in the 1990s is attributed to the relative prices changes that took place. Malaysia increased its market share of the EU from 3% in 1983 to 17% in 1989, taking advantage of the large relative-price coefficient of export demand. However, as Malaysian total exports of cocoa beans started to decline and the relative price advantage deteriorated<sup>46</sup>, the market share decreased to less than 1% by 2000.

The sharp decrease in market share that Malaysian natural rubber exporters have experienced since the mid 1980s has also resulted from price competition among suppliers. Thailand has increased its natural rubber exports through relative price decreases, while Malaysia, which used to be the dominant supplier of rubber to the EU, has lost its market share quickly in the early 1990s due to relative price increases. According to Tengku Ariff (1998) Malaysia's strategy for the rubber industry has shifted its focus on production to marketing for rubber products, as the country's competitiveness of natural rubber has declined.

These findings, combined with the result of import price elasticities in Table 9, indicate that, although agricultural imports are relatively insensitive to price changes on a commodity basis, once the total amount to be spent for imports of a commodity is determined, then the EU importers seek cheaper products, so that price competition among suppliers is inevitable. On the other hand, the sharp contrast of relative price coefficients in the same commodity justifies the assumption that importers distinguish agricultur-

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<sup>46</sup> This can be attributed to two major reasons. First is the decline in cocoa production leading to lower exports. The other reason is an increase in the local processing of cocoa beans into cocoa powder, paste and butter, resulting in higher domestic utilisation and lower exports (Tengku Ariff 1998).

al products by place of production, even though the products are called by a common commodity name.

The adjustment of export demand from one level of foreign import demand to another is determined by the error correction term. The error correction terms for all the trade flow equations are strongly significant with an adjustment coefficients showing wide variations from  $-0.07$  to  $-0.75$ . Among the small feed back coefficients, those of rubber exports from Malaysia and Indonesia deserve attention. The estimated coefficients,  $-0.07$  and  $-0.08$ , respectively, imply a very slow adjustment towards the estimated equilibrium state. It takes 21 and 17 years, respectively, for these trade flows to adjust to 90 per cent of their new steady-state solutions.

In contrast, exports of Indonesian palm oil, coconut oil, cocoa and pepper plus Malaysian pepper, have the coefficients of the error correction terms above 0.5 in absolute terms. This fact reflects a relatively quick response of exports to changes in the level of EU imports and relative price, i.e. it does not take a great deal of time for export demand to resume its long-term equilibrium growth path when a short-run disequilibrium arises between export demand and import demand. For example, it takes only three periods for Indonesian palm oil exports to the EU to adjust to 90 per cent of its new steady-state solutions.

The estimation results also confirm the assumption that export demand for commodities from ASEAN have, in general, more or less proportional response to changes in the level of EU import. Therefore, at given relative-price levels, any increase or decrease in commodity imports by the EU would be reflected in an almost equivalent percentage change in its demand for exports from ASEAN countries. In other words, the market share of the country does not change unless relative prices change in homothetic demand.

However, if the estimated coefficient of the import response variable is significantly greater than unity, it is a good indication for an exporting country that its exports can expand more than

others and its share increase as EU market grows. Among the selected commodity trade flows, coconut oil from Indonesia and palm oil from Malaysia have clearly more than proportional response to changes in the level of EU import.

The import response coefficient of coconut oil from Indonesia, in particular, shows exceptionally large value ( $\cong 5.15$ ), reflecting a quick shift of EU's source of imports from the Philippines to Indonesia in the early 1990s, which cannot be explained solely by relative price competition. This happened partly because Indonesia surpassed the Philippines in volume of production and area devoted to coconut, and importers expected the Philippines to lose competitiveness against Indonesia.

Malaysian palm oil exports to the EU from the mid 1960s to early 1980s is another example of the more than proportional export expansion. EU importers consider Malaysian palm oil to be of higher quality, and as a result, Malaysian palm oil is priced higher than Indonesian palm oil in the world market. Malaysia became a major supplier of palm oil to the EU in the late 1960s, enjoying a market share in a range between 60–70% in the mid-1970s. However, since the mid-1980s Malaysia has lost its market share to Indonesia, after investments in the Indonesian plantations have enabled Indonesia to offer cheaper prices.

Another influence on the export demand, or market share, of an exporter is the dynamic effect originating from changes in the rate of growth of imports. The estimated import growth elasticity of export demand ranges from  $-2.80$  for Malaysian cocoa beans to 1.55 for Indonesian coconut oil. Therefore, at given import quantity and relative-price levels, a 1 per cent increase in the rate of growth of EU cocoa imports leads to a 2.8 per cent decrease in the average ratio of cocoa exports from Malaysia. On other hand, for Indonesian coconut oil, a 1 per cent increase in the rate of growth of EU coconut oil imports leads to a 1.55 per cent increase in the average ratio of coconut oil exports from Indonesia.

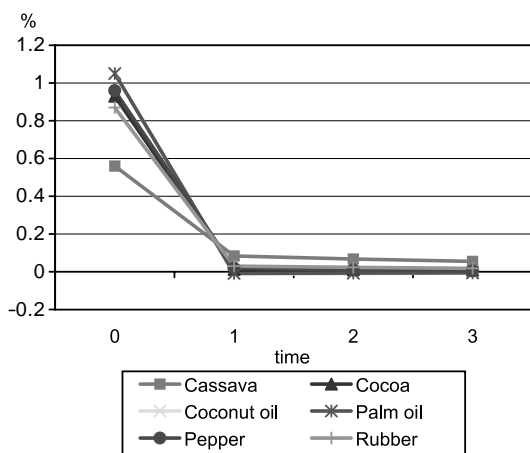


Figure 10. The pattern of response of EU import price to one-time change in world market price.

## 6.4.2 The supply functions

### 6.4.2.1 The import supply

The average lag responses of import prices to a one-time change in the world market price of each commodity are presented in Figure 10 and Table 11. These results are based on coefficient estimates of the import price relationship, which in all cases are significant at the 1 per cent level. The models as a whole appear to fit the data very well, as evidenced by high  $R^2$  and t-values.

The various diagnostic checks are not significant and the residuals obtained do not show ev-

idence of serial correlation, ARCH effects, non-normality, heteroskedasticity or non-linearity. Furthermore, the tests for stability of coefficients do not reject the null hypotheses of parameter constancy in any of the estimated relationships. The detailed estimation results are presented in Appendix G.

The pattern of the response of import prices to changes in the world markets price is generally characterised by a dampened smooth response. After an initial impact on import prices, a change in the world market price quickly becomes ineffective. The findings of the regression analysis demonstrates that more than three-quarters of the price adjustments in the commodities examined here occurs usually within the same period as changes in world prices of those commodities. The fastest adjustments of EU import prices to world market price changes take place in coconut oil, the slowest adjustment occur in cassava. Rapid adjustment process of individual commodity prices to the equilibrium relationship in international markets has also been recorded by Vataja (1996).

### 6.4.2.2 The export supply

As with export demand, each of the export supply relationships has been estimated by OLS for each 14 commodity-country combination of interest. The full set of regression estimates are presented in Appendix H. Table 12 summarises the estimated elasticities derived using the composite price and exchange rate variable specifi-

Table 11. Estimated coefficient of import supply equations and lag response of EU import prices to a one-time change in world market price.

Commodity	Estimated coefficients		Number of periods for % of response		
	Short-run world price elasticity	Error-correction term	50%	75%	99%
Cassava	0.56	-0.19	0	3	18
Cocoa	0.93	-0.17	0	0	11
Coconut oil	1.05	-0.25	0	0	0
Palm oil	1.05	-0.17	0	0	0
Pepper	0.96	-0.50	0	0	2
Rubber	0.87	-0.23	0	0	2

Table 12. Export supply response to price change for selected commodities exported from ASEAN into the EU.

Commodity	Price elasticity of export supply		Number of periods for % response		
	Short-run <sup>a</sup>	Long-run	75%	90%	99%
Cassava					
Indonesia	1.65	4.03	2	4	8
Thailand	0.95	0.95	0	0	0
Cocoa					
Indonesia	0.53 (n = 3)	0.35	0	0	0
Malaysia	0.95 (n = 3)	4.59	8	11	19
Coconut oil					
Indonesia	0.47 (n = 1)	0.70	6	6	7
Philippines	0.97	2.07	1	2	4
Palm oil					
Indonesia	0.16	0.18	0	1	2
Malaysia	0.37	0.96	2	7	9
Pepper					
Indonesia	0.08 (n = 2)	0.11	3	3	5
Malaysia	0.11 (n = 2)	0.15	3	3	5
Rubber					
Indonesia	0.14	1.28	19	29	38
Malaysia	0.29	0.95	14	23	37
Thailand	0.68	0.52	0	0	0
Tea					
Indonesia	0.05 (n = 1)	0.24	6	10	20

<sup>a</sup> The short-run price elasticity measures the response of exports to a change in prices within the same year as the changes occur. If there is a delay in the adjustment, the notation in parentheses indicate the year in which exports first respond to a change in price.

cation<sup>47</sup>. The signs and magnitudes of the estimated coefficients, at least those statistically significant, are broadly in line with theoretical expectations. The results also indicate satisfactory statistical fit as judged by the adjusted R<sup>2</sup>s.

The Ljung and Box (LB) statistic for residual autocorrelation does not reject the null hypothesis of no autocorrelation in the residuals for any of the 14 equations. None of the Lagrange multiplier LM tests gave evidence in favour of a two- or three-year lagged variable. Based on the evidence of the Breusch-Pagan-Godfrey (BPG) and

ARCH tests, heteroskedasticity does not pose any problem in 13 out of 14 supply relationships. It should be noted, however, that these test are sensitive to the assumption that the regression disturbances  $u_t$  are normally distributed. The Jarque-Bera test provides evidence against normality of the residuals in 5 cases, of which two are significant at the 1% significance level, and three at the 5% level.

According to the RESET test, it is not possible to reject the assumption of correct functional form in 12 out of 14 cases. The two equations failing the RESET test at the 5% significance level are export supply of Indonesian coconut, and export supply of Malaysian pepper. The tests also indicate a rather good out-of-the sample forecasting, except for the three relationships which fails the Chow test for structural stability.

<sup>47</sup> When variables representing exchange rates and prices are included separately as regressors, the econometric results are somewhat weaker and include more negatively signed coefficients (particularly for the price variable for perennials).

The models can therefore be accepted as an adequate representation of the export supply relationships.

Two statistics are central to the characterisation of the export supply relationship. The first is the price elasticity, which indicates the relative influence of relevant price and non-price factors and associated policies in stimulating the supply of exports. The other is the lag structure, which determines how fast exporters respond to changes in conditions prevailing in their markets. The lag distribution (the shape and length of the lag) in export supply is very critical, since the effects of price changes usually take a long time to work themselves through and since the transmission of the price effects can be complex.

The lag structure in many instances reflects the special characteristics of the commodity in question, though lag distributions differ not only among commodities, but also exporters of the same commodity. For commodity markets, the lag structure determines the speed and manner in which adjustments from one steady-state solution to another take place; for individual producing countries it determines how the amount exported will be allocated over time (Lord 1991). The lag coefficients, which determine the way in which export supply will respond to a change in price, are derived from solved coefficients of the export supply equation.

The results show that export supply is inelastic with respect to price in the short run for nearly all the commodity-country combinations considered (Table 12). The short-term price responsiveness of export supply is closely associated with the interval between planting decision and harvesting in agricultural commodities. For example, in the case of cocoa, the coefficient estimates for the distributed lags of real price follow the expected patterns that are consistent with the typical age-yield profile of the cocoa tree. The results indicate that coefficient of current price is positive, but not significant explaining the export supply of cocoa. Only prices lagged three to four years influence significantly export supply of cocoa. The coefficients for prices lagged one and two periods are negative.

This effect can be explained in terms of the time lag between planting decision and harvesting. The decision to invest in planting cocoa is determined by the price which is expected to prevail during the fruit bearing age. Since cocoa starts bearing at the age of about three years, the prices lagged three years were therefore expected to be positive (Mad Nasir et al. 1993).

Production of palm oil as a perennial is also characterised by a long lag between planting and harvesting, lengthy response to technological and seasonal changes. The price coefficients have negative values from one to three lagged periods and show positive values on current and lagged four to seven periods. The current price which represents the harvesting decision is as expected an important factor in palm oil export supply. The impact of the price at lagged four, five and six periods are positive, but not significant at 5% level. The positive values of the prices lagged five and six period again reflect the time period in which producers decide to invest in palm oil production in response to price changes.

The other perennial crops – coconut oil and rubber – have also rather low short-run elasticities because of the long lead time period (four to six years) between the planting response to a price change and the production. Thus once the trees are planted, they become a fixed investment and as long as the market price is above the average variable cost, the trees will be harvested. Exports of commodities like cocoa, coconut oil, palm oil, and rubber may be increased in the short run only by an expansion of output arising from yields or the release of stocks (Lord 1991).

Pepper exporters also take quite a long time (two to three years) to respond to price changes. The coefficient of price lagged two years was found to be positive and significant in both of pepper trade flows. The effect of price lagged from two to five years were expected to be positive, since pepper starts bearing fruits at age of two or three years and reaching a peak in the fourth or fifth year.

In contrast, ASEAN cassava exporters are very sensitive to short term price changes that

occur in their market as the possibilities for adjustment of production to prices are greater than with tree crops. Indonesian cassava exporters respond price changes very fast, having a short-run price elasticity of 1.65. There are plenty of attributes, which explains cassava being sensitive to price changes in the short run. Cassava is easily propagated, planted and harvested, it is relatively inexpensive to produce, and it does not have a critical planting or harvesting time, hence it not season-bound. Furthermore, the possibility of leaving mature roots in the ground for up to 2 years until harvesting without any serious deterioration, provides room to react price changes quite flexibly.

The long-run average price elasticity of export supply, which is calculated as the sum of lag coefficients, varies widely for 14 country-commodity combinations under examination. For the combined commodity exports of the region, the trade-weighted average long-run price elasticity of export supply in the region is equal to 0.9. Cassava exporters from Indonesia and cocoa exporters from Malaysia are the most sensitive to price changes in the long run.

The exceptionally high long-run price coefficient ( $\approx 4.6$ ) for Malaysian cocoa exports was not expected. Earlier studies on export supply of cocoa have suggested the price elasticity to be in a range between 0.2 and 0.4 (Behrman 1968, Lord 1991). The large coefficient could be attributed to attractive real prices in the 1970s and 1980s that accelerated the development of Malaysian cocoa industry. As a result, cocoa became one of the important export commodities, providing a more diversified stream of foreign exchange earning for Malaysia (Mad Nasir et al. 1993). Prior to 1970 cocoa was not important to Malaysia's economy. As the cocoa prices started to decline in the early 1990s, Malaysian exports experience a sharp decrease.

However, a number of commodity trade flows examined in the study have poor response to price changes even in the long run, i.e. export supply increases less than 0.5% when real prices goes up by 1%. They include pepper exports from Indonesia and Malaysia, palm oil exports

from Malaysia, tea exports from Indonesia, and cocoa exports from Indonesia. The low elasticities mean a relatively weak growth potential for these commodities in the ASEAN countries. At the same token, these trade flows are not susceptible to larger swings during business cycles, either. The real price coefficient of export supply for Indonesian pepper shows the smallest value ( $\approx 0.1$ ) among the trade flows in the study.

The low price elasticity of supply of agricultural commodities has been recorded in many studies covering a wide range of commodities (Behrman 1968, Bateman 1965, Wickens and Greenfield 1973, Hwa 1981, Mohd. Yusoff 1988 and 1993, Abdul Rahman 1994). Inelastic supply is very common particularly for perennial crops because once the trees are planted, they become fixed investment.

The findings are, therefore, similar with the studies on agricultural commodity supply, though it should be noted that the estimated elasticities for export supply cannot be directly compared with estimated elasticities production of the same commodities. The reason is that world agricultural trade has grown at a much faster rate than world agricultural output, as economies have become more open. Consequently, changes in export supply associated with changes in market prices of commodities have been greater than changes in output associated with the same price changes (Lord 1991).

The appropriate comparison is with other elasticity estimates of export supply. Unfortunately, there are far fewer estimates of export supply relationships than there are of export demand relationships. Overall, the results suggest that export supply of commodities from the ASEAN region is generally responsive to price movement, but this price responsiveness varies considerably among commodity-country combination of the region. Consequently, export incentive policies would tend to work in these countries, though the degree of their effectiveness would vary considerably across commodities and countries.

## 6.5 Summary

This chapter has dealt with the dynamic specification and estimation of the demand and supply relationships in the system of equations used to characterise commodity exports from ASEAN to the EU. The empirical results indicate that the model specifications provide a good representation of the data-generating process for agricultural commodity flows from ASEAN countries to the EU. A major decision in the model specification has been the choice of lag length, which in many instances reflects the special characteristics of different commodities. On the demand side, the dynamics are of a relatively small order, and have been conveniently restricted to cases where the lagged values of the variables are of one period. Therefore, for the demand relationships, the error correction mechanism has offered a particularly appropriate means which to characterise the data-generating processes within equations. It has also been used in the relationships for import prices, where the long run rate of change of these prices must be proportional to that of the world market price for the commodity. On the export supply side, a special attention has been given to the natural lags involved in developing new production. Since the nature of the response to price changes is central to the dynamic specification of the export supply relationships, the stochastic difference

equation framework has provided a convenient means by which to move from a general to a specific lag structure.

The import demand analysis of the study suggest that income effects play a dominant role in determining EU's import demand both in the short and the long run, though with a low elasticity. Examination of the price elasticities confirm the expectation that demand for commodity imports in the EU is relatively inelastic with respect to price. The estimations of the export demand relationships indicate that relative price movements affect significantly the trade flows of all commodities, implying that exporter's market share is influenced by price competitiveness. Another influence on the export demand of an exporter is the dynamic effect originating from changes in the rate of growth of imports.

The estimation of import supply function, which examines the response of EU import prices to changes in the world market price of a commodity, demonstrates that more than three-quarters of the price adjustments in the commodities examined here occurs usually within the same period as changes in world prices of those commodities. Export supply of ASEAN agricultural commodities to the EU is found to be generally responsive to price movement. This responsiveness depends greatly on the commodity – tree crop of course respond more slowly than field crops – but it depends also on the exporting country.

## 7 Model simulations: The effects of alternative trade policies on the trade flows between ASEAN and the EU

The purpose of this chapter is to illustrate how the set of dynamic econometric models developed in the preceding chapters can be used to analyse the effects of changes in economic environment and trade policies on agricultural commodity trade between ASEAN and the EU. To

accomplish this task, several simulation analyses are performed to compare the results of a number of alternative policy scenarios. More specifically, the chapter presents the empirical findings of the effects of the removal of import barriers, the imposition of subsidies or taxes on



commodity exports as well as the effects of exchange rate adjustments on ASEAN agricultural exports to the EU. In accordance with the data sample selected in chapter 5, the commodities examined are those that represent the most important agricultural exports of ASEAN.

For any policy analysis, a baseline scenario is required as a reference for evaluating the effects of policy changes. The baseline scenario described in this chapter is basically a “no change in policies” scenario. Past policy regimes, as embodied in the price transmission regressions, are continued in this scenario. The primary role of the reference run is to serve as a “neutral” point of departure, so to speak, from which policy scenarios take off as variants, with the impacts of a policy being seen in the deviation of that policy run from the reference run. In other words, using the estimated models, evaluation of the impact of trade policy changes will be carried out by comparing the results of a number of policy scenarios to a baseline scenario.

It should also be kept in mind that the results here are derived from a partial equilibrium model and are of course dependent on the various parameter values estimated. Changes in the parameter values used in the models would of course change the magnitude of the estimates presented above, but within feasible ranges the would unlikely to change the basic thrust of the results.

## 7.1 The impact of tariff reductions on trade volume and price level

Since the Common Agricultural Policy (CAP) of the EU is regarded as a policy that distorts global agricultural trade quite significantly, it is of interest to see what would happen to the EU agricultural commodity imports from ASEAN if the EU removes its import protection. Recall equa-

tion (15) in page 47, which shows that the effect of a tariff depend on the price elasticity of import demand,  $\epsilon_m^p$ , and the tariff-equivalent rate,  $t$ , in the importing country. In addition feedback effects can occur between domestic prices and the world market price of a commodity when tariff removal take place either in a large importing country or in several countries at the same time. These effects would influence production and consumption decisions in both exporting and importing countries.

The empirical findings presented here are analysed without the feedback effects between domestic prices and the world market price. The analysis simply examines the effects of a unilateral tariff removal by the EU on its agricultural commodity imports from ASEAN. Of interest are both the short-run effects and the long-run effects after the full adjustment has taken place. The first can be obtained using the short-run elasticity of import demand. The second is derived using the long-run static equilibrium. Econometrically estimated parameter values from chapter 6 are used as the reference run. The base tariffs are given in Table 3 (page 28).

The effects of tariff reductions to zero are summarised in Table 13, from which a number of points can be made. The reduction of tariffs would have a price-decreasing effect on the EU market. As a result, an increase in EU imports would take place. The effects of a change in imports tariffs on import volumes are relatively small, however. This is explained by the estimation results in Chapter 6. Commodity imports in the EU was found to be relatively inelastic with respect to price. The estimated increases in import volumes range from 0.1 to 6.0 in the short-run, and from 0.2 to 8.4 in the long run.

As expected, the largest percentage increase in import volumes is shown by cassava, which is a close substitute for grain produced in the EU. The EU would increase its cassava imports by 8.4%, i.e. 640,000 mill tonnes, of which 80% represents additional export quantities sold by Thailand and 7% by Indonesia. The case is similar in coconut oil products where the EU would increase its imports by 8.3%. EU imports of

Table 13. Percentage changes in prices and volumes imported into the EU due to a unilateral trade liberalisation by the EU for selected commodities.

Commodity	Import price	Import volume		Number of period for % response		
		Initial effect	Long-term effect	75%	90%	99%
Cassava	-5.7	5.96	8.39	1	2	6
Cocoa	-2.9	0.42	0.79	1	1	2
Coconut oil	-9.9	2.85	8.34	1	2	3
Palm oil	-10.7	3.15	5.63	2	4	10
Rubber	-2.9	0.00	0.84	4	6	11
Pepper	-3.1	0.12	0.15	0	1	2

palm oil would increase by 5.6%. Indonesia supplies forty-five percent of this additional import. All other commodities show much smaller changes. The low price and income elasticities of the EU result in small changes in import volumes.

Since tariffs take several years to exercise their full impact on import demand, the effect would continue past the time when the tariff removal has taken place. The findings of the analysis demonstrates the extent of this time lag between the initial reduction in import prices after tariff removal and the time required for imports to adjust fully to the new price level in the market area (Figure 11). Imports of cocoa, coconut oil, and pepper respond relatively quickly to

changes in prices. In case of pepper, 75 per cent of the import level adjustments occur in the same year in which tariff changes occur, and 99 per cent of the adjustments occur within two years of a change in tariff. The case is similar for cocoa and coconut oil, where it also takes only one period to adjust to 90 per cent of the new steady state solution. However, imports of palm oil and rubber adjust to price changes slower, a characteristic that is reflected in lower coefficient of the error-correcting term. More specifically, it takes four periods for palm oil imports of the EU, and six periods for rubber imports of the EU to adjust to 90 per cent of their new steady-state solutions.

The effects of tariff removal on the level of EU imports from an individual ASEAN country are proportional to the change in the total imports for most of the commodities under examination. When relative prices remain unchanged, the change in export demand is proportional to the change in import demand in the geographic market (see equation (16) in page 47). Since relative price would be unaffected by the tariff removal, the market shares of the ASEAN countries and other exporters in the EU would remain unaltered. Only in two out of 14 cases export demand is not proportional to the change in import demand in the EU. Among the trade flows examined, coconut oil exports from Indonesia and palm oil exports from Malaysia have more than proportional response to changes in the level of EU import.

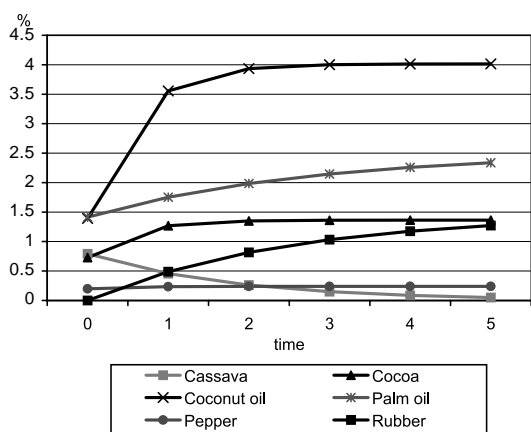


Figure 11. The pattern of EU import response to a 5% change in tariff for selected commodities.

## 7.2 Export subsidy or export tax impacts on trade volume and price level

There is widespread perception that export promotion policies (e.g. subsidies of various types that lower unit costs of exports) have significantly influenced growth of agricultural commodity exports from the developed countries. In recent years, many less developed countries have switched their development strategies from import substitution to export promotion. Empirical evidence regarding the effectiveness and costs of these export promotion policies is limited, however. In this subsection, the estimated models are used to measure the impacts of an export subsidy as well as an export tax on the volume and equilibrium prices of ASEAN agricultural exports to the EU. It is assumed here that the policies of the ASEAN countries are formulated independently from one another. In other words, the strategic policy alternatives for ASEAN countries are considered against the background of non-cooperative games involving a large number of countries exporting differentiated products.

The applied approach allows consideration of trade policies aimed at expanding exports without fear of retaliation by the competing exporters. A market structure of this type is appropriate for the analysis of trade in most commodities, since there are usually a number of countries that export a given commodity and the actions of those countries have a negligible effect on the world market. The exporting countries can none the less exert some influence on the price of their exports.

The first simulation exercise to consider is, therefore, the impacts of the export subsidies. Export subsidies occur when the government gives an exporter a direct per-unit payment on the volume of goods cleared for foreign destinations. As discussed previously in section 4.2.1 (pages 49–51), an export subsidy is an appropriate instrument, when the desired target is higher

level of exports (i.e. higher level of market share). An increase in the subsidy will generate both greater exports and higher export revenues, provided the price elasticity of export demand for the commodity trade flow in question is greater than unity. Foreign exchange earnings expand because of the subsidy-enhanced per-unit value of output and larger export volumes. However, if the price elasticity of export demand is less than unity, an increase in the subsidy will only generate greater exports, but lower foreign exchange earnings.

Calculations of the effects of export subsidy rate changes in the estimated commodity trade flows are based on a common set of target rates for exports. The calculations implicitly assume that the growth of exports attained by the export subsidy is socially desired – an issue not addressed in the calculations. The target rate for export volume is established here at 5 per cent higher than in the reference run. Each country is assumed to establish its export quantity in accordance with Brander and Spencer's approach, but without strategic interactions between exporters. Thus a unilateral export subsidy is offered by the government to the export industry as shown in equation (19) in page 53. Although this exercise is relatively simple, it provides insights into the options available to countries in formulating their export policies.

Table 14 presents the results of the exercise. Column 2 offers estimates of the percentage point changes needed in the export subsidy rate in order to reach the target rate in export volume. Next, columns 3 through 7 shows the effects of this subsidy rate change on export price, export revenues, and market share. The impacts on foreign exchange earnings are compared with the budgetary costs, which constitutes a lower bound for the cost of the subsidy. A number of points can be raised from the results.

First, the results reveal considerable variations in the amount of subsidy required to achieve the target rate of exports. The more perfectly competitive the export market, the smaller the price decrease and the greater the foreign exchange earnings from the export subsidy. Thus,

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Table 14. Percentage changes in export subsidy rate, export price, export revenues, and market share due to the export subsidy required to achieve 5 per cent increase in export volume.

Commodity Exporter	Change in export subsidy rate	Change in export price	Change in export revenues		Initial market share <sup>c</sup>	Market share after
			(1) <sup>a</sup>	(2) <sup>b</sup>		
Cassava						
Indonesia	4.8	-3.4	1.5	-3.7	7.6	8.0
Thailand	0.0	0.0	0.0	0.0	77.3	77.3
Cocoa						
Indonesia	16.3	-0.8	4.2	-13.9	2.9	3.0
Malaysia	1.7	-0.6	4.4	2.5	3.8	4.0
Coconut oil						
Indonesia	8.2	-0.6	4.4	-4.7	22.5	23.6
Philippines	4.7	-2.4	2.5	-3.0	58.8	61.8
Palm oil						
Indonesia	36.7	-4.2	0.6	-40.4	37.0	38.8
Malaysia	7.1	-1.0	4.0	-3.9	32.8	34.4
Pepper						
Indonesia	63.3	-4.2	0.6	-69.9	30.1	31.6
Malaysia	43.3	-3.0	1.8	-44.6	10.4	11.0
Rubber						
Indonesia	5.3	-1.3	3.6	-2.4	11.8	12.4
Malaysia	7.2	-1.8	3.1	-5.1	41.2	43.3
Thailand	11.7	-1.4	3.5	-9.6	11.9	12.5
Tea						
Indonesia	25.6	-1.9	3.0	-25.5	6.5	6.8

The subsidy rate equals the amount of subsidy divided by the export price of the product. For comparative purposes, it is assumed that there is a uniform initial subsidy rate equal to 5%.

<sup>a</sup> Change in exporting country's foreign exchange earnings.

<sup>b</sup> Change in exporting country's export revenues (foreign exchange earnings – export subsidy budgetary expenditures).

<sup>c</sup> Weighted average of market shares of the exporting country.

in those commodity trade flows that have more price-elastic export demand function, a 5 per cent higher export volume is accompanied by a smaller reduction in export prices and, therefore, greater increases in foreign exchange earnings. In contrast, for those commodity trade flows that have less price-elastic export demand functions, it takes a greater reduction in export prices to achieve the target volume in exports.

For example, cocoa exporters from Malaysia and coconut oil exporters from Indonesia would experience price cuts of only about 0.6 per cent to achieve a 5 per cent higher export volume. At the same token, the subsidy change would increase foreign exchange earnings of Malaysian

cocoa exporters and Indonesian coconut oil exporters by about 4.4%. On the other hand, in case of Indonesian palm oil and pepper exports, a 5 per cent expansion in export volumes is accompanied by over 4 per cent fall in export prices and only about 0.6% increase in foreign exchange earnings.

Export promotion activities financed with public funds naturally attempt to shift the excess demand for a nation's exports outward sufficiently far enough to generate significant increases in export volume and foreign exchange earnings. The direct costs of the export subsidy program should, therefore, be compared to the gains in foreign exchange earnings. Column 4

in Table 14 shows that the export subsidy expenditures tend to be much higher than the gains in foreign exchange earnings received by exporters. This means that as a result of the subsidy increase countries would spend more money on export subsidies than what they would gain in foreign exchange earnings.

The steeper the export demand and supply functions of the commodity trade flow, the greater the exporting country's revenue loss as a result of export subsidy increase. In the case of Indonesian pepper exports, a 5 per cent expansion in export volumes is accompanied by about 70 per cent fall in country's net export revenues. Only in the case of Malaysian cocoa exports, where both export demand functions as well export supply functions are highly elastic, the exporting country could obtain foreign exchange earnings sufficient to offset the export subsidy expenditures – and have something left over.

It should also be considered that export demand generally takes several periods to adjust to the export subsidy change. Exports of Indonesian palm oil, coconut oil, cocoa and pepper plus Malaysian pepper adjust to export subsidy changes relatively quickly. It takes only three periods for Indonesian palm oil exports to the EU to adjust to 90 per cent of the new steady state solution. However, rubber exports from Indonesia and Malaysia adjust to subsidy changes slowly, a characteristic that is reflected in near-zero coefficient of the error-correcting term. It takes 21 and 17 periods, respectively, for these trade flows to adjust to 90 per cent of their new steady-state solutions.

The next exercise is concerned with the effects of an export tax on price and quantity of ASEAN agricultural exports to the EU [see equation (20) in page 56]. As with the export subsidy simulations, the exercise assume that the policies of the ASEAN countries are formulated independently from one another. This assumption, in turn, limits the analysis to unilateral government incentives to tax exports.

Export taxes are levied by governments for two main reasons. One is to deliberately depress domestic prices to protect internal buyers or con-

sumers of the exported product from having to pay higher international prices. The other reason is to generate revenue for the central authority. Both effects occur when an export tax is levied, but usually one is the dominant motive. If a given total revenue is to be raised from export taxes, the optimum revenue-tax structure is non-uniform. Recall discussion in section 4.2.3 (pages 55–56), this will involve high rates of tax on trade flows where elasticities of export demand and export supply are low and low rates on trade flows where those elasticities are high- so that little distortion is caused by the tax.

In the case of commodity trade flows with price-inelastic export demand and export supply functions, export tax is an appropriate instrument to use in order obtain higher export revenues, as shown in chapter 4.2.3. It is even possible that the additional export revenues (foreign exchange earnings + export tax revenues) generated by pressing up the export price can be made large enough to offset the welfare losses. The more inelastic export demand and export supply functions are, the more likely is that such an export tax policy can be pursued.

Yet, the estimation results in the previous chapter suggest that all the commodity trade flows under examination have price-elastic export demand functions. Therefore, it is plain that export tax increase for the commodity trade flows under study will reduce the export revenues of the exporting countries. Turning to Table 15, where the percentage changes in export price, export volume, export revenues and market share due to the 10 percentage point increase in export tax are given, these expectations are confirmed. The increase in export tax presses the export price up as export volumes and export revenues fall. The steeper the export supply function of the commodity trade flow, the smaller the export revenue loss as a result of the tax.

For example, pepper exporters from Indonesia would experience export revenue loss less than –0.1 per cent due to the 10 percentage point increase in export tax to. At the same token, the export volumes would decrease only about 1 per cent. On the other hand, in case of Malaysian

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Table 15. Percentage changes in export price, export volume, export revenues and market share due to the 10 percentage point increase in export tax rate.

Commodity Exporter	Change in export price	Change in export volume	Change in export revenues		Initial market share <sup>c</sup>	Market share after
			(1) <sup>a</sup>	(2) <sup>b</sup>		
<b>Cassava</b>						
Indonesia	7.7	-10.1	-11.9	-3.1	7.6	6.9
Thailand	0.0	0.0	0.0	0.0	77.3	77.3
<b>Cocoa</b>						
Indonesia	0.6	-3.6	-13.1	-3.0	2.9	2.8
Malaysia	3.8	-27.0	-31.6	-24.2	3.8	2.8
<b>Coconut oil</b>						
Indonesia	0.9	-6.8	-15.7	-6.0	22.5	20.9
Philippines	5.4	-10.1	-14.2	-5.3	58.8	52.9
<b>Palm oil</b>						
Indonesia	1.5	-1.7	-10.4	-0.2	37.0	36.4
Malaysia	1.6	-7.7	-15.8	-6.2	32.8	30.3
<b>Pepper</b>						
Indonesia	1.0	-1.1	-10.4	-0.1	30.1	29.8
Malaysia	0.9	-1.5	-10.8	-0.6	10.4	10.3
<b>Rubber</b>						
Indonesia	2.8	-9.7	-16.4	-7.2	11.8	10.6
Malaysia	2.9	-7.3	-14.1	-4.6	41.2	38.2
Thailand	1.4	-4.8	-13.3	-3.4	11.9	11.3
<b>Tea</b>						
Indonesia	1.0	-2.4	-11.6	-1.4	6.5	6.3

The export tax rate equals the amount of tax divided by the export price of the product. For comparative purposes, it is assumed that there is a uniform initial export tax rate equal to 5%.

<sup>a</sup> Change in country's foreign exchange earnings.

<sup>b</sup> Change in country's export revenues (foreign exchange earnings + export tax revenues).

<sup>c</sup> Weighted average of market shares of the exporting country.

cocoa exports, a 10 percentage point increase in export tax is accompanied by more than 24 per cent fall in export revenues and about 27 per cent decrease in export volumes.

## 7.3 The effects of exchange rate changes on trade volume and price level

Considerable evidence exists that exchange rate changes have a strong effect on agricultural out-

put as well as agricultural exports in developing economies (Jaeger and Humphreys 1988, Krueger et al. 1988, Elbadawi 1992, Ghura and Grennes 1993). Real exchange rate depreciation achieved through nominal exchange rate adjustment has thus been the most common and substantial corrective introduced in structural adjustment programs over the past decades (Barrett 1999). Exchange rate depreciation, which has expansionary effects for agriculture, is also frequently suggested as a way to compensate for a reduction in export subsidies. The issue is of considerable importance given contemporary emphasis on both macroeconomic adjustment and agricultural development in low-income economies.

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Table 16. Percentage changes in export price, export volume, foreign exchange earnings, and market share due to a 10% exchange rate depreciation.

Commodity Exporter	Change in export price (%)	Change in export volume (%)	Change in foreign exchange earnings (%)	Initial market share <sup>a</sup> (%)	Market share after 5 years (%)
Cassava					
Indonesia	-7.7	12.0	3.5	7.6	8.5
Thailand	-	-	-	-	-
Cocoa					
Indonesia	-0.6	3.6	3.0	2.9	3.0
Malaysia	-3.7	37.5	32.4	3.8	5.3
Coconut oil					
Indonesia	-0.8	7.0	6.1	22.5	24.1
Philippines	-5.3	11.6	5.8	58.8	65.7
Palm oil					
Indonesia	-1.4	1.7	0.2	37.0	37.6
Malaysia	-1.5	8.1	6.4	32.8	35.4
Pepper					
Indonesia	-0.9	1.1	0.1	30.1	30.5
Malaysia	-0.9	1.5	0.5	10.4	10.6
Rubber					
Indonesia	-2.7	10.7	7.7	11.8	13.0
Malaysia	-2.8	7.8	4.8	41.2	44.4
Thailand	-1.4	4.9	3.5	11.9	12.5
Tea					
Indonesia	-0.9	2.3	1.4	6.5	6.6

The exchange rate depreciation is defined here as a 10% fall in the exporting country's currency against the euro (the importing country's currency).

<sup>a</sup> Weighted average of market shares of the exporting country.

In relation to the above, it is interesting and worthwhile to quantify how changes in the exchange rate affect the volume and prices of ASEAN agricultural exports to the EU. The impact assessment exercise in Table 16 is based on a 10% exchange rate depreciation of the ASEAN currencies against the euro. The results reveal considerable variations in the amount of extra volumes of exports and foreign exchange earnings generated by a 10% currency devaluation. As with export subsidy impacts, the exchange rate depreciation will generate both greater exports and higher export revenues, provided the price elasticity of export demand for the commodity trade flow in question is greater than uni-

ty. In contrast, for the commodity trade flows that have price-inelastic export demand functions, currency depreciation will only generate greater exports, but lower foreign exchange earnings.

Thus, in those commodity trade flows that have more price-elastic export demand function, a 10% currency depreciation is accompanied by a smaller reduction in export prices and, therefore, greater increases in foreign exchange earnings. Furthermore, the more elastic is the export supply function of the commodity trade flow, the greater are the foreign exchange earnings from the currency devaluation.

Summarising, one may thus note that the more elastic both export demand and export sup-

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Table 17. Percentage changes in exchange rate, export price, export revenues, and market share due to the exchange rate change required to achieve 5 per cent increase in export volume.

Commodity Exporter	Change in exchange rate <sup>a</sup>	Change in export price <sup>b</sup>		Change in export revenues <sup>c</sup>	
		(1)	(2)	(1)	(2)
Cassava					
Indonesia	4.4	-3.4	1.0	1.5	6.1
Thailand	-	-	-	-	-
Cocoa					
Indonesia	13.6	-0.8	14.8	4.2	20.5
Malaysia	1.6	-0.6	1.0	4.4	6.1
Coconut oil					
Indonesia	7.3	-0.6	7.2	4.4	12.6
Philippines	4.6	-2.4	2.3	2.5	7.4
Palm oil					
Indonesia	26.9	-4.2	31.0	0.6	37.6
Malaysia	6.4	-1.0	5.8	4.0	11.1
Pepper					
Indonesia	38.7	-4.2	0.6	0.6	30.1
Malaysia	29.9	-3.0	1.8	1.8	10.4
Rubber					
Indonesia	5.0	-1.3	3.8	3.6	9.0
Malaysia	6.6	-1.8	5.2	3.1	10.4
Thailand	10.2	-1.4	9.8	3.5	15.3
Tea					
Indonesia	20.0	-1.9	22.6	3.0	28.7

<sup>a</sup> The change in exchange rate is defined as the percentage decrease in the currency of the exporting country against the euro (the currency of the importing country).

<sup>b</sup> Change in export price is calculated in two ways; (1) in terms of the euro, the importing country's currency, and (2) in terms of the exporting country's currency.

<sup>c</sup> Change in exporting country's export revenues is calculated in two ways; (1) in terms of the euro, the importing country's currency, and (2) in terms of the exporting country's currency.

ply functions, the greater the foreign exchange earnings from the currency depreciation. In the case of Malaysian cocoa exports, a 10% currency devaluation is accompanied by over 37% increase in export volumes and over 32 per cent increase in country's foreign exchange earnings. On the other hand, in case of Indonesian pepper exports, a 10 per cent currency devaluation is accompanied by only 1.1% increase in export volume and only about 0.1% increase in foreign exchange earnings.

Since exchange rate depreciation is often prescribed as a substitute for export subsidy, it is interesting to calculate the depreciation required

to achieve the 5% target growth in exports, and to assess the trade-off between export subsidy and exchange rate depreciation. Table 17 presents the results of this exercise. Column 2 in the table offers estimates of the percentage depreciation needed in the currencies of the ASEAN countries in order to reach the 5% target growth in export volume. Then columns 2 through 5 show the effects of these exchange rate changes on export price and export revenues in two ways, as a percentage change in terms of euros (the importing country's currency), and as a percentage change in terms of the exporting country's own currency.



A number of points can be raised from the results. First, the results show that 5% target growth in export volume achieved through exchange rate depreciation is accompanied by same amount of reduction in export price (in terms of euros) as in the export subsidy case shown in Table 14. This applies to changes in export revenues as well. In contrast, in terms of the currencies of the exporting countries, the effects of the depreciations on export price and export revenues, are very different. In particular, the domestic price faced by exporters would increase in all the commodity trade flows considered, though export price in terms of the euros would decrease. The appreciation of the euro also raises the exporting country's export revenues in terms of domestic currency. In addition, compared to the export subsidy case, exporting country saves the budgetary expenditures.

It should be noted, however, that it is possible that the depreciation will inevitably affect domestic price of exportables, thus reducing its impact on exports. A higher rate of depreciation will tend to increase the domestic cost of imported goods, and can thus contribute to higher prices, which will tend to reduce the effectiveness of nominal depreciation (Hoffmeister 1992). The net impact of the exchange rate depreciation on domestic prices is therefore an empirical issue that can only be measured by a complete macro models of the ASEAN economies. The depreciation affects domestic prices of traded and nontraded agricultural commodities through its influence on the entire domestic cost structure. The present calculations of the compensating depreciation assume that the effects on inflation offset each other, thus replicating the concept analogous to real depreciation.

## 7.4 Summary

In this chapter, the estimated equations of the individual commodities have been used to simulate different types of trade policies. The first

simulation exercise has considered the effects of a tariff removal by the EU on its agricultural commodity imports. The results suggest that trade liberalisation in the form of tariff removal would not be very significant in changing the quantity of imports demanded by the EU. The relatively small changes in import quantities are explained by low price elasticities of import demand.

The export policy simulations examined are the imposition of subsidies that lower the unit cost of exports, and an export tax that has exactly the opposite effect. These simulations assume that the export policies of the ASEAN countries are formulated independently of one another, which limits the analysis to unilateral government incentives to subsidise or tax exports. The export subsidy simulations reveal considerable variations in the amount of subsidy required to achieve certain target level of exports. For example, cocoa exporters from Malaysia and coconut oil exporters from Indonesia would experience price cuts less than 1 per cent to achieve a 5 per cent higher export volume. At the same token, the subsidy change would increase foreign exchange earnings of Malaysian palm oil exporters and the Philippine coconut oil exporters by more than 4%. On the other hand, in case of Indonesian palm oil and pepper exports, a 5 per cent expansion in export volumes is accompanied by over 4 per cent fall in export prices, but less than 1% increase in foreign exchange earnings. It should be noted, however, that export demand generally takes several periods to adjust to the policy change.

Summarising, one may note that though the broad patterns of reactions to alternative trade policies are fairly predictable, the specific dynamic details were not so. In some cases, the response of trade flows to a sustained change in explanatory variable tends to be fast, and in some cases, the adjustment from the initial to the new steady-state growth path occurs only after several periods. These different responses are often critical to the outcomes of the types of trade policies considered. The results, therefore, demonstrate the importance of dynamics underlying the

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adjustment processes of commodity markets. Dynamic effects cannot be examined in comparative-static models. While the markets differ significantly, dynamic responses are observed in all

cases, frequently in accord with prior expectation on the nature of the commodity and its market.

## 8 Summary, conclusions, and suggestions for future research

### 8.1 Summary of the study

The objective of this study was to increase our understanding of the specification and estimation of agricultural commodity trade models as well as to provide instruments for trade policy analysis. More specifically, the aim was to build a set of dynamic, theory-based econometric models which are able to capture both short-run and long-run effects of income and price changes, and which can be used for prediction and policy simulation under alternative assumed conditions. A relatively unrestricted, data determined, econometric modelling approach based on the error correction mechanism was used, in order to emphasise the importance of dynamics of trade functions. Econometric models were constructed for seven agricultural commodities – cassava, cocoa, coconut oil, palm oil, pepper, rubber, and tea – exported from the Association of Southeast Asian Nations (ASEAN) to the European Union (EU). With the aim of providing broad commodity coverage, the intent was to explore whether the chosen modelling approach is able to catch the essentials of the behavioural relationships underlying the specialised nature of each commodity market.

The study began with the formulation of a general theoretical framework. Armington's (1969) model, which allows each exporting country to exert some influence on the demand for its exports through relative price changes, was used to specify the demand equations for traded commodities. The model recognises that the same commodities of different origins are im-

perfect substitutes within an importing country's commodity market. Following the model, the importing decision was split into two stages. At the first stage, the importer decides how much to consume the imported commodity against all other goods. At the second stage, once the level of expenditures for the imported commodity is determined, the utility maximisation problem is of how much of the commodity to purchase from alternative suppliers. In order to reduce to number of parameters to be estimated, the model further assumes a constant elasticity of substitution (CES) for each product pair.

The supply analysis aimed at determining the importance of price factors in export responsiveness was based on the exporter's objective of maximising net foreign exchange earnings by means of a cost-minimising combination of the factor inputs used to produce the commodity. The production function was specified as CES. The key behavioural assumption in the determination of the price and quantity of exporters was that each exporting country ignores the actions of their competitors and is, therefore, not concerned about the reactions of competing exporters to their own actions. A market structure of this type was considered appropriate for the analysis of commodity trade covered by the study, since there are usually a large number of countries that export a given commodity and the actions of those countries have a negligible effect on the world market.

The next step in the study was to econometrically estimate import demand and export demand functions as well as import supply and export supply functions. Given that economic

time series often exhibit nonstationary stochastic processes, the econometric analysis was conducted in a framework that allows for nonstationary but potentially cointegrated variables. The approach adopted was to convert the dynamic model into error-correction formulation (ECM), and it was shown that this formulation contains information on both the short-run and long-run properties of the model, with disequilibrium as a process of adjustment to the long-run model. Equations estimated in this manner allow the relevant economic theory to enter the formulation of long-run equilibrium in levels while the short-run dynamics of the equation are determined by growth rates.

Since the validity of the error correction specification requires the existence of a long-run relationship or cointegration between the variables concerned, the analysis began with the tests for the existence of a cointegrating vector. The first step in the analysis of cointegration was to determine the time series properties (i.e., the order of integration) of each variable, whether they have a unit root or not. Tests for unit roots were performed using the augmented Dickey-Fuller (ADF) univariate tests. Having established the order of integration of each variable, tests for cointegration were undertaken, and the nature of any cointegrating vectors explored. A formal test of cointegration was carried out following the residual-based approach proposed by Engle-Granger (1987) as well as the sequential testing procedure put forward by Perron (1988). The econometric analyses were conducted with a sample of annual data that cover ASEAN's major commodity exports to the EU from 1961 to 2000.

After testing for unit roots and cointegration in the data, the ECM specification was derived as a reparameterisation of a general unrestricted autoregressive distributed lag (ADL) model. The major advantage of the ADL approach is that it generally provides unbiased estimates of the long-run model and valid t-statistics (even when some of the regressors in the model are endogenous). The 'general to specific' methodology advocated by Hendry (1986) was applied in the

determination of the model specification. A major decision was the choice of lag length, which in many instances reflects the special characteristics of different commodities. On the supply side this required special attention to the natural lags involved in developing new production. It takes many years for tree crops, for example, to obtain benefits of expanded acreage. On the demand side, the dynamics are of a relatively small order, and therefore were conveniently restricted to cases where the lagged values of the variables are of one period.

The dynamic specifications of equations that characterise agricultural commodity trade between ASEAN and the EU were then estimated in their structural form. The import demand analysis of the study examined two key features: (1) the total response of EU's agricultural commodity imports to income and price changes, and (2) the length of time required for this response to occur. The empirical results confirmed that income effects play a dominant role in determining EU's import demand both in the short and the long run, though with a low elasticity. The income elasticities were found to be statistically different from zero in six out of the seven commodities, ranging from close to zero for rubber to around 1.9 for cassava. Examination of the price elasticities confirmed the expectation that demand for commodity imports in the EU is relatively inelastic with respect to price. The price elasticities range from from  $-0.04$  to  $-0.27$  in the short-run, and from  $0.05$  to  $-0.77$  in the long run.

The adjustment of import demand from one level of income and prices to another is determined in the model by the coefficient of the error correction term. It is the mechanism for adjusting any disequilibrium in the previous period to the long-run equilibrium. The results indicate a relatively quick response of EU importers to changes in income and prices, i.e. it does not take a great deal of time for import demand to resume its long-term equilibrium growth path when a short-run disequilibrium arises between import demand and income. Only imports of few products (palm oil and rubber) appear to adjust to income and price changes relatively slowly.

Furthermore, the results show that the estimated import demand functions track the sizes and the directions of changes in the volume of EU agricultural imports fairly well. Considering that the equations explain the rate of changes in the import volumes, the  $R^2$  values ranging from 0.54 to 0.88 can be considered quite good. Coefficient signs and magnitudes in the import demand relationships are acceptable in terms of a priori expectations. Tests of model adequacy yield satisfactory results.

The estimation of import supply function, which examined the response of EU import prices to changes in the world market price of a commodity, yield also useful information. The findings of the regression analysis demonstrated that more than three-quarters of the price adjustments in the commodities examined here occurs usually within the same period as changes in world prices of those commodities. The pattern of the response is generally characterised by a dampened smooth response. After an initial impact on import prices, a change in the world market price quickly becomes ineffective.

The estimations of the export demand relationships provided a test whether the exporter's market share has been influenced by the level of relative export price, and whether exports are affected by variations in the rate of growth of imports. The findings showed that the signs and magnitudes of the estimated coefficients are broadly in line with theoretical expectations and the diagnostic test statistics are quite satisfactory. Relative prices and error correction terms were found to be strongly significant with an adjustment coefficients ranging from  $-0.07$  to  $-0.75$ . Furthermore, the estimated models explain the changes in the volume of ASEAN agricultural exports to the EU rather accurately. The models also pick up quite well the turning points and rapid rises in export demand. Goodness of fits are acceptable with an  $R^2$  in a range between 0.63 and 0.96. As with import demand equations, all tests for model adequacy yield satisfactory results.

Relative prices in the export demand functions were found to be statistically different from

zero in 13 out of the 14 trade flows. The sizes of relative price coefficients, of course, differ by commodity as well as by source of supply in each commodity. The short-run relative price elasticity of export demand range from  $-0.5$  to  $-7.0$ , and the long-run elasticity from  $-1.1$  to  $-8.5$ . Thus, it appears that relative price movements affect significantly the trade flows of all commodities, implying that exporter's market share is influenced by price competitiveness. On the other hand, the sharp contrast of relative price coefficients in the same commodity across countries justifies the assumption that importers distinguish agricultural products by place of production, even though the products are called by a common commodity name.

Another influence on the export demand, or market share, of an exporter is the dynamic effect originating from changes in the rate of growth of imports. The estimated import growth elasticity of export demand range from  $-2.80$  for Malaysian cocoa beans to 1.55 for Indonesian coconut oil. These elasticities have the following interpretation: at given import quantity and relative-price levels, a 1 per cent increase in the rate of growth of EU cocoa imports leads to a 2.8 per cent decrease in the average ratio of cocoa exports from Malaysia. On other hand, for Indonesian coconut oil, a 1 per cent increase in the rate of growth of EU coconut oil imports leads to a 1.55 per cent increase in the average ratio of coconut oil exports from Indonesia.

The export supply analysis examined two statistics, which are considered central to the characterisation of the export supply relationship. The first is the price responsiveness, which indicates the relative influence of real price and some non-price factors in stimulating the supply of exports. The other is the lag structure, which determines how fast exporters respond to changes in conditions prevailing in their markets. As with export demand, each of the export supply relationships was estimated by ordinary least squares for each 14 commodity-country combination of interest. The signs and magnitudes of the estimated coefficients, at least those statistically significant, were broadly in line with theo-

retical expectations. The results also indicate satisfactory statistical fit as judged by the adjusted  $R^2$ s.

Export supply of ASEAN agricultural commodities to the EU was found to be generally responsive to price movement. This responsiveness depends greatly on the commodity – tree crop of course respond more slowly than field crops – but it depends also on the exporting country. The short-run relative price elasticity of export supply ranges from 0.1 to 1.7, and the long-run elasticity from 0.1 to 4.0. The lag distribution (the shape and length of the lag) in export supply was found to be very critical, since the effects of price changes usually take a long time to work themselves through and since the transmission of the price effects can be complex.

Having treated the specification and estimation of agricultural commodity trade flows between ASEAN and the EU, the estimated equations of the individual commodities were used to simulate different types of trade policies. The first simulation exercise considered the effects of a tariff removal by the EU on its agricultural commodity imports. The results suggest that trade liberalisation in the form of tariff removal would not be very significant in changing the quantity of imports demanded by the EU. The relatively small changes in import quantities are explained by low price elasticities of import demand.

The export policy simulations considered in the study were the imposition of subsidies that lower the unit cost of exports, and an export tax that has exactly the opposite effect. These simulations assumed that the export policies of the ASEAN countries are formulated independently of one another, which limited the analysis to unilateral government incentives to subsidise or tax exports.

The export subsidy simulations reveal considerable variations in the amount of subsidy required to achieve certain target level of exports. For example, cocoa exporters from Malaysia and coconut oil exporters from Indonesia would experience price cuts less than 1 per cent to achieve a 5 per cent higher export volume. At the same

token, the subsidy change would increase foreign exchange earnings of Malaysian palm oil exporters and the Philippine coconut oil exporters by more than 4%. On the other hand, in case of Indonesian palm oil and pepper exports, a 5 per cent expansion in export volumes is accompanied by over 4 per cent fall in export prices, but less than 1% increase in foreign exchange earnings. It should be noted, however, that export demand generally takes several periods to adjust to the policy change.

Summarising, one may note that though the broad patterns of reactions to alternative trade policies were fairly predictable, the specific dynamic details were not so. In some cases, the response of trade flows to a sustained change in explanatory variable tends to be fast, and in some cases, the adjustment from the initial to the new steady-state growth path occurs only after several periods. These different responses are often critical to the outcomes of the types of trade policies considered. The results, therefore, demonstrated the importance of dynamics underlying the adjustment processes of commodity markets. Dynamic effects cannot be examined in comparative-static models. While the markets differ significantly, dynamic responses are observed in all cases, frequently in accord with prior expectation on the nature of the commodity and its market.

## 8.2 Conclusions and suggestions for future research

At the end of such study, the following questions naturally arise: What are the major findings and what do they mean? To what extent do the results reflect reality and to what extent can they be ascribed to the characteristics of the analytical tool used? How useful is the chosen modelling approach as an analytical tool? How useful and relevant is the error correction specification to agricultural trade modelling? Could one have

arrived at the results with the same degree of confidence through a much simpler approach? What are the methodological or analytical lessons to be learned from the study? What are suggestions for future research? These questions are addressed in this section.

The study has increased our understanding of the specification and estimation of the behavioural relationships underlying agricultural commodity trade flows between ASEAN and the EU. In particular, the results of the study have indicated the importance of inspection of the time series properties and the examination of both short- and long-run adjustment when studying trade functions. Many previous studies on agricultural trade modelling have tended to ignore the dynamics underlying the adjustment processes of commodity markets. Furthermore, the study has shown that concepts such as co-integration and error correction specification are well suited for the study of trade flows, which are clearly non-stationary time series. The error correction specification was found to provide a good representation of the data-generating process for agricultural commodity flows from ASEAN countries to the EU.

Commodity experts in each of the markets considered will still be able to contribute information, which may modify each of the models. But it is highly promising that the chosen modelling approach was able to catch the essentials of the behavioural relationships underlying the specialised nature of each commodity market. Although the markets differ significantly, it was possible to build models in each case and to observe dynamic behaviour properties for these models, which are substantially in accord with prior notions. Most of the equations have significant and correctly signed coefficient estimates and satisfy most of the standard statistical criteria. While the models cannot be considered definitive, they reveal a richness of response properties.

Elasticities obtained from regression analysis can be used for projections and policy analysis, since the examination of the stability of the income and price elasticities was one of the con-

cerns in the study. On contrary to some recent studies that use more "conventional" econometric techniques, the estimated income and price elasticities do not show significant changes over time for the period under consideration. Instead they provide relatively accurate forecasts, although there are errors in particular years.

Unfortunately, the adopted modelling approach has also some limitations. The problems associated with econometric methodology concern testing for non-stationarity and cointegration. The first is the issue of the trade-off that exists between the size and power properties of unit root tests. The important problem faced when applying the Dickey-Fuller (DF) and the augmented Dickey-Fuller (ADF) unit root tests is their probable poor size and power properties (i.e. the tendency to over-reject the null when it is true and under-reject the null when it is false, respectively). Choosing the correct form of the ADF model is therefore problematic and using different lag-lengths often results in different outcomes with respect to rejecting the null hypothesis of nonstationarity. This problem occurs because of the near equivalence of non-stationarity and stationary processes in finite samples, which makes it difficult to distinguish between trend-stationary and difference-stationary processes. This, in turn, raises the issue of whether current procedures are sufficiently robust to provide any substantial method of discriminating between non-stationary and trend-stationary processes.

Testing for cointegration using a single equation is also somewhat problematic, since it is only really applicable to use the single equation approach when all the right-hand-side variables are weakly exogenous and when there is a single unique cointegration vector. The problem of endogeneity may be relatively unimportant in many situations, as suggested by Inder (1993), on the basis of Monte Carlo experiments. However, there is still the important issue of how many possible  $(n-1)$  cointegration relations exist in a model, which includes  $n$  variables. The single equation approach can be misleading, particularly if more than one cointegration relation-

ship is present. The unrestricted dynamic modelling approach would be most likely to produce unbiased estimates of the long-run relationships, with appropriate t- and F-statistics, even though single equation methods are used. The test of cointegration associated with this approach is also more powerful against alternatives, such as the usual Engle-Granger static model (Harris 1995). However, given the need to allow all variables to be potentially endogenous, an area of future research is to apply Johansen's (1988) maximum likelihood methodology for the estimation and testing of the cointegrating vectors in a vector autoregression (VAR) system (see Johansen and Juselius 1990, Johansen 1992).

There are also some important modelling limitations involved in the use of the Armington model as a base for agricultural trade analysis. The Armington model contains two major assumptions induced by the constant elasticity of substitution (CES) subutility function: the single CES and homotheticity assumptions. The empirical analysis applied here to the ASEAN-EU trade showed that these assumptions are too restrictive. The results of this research are therefore basically consistent with those found by Winters (1984), Alston et al. (1990), Ito et al. (1990), and Yang and Koo (1993).

To overcome the weaknesses of the Armington model, one needs to use more general functional forms and models that account for both non-homogeneity and the existence of variable elasticities of substitution among import sources. However, a problem with introducing more general flexible functional forms, such as the Almost Ideal Demand System or the Translog models, is that it substantially complicates the model structure. Furthermore, as analysed by Blackorby et al. (1975) for the case of the 'generalised quadratic' functional form (which includes the translog as a special case), almost all of these functional forms themselves impose certain restrictions on the parameters.

Finally, when these more general flexible functional forms were applied to the trade flow data in this study, preliminary examinations indicated that they do not result in statistically sig-

nificant estimates of parameters. The double-log specification adopted in the study is therefore a compromise with the reality that EU's agricultural import performance not only reflects consumer's behaviour, but also results from business activities of traders, who may not directly reflect consumer's preferences in their import businesses.

The refinement of the original Armington model by relaxing the homogeneity condition (Ito et al. 1990, Yang and Koo 1993) could be a fruitful avenue for future research. For example, the alternative modelling framework based on the constant difference of elasticities (CDE) function, developed recently by Surry et al. (2002), is promising and worth considering. This framework is able to capture non-homothetic consumer preferences but also allows for testable restrictive structures such as homogeneity, and weak separability. Like the Armington model, the model assumes two-stage utility maximisation. However, because of the non-homothetic structure of the utility function, the model also suffers from a theoretical inconsistency in that it is impossible to generate exact price and quantity aggregators for use in the first stage. This constitutes a major drawback in an applied analysis. The issue does not arise in the Armington model because it assumes a homogenous separable utility function, which allows for the derivation of exact aggregate quantity and price indices for the total supplies of each good.

A major weakness in the policy simulation was that the policies of the exporting countries were formulated independently from one another. This limited the model's ability to describe strategic behaviour of exporters. The model simply assumes that each exporting country ignores the actions of their competitors and is, therefore, not concerned about the reactions of competing exporters to their own actions. In other words, the applied approach allows consideration of trade policies aimed at expanding exports without fear of retaliation by the competing exporters. However, in reality, firms and governments are interacting repeatedly. An area of future research should be to develop a model of interna-

tional trade that is able to capture real world strategic interaction between the participants who exercise market power in the market. For example, the modelling approach with switching costs has been found to be useful, because it provides insight into the importance attached to market shares by exporting countries. To do this requires using the tools of game theory in the model building process.

Future research also needs to consider the role of expectations and speculation in the determination of agricultural commodity prices. When a commodity can be stored for a long period of time, equilibrium in the market occurs when the supply of stocks is equal to the demand of stocks by agents in the market. Market prices are then usually determined by the 'stock-adjustment processes.'

Thus there remains substantial scope for further research on improving the estimation and specification of the models. However, the estimated models offer considerable potential for application even without additional development. They provide the basis for relatively straightfor-

ward prediction, since they require only very limited projections for the exogenous variables. Second, they provide an initial framework for trade policy analysis. It is possible to introduce into the models modifications of supply and demand that approximate some potential policy measures and to get measurements of market responses under alternative policies. Moreover, the application of concepts such as co-integration and error correction mechanism has contributed to a better understanding of short-run and long-run dynamics in agricultural commodity trade. Finally, the estimated models are well adapted for introduction into a framework of multi-country model. Such a comprehensive interactive framework of models would lend itself for the study of the world commodity trade, its responses to world business cycles, the international transmission of concurrent income changes by importers, the impact of multilateral trade liberalisation, etc. The potentials in this direction are considerable and this study could be a step in the direction of comprehensive modelling of world trade in each of the commodity.

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## SELOSTUS

### **Yhteisintegroituvuus ja virheenkorjausmallin soveltaminen maataloustuotteiden kansainvälisen kaupan mallittamisessa: Tapaustutkimus ASEAN-maiden maatalousviennistä EU-alueelle.**

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Tämän tutkimuksen tavoitteena oli rakentaa maataloustuotekauppaa kuvaavia ekonometrisia malleja, joilla pystytään selittämään tulo- ja hintamuutosten sekä lyhyen että pitkän aikavälin vaikutuksia kauppavirtoihin, ja joita voidaan käyttää ennustamiseen ja simulointitarkoituksiin esimerkiksi valuutta-, tuki- ja kauppapolitiikan vaikutusten arvioimisessa. Tutkimus on luonteeltaan empiirinen tutkimus, jossa aikasarjaekonometrian välinein tutkitaan ASEAN-maiden (Brunei, Indonesia, Malesia, Filippiinit, Singapore, Thaimaa ja Vietnam) eräiden keskeisten maataloustuotteiden vientiä EU-alueelle. Tutkimusmenetelmänä sovelletaan parin viimeisen vuosikymmenen aikana kehitettyjä ns. yhteisintegroituvuuteen liittyviä analyysitekniikoita. Keskeisellä sijalla näissä menetelmissä on pitkän aikavälin rajoitusten huomioon ottaminen ekonometrisia malleja rakennettaessa

Tutkimuksen teoreettisessa osassa muodostetaan kaupan volyyymiä selittävät kysyntä- ja tarjontamallit, jotka estimoidaan tutkimuksen empiirisessä osassa. Tuontikysyntäfunktio kuvaa tuotteen tuonnin määrää reaalityulojen ja tuotteen reaalisien tuontihinnan funktiona tietyssä tuontimaassa, tässä tapauksessa tuontikysyntää EU-alueella. Kun yksittäisen maataloustuotteen kokonaistuonti on selvillä, johdetaan kysyntä EU-tuonnille eri ASEAN-maista (jota tutkimuksessa kutsutaan vientikysynnäksi) olettaen, että eri maissa tuotetut tuotteet ovat keskenään epätäydellisiä

substituutteja. Keskeinen tekijä vientikysynnän määräytymisessä on viennin suhteellisilla hinnoilla eli hintakilpailukyvyllä. Tämän jälkeen tarkastellaan tarjontayhtälöitä. Tuonnin tarjonnaksi kutsutaan tuotteen kokonaistarjontaa muista maista EU-alueelle. Kun tarkastellaan vientiä yksittäisestä ASEAN-maasta EU-alueelle, johdetaan vientitarjonta ASEAN-maiden maataloustuottajien voiton maksimoinnista. Vientitarjonta määräytyy pitkällä aikavälillä vientituotteen nimellisen hinnan, valuuttakurssimuutosten, inflaation ja teknologisen kehityksen perusteella.

Tutkimuksen empiirisessä osassa päähuomio on yksikköjuurten testaamisessa sekä muuttujien välisen yhteisintegraation testaamisessa yhden yhtälön Engle-Granger menetelmällä. Lisäksi selittävien ja selitettävien muuttujien pitkän ja lyhyen aikavälin välisen yhteyden osoittamiseksi sovelletaan yhteisintegroituvuuteen perustuvaa virheenkorjausmallia. Virheenkorjausmallissa muutosta kuvaavat selittävien ja selitettävien sarjojen differenssit edustavat lyhyen aikavälin poikkeamia taloudellisesta tasapainosta, kun taas niitä vastaavien differentioimattomien aikasarjojen lineaarikombinaatioiden viipeet osoittavat pitkän aikavälin taloudellista tasapainoa sarjojen välillä. Estimoinneista saadut tulokset ovat järkeviä ja linjassa aiemman tutkimuksen kanssa. Lisäksi käytetyt muuttujat ovat sellaisia, että mallit sopivat ennustamiseen ja politiikkasimulointiin.

**Appendix A: Derivation of demand equations**

A.1

The appropriate mean of describing the importer's preference ordering for commodities differentiated by country of origin is the utility tree approach (Leontief 1947, Sono 1960). Following this approach, the importing decision is split into two stages. At the first stage, the importer decides how much to consume of commodity  $Q$  and all other goods, whose composite forms the numeraire  $N_0$ . This decision is based on total expenditures and prices of the goods. At the next stage, a choice is made about how much to consume of the products from different sources ( $Q_1, \dots, Q_n$ ).

The necessary and sufficient condition for the second-stage budget allocation is that the goods in a group are weakly separable from goods in any other group in importer's utility function (see, for example, Strotz 1957, Pearce 1961, and Barten 1977). A utility function is weakly separable if the goods can be partitioned in two (or more) groups ( $q_1, \dots, q_k$ ) and ( $q_{k+1}, \dots, q_n$ ) such that

$$U = F[f_1(q_1, \dots, q_k), f_2(q_{k+1}, \dots, q_n)]$$

The constant elasticity of substitution (CES) specification implies weak separability between different import sources. The importer's overall utility schedule is thus given by

$$(A-1) \quad U(M_j, N_{0j}) = \left[ \pi_j M_j^\alpha + (1 - \pi_j) N_{0j}^\alpha \right]^{1/\alpha}$$

where  $U$  is the total utility of the importer,  $M_j$  is the quantity of good  $Q$  imported by country  $j$ , and  $N_0$  is the numeraire, i.e. the income relative to which all other goods are measured. The parameter  $\pi$  (the distribution parameter), therefore, has here no economic interpretation because it relates different units of accounts, namely quantities of imports to relative income. The parameter  $\alpha$  (the substitution parameter) is what determines the value of the constant elasticity of intersectoral substitution. It is assumed that the parameters  $\alpha < 1$  and  $0 < \pi < 1$ .

Now let the subscript  $i$  refer to a particular supplying country of interest and let  $k$  refer to the rest of the  $n-1$  other foreign supplying countries. Then the importer's sub-utility schedule  $U_m$  is given by,

$$(A-2) \quad U_m(X_1, \dots, X_n) = \left[ \pi_{ij} X_{ij}^\beta + (1 - \pi_{ij}) X_{kj}^\beta \right]^{1/\beta}$$

where  $X_{ij}$  is the quantity of the good exported from country  $i$  to country  $j$ . Here the parameter  $\pi$  has to do with the relative market shares of each exporter, and the parameter  $\beta$  measures the constant rate at which intrasectoral substitution takes place. It is assumed again the values of parameters are constrained such that  $\beta < 1$  and  $\sum_{i=1}^n \pi_{ij} = 1$ .

It can be shown that both indifference curve in (A-1) and (A-2) are strictly convex for positive values of  $Q_{ij}$  and for  $\alpha, \beta < 1$  (for a proof, see Chiang 1984).

*1. Import demand*

Given the importer's preference ordering, it is now possible to derive the importer's demand schedule as well as the export demand schedules of its foreign suppliers. The utility maximisation problem for the first level of decision by geographic market  $j$ , given a commodity import price  $P$  and a level of nominal income  $Y^n$ , is

$$(A-3) \quad \begin{aligned} \max U(M_j, N_{0j}) &= \max [\pi_j M_j^\alpha + (1 - \pi_j) N_{0j}^\alpha]^{1/\alpha} \\ \text{subject to } P_j M_j + N_{0j} &= Y_j^n \end{aligned}$$

where  $\alpha < 1$  and  $0 < \pi < 1$ .

Note that in the equations that follow the subscript reference  $j$  to the importer is implicit. The subscript is therefore dropped in the following notations.

The first order conditions for utility maximisation are derived by setting the partials of the following Lagrangian function

$$(A-4) \quad \lambda_1 = [\pi M^\alpha + (1 - \pi) N_0^\alpha]^{1/\alpha} + \lambda(Y^n - PM - N_0),$$

with respect to  $M$ ,  $N_0$ , and  $\lambda$ , equal to zero:

$$(A-5a) \quad \frac{\partial \lambda_1}{\partial M} = [\pi M^\alpha + (1 - \pi) N_0^\alpha]^{1/\alpha - 1} \pi M^{\alpha - 1} - \lambda P = 0$$

$$(A-5b) \quad \frac{\partial \lambda_1}{\partial N_0} = [\pi M^\alpha + (1 - \pi) N_0^\alpha]^{1/\alpha - 1} (1 - \pi) N_0^{\alpha - 1} - \lambda = 0$$

$$(A-5c) \quad \frac{\partial \lambda_1}{\partial \lambda} = Y^n - PM - N_0 = 0$$

The first two equations can be combined to get the marginal rate of substitution

$$(A-6) \quad \frac{\pi}{1 - \pi} \frac{M^{\alpha - 1}}{N_0^{\alpha - 1}} = P$$

Solve for  $N_0$ :

$$(A-7) \quad N_0 = \left( \frac{\pi}{1-\pi} \right)^{1/(\alpha-1)} P^{-1/(\alpha-1)} M,$$

and substitute into the first-order condition for  $\lambda$ :

$$(A-8) \quad Y^n = \left[ P + \left( \frac{\pi}{1-\pi} \right)^{1/(\alpha-1)} P^{-1/(\alpha-1)} \right] M.$$

Solve for  $M$ :

$$(A-9) \quad M = \frac{Y^n}{P + [\pi/(1-\alpha)]^{-1/(\alpha-1)} P^{-1/(\alpha-1)}}$$

Dividing through by  $Y^n$ , and factoring out  $\pi$  and  $P$  from the expression in the denominator of the right-hand side, we can transform (A-9) into

$$(A-10) \quad \frac{M}{Y^n} = \left( \frac{\pi}{1-\pi} \right)^{-1/(\alpha-1)} \frac{P^{1/(\alpha-1)}}{[\pi/(1-\pi)]^{-1/(\alpha-1)} P^{\alpha/(\alpha-1)} + 1}$$

Raising the above expression by the power of  $\alpha-1$ :

$$(A-11) \quad \left( \frac{M}{Y^n} \right)^{\alpha-1} = \left( \frac{\pi}{1-\pi} \right)^{-1} \frac{P}{\{[\pi/(1-\pi)]^{-1/(\alpha-1)} P^{\alpha/(\alpha-1)} + 1\}^{\alpha-1}}$$

Then raising the above expression by the power of  $1/\alpha$ :

$$(A-12) \quad \left( \frac{M}{Y^n} \right)^{(\alpha-1)/\alpha} = \left( \frac{\pi}{1-\pi} \right)^{-1/\alpha} \frac{P^{1/\alpha}}{\{[\pi/(1-\pi)]^{-1/(\alpha-1)} P^{\alpha/(\alpha-1)} + 1\}^{(\alpha-1)/\alpha}}$$

we can finally derive the demand schedule for  $M$  (with the subscript  $j$  in place):

$$(A-13a) \quad M_j^d = \hat{a}_1 Y_j^n \left( \frac{P_j}{D_j} \right)^{\epsilon_m^p}$$

where  $M_j^d$  is the quantity of good  $M$  imported by country  $j$ ;  $\hat{a}_1 = [(1-\pi_j)/\pi_j]^{1/(1-\alpha)}$  is a constant with expected sign  $\hat{a}_1 > 0$ ;  $Y = Y^n/D$  is constant income in country  $j$ ;  $P_j$  is the average price of the good imported by country  $j$  from different sources,  $D_j = (1 + \hat{a}_1 P_j^{\alpha/(\alpha-1)})^{(\alpha-1)/\alpha}$  is the deflator in country  $j$ ; and  $\epsilon_m^p = 1/(\alpha-1)$  is the price elasticity of import demand for good  $M$ .

The overall demand schedule for the numeraire  $N_0$  is

$$(A-13b) \quad N_{0,j} = (1 - \hat{\alpha}_1) Y_j^n \left( \frac{P_j}{D_j} \right)^{\epsilon_n^j}$$

### 2. Export demand

The importer's utility maximisation problem for the second level of decision is as follows:

$$(A-14) \quad \begin{aligned} \max U_m(X_i, \dots, X_n) &= \max [\pi_{ij} X_{ij}^\beta + (1 - \pi_{ij}) X_{kj}^\beta]^{1/\beta} \\ \text{subject to } P_{ij} X_{ij} + P_{kj} X_{kj} &= Y_{m,j}^n \end{aligned}$$

where  $\beta < 1$  and  $0 \leq \pi_{ij} \leq 1$ .

Note that in the equations that follow the subscript reference  $j$  to the importer is implicit. The subscript is therefore dropped in the following notations.

Using the Lagrangian

$$(A-15) \quad l_2 = [\pi_i X_i^\beta + (1 - \pi_i) X_k^\beta]^{1/\beta} + \lambda_m (Y_m^n - P_i X_i - P_k X_k)$$

The first order conditions are

$$(A-16a) \quad \frac{\partial l_2}{\partial X_i} = [\pi_i X_i^\beta + (1 - \pi_i) X_k^\beta]^{1/\beta - 1} \pi_i X_i^{\beta-1} - \lambda_m P_i = 0$$

$$(A-16b) \quad \frac{\partial l_2}{\partial X_k} = [\pi_i X_i^\beta + (1 - \pi_i) X_k^\beta]^{1/\beta - 1} (1 - \pi_i) X_k^{\beta-1} - \lambda_m P_k = 0$$

$$(A-16c) \quad \frac{\partial \lambda_1}{\partial \lambda_k} = Y_m^n - P_i X_i - P_k X_k = 0$$

The first two equations can be combined to get the marginal rate of product substitution

$$(A-17a) \quad \frac{X_i}{X_k} \left( \frac{\pi_i}{1 - \pi_i} \right)^{1/(\beta-1)} = \left( \frac{P_i}{P_k} \right)^{1/(\beta-1)}$$

or

$$(A-17b) \quad \frac{X_i}{X_k} = \left( \frac{\pi_i}{1 - \pi_i} \right)^{-1/(\beta-1)} \left( \frac{P_i}{P_k} \right)^{1/(\beta-1)}$$

Invert the above expression, then raise it by the power of  $\beta$  and add one to both sides:

$$(A-18) \quad \frac{X_i^\beta + X_k^\beta}{X_i^\beta} = \left( \frac{1 - \pi_i}{\pi_i} \right)^{-\beta/(1-\beta)} \left( \frac{P_i^{\beta/(1-\beta)} + P_k^{\beta/(1-\beta)}}{P_i^{\beta/(1-\beta)}} \right)$$

Raising the expression by the power of  $1/\beta$ :

$$(A-19a) \quad \frac{(X_i^\beta + X_k^\beta)^{1/\beta}}{X_i} = \left( \frac{1 - \pi_i}{\pi_i} \right)^{-1/(\beta-1)} \left( \frac{P_i^{\beta/(1-\beta)} + P_k^{\beta/(1-\beta)}}{P_i^{\beta/(1-\beta)}} \right)^{1/\beta}$$

or

$$(A-19b) \quad \frac{M}{X_i} = \left( \frac{1 - \pi_i}{\pi_i} \right)^{-1/(\beta-1)} \left( \frac{P}{P_i} \right)^{1/(\beta-1)}$$

where  $P = (P_i^{\beta/(1-\beta)} + P_k^{\beta/(1-\beta)})^{(1-\beta)/\beta}$  and, as before,  $M = (X_i^\beta + X_k^\beta)^{1/\beta}$ .

Solve the above expression to derive the demand schedule for  $X_i$  (with the subscript  $j$  in place):

$$(A-20a) \quad X_{ij}^d = \hat{a}_2 M_j \left( \frac{P_{ij}}{P_j} \right)^{\epsilon_x^d}$$

and by symmetry

$$(A-20b) \quad X_{kj}^d = (1 - \hat{a}_2) M_j \left( \frac{P_{kj}}{P_j} \right)^{\epsilon_x^d}$$

where  $X_{ij}$  is the quantity of the good exported from country  $i$  to country  $j$ ;  $M_j^d$  is the quantity of good  $M$  imported by country  $j$ ;  $P_{ij}$  is the price of the good imported from country  $i$  to country  $j$ ;  $P_j = (P_{ij}^{b/(b-1)} + P_{kj}^{b/(b-1)})^{(b-1)/b}$  is the average import price of the good imported to country  $j$  from different sources;  $\hat{a}_2 = [(1 - \pi_{ij})/\pi_{ij}]^{1/(1-\beta)}$  is a constant with expected sign  $\hat{a}_2 > 0$ ; and  $\epsilon_x^d = 1/(\beta-1)$  is the price elasticity of export demand.

**Appendix B: Derivation of supply equations**

B.1

*1. Import supply*

1.1. Let the import supply schedule be described by a generalised exponential function. The equation of this function is

$$(B-1) \quad M_j^s = A (P_w / D_w)^{\delta_1} (P_j / P_w)^{\delta_2} FEX_j^{\delta_3}$$

where  $M_j^s$  is the quantity of good  $M$  imported by country  $j$ ;  $(P_w/D_w)$  is the real world market price of the commodity;  $P_j$  is the average import price in country  $j$  supplied from different sources ( $i = 1, \dots, k$ ),  $(P_j / P_w)$  is the ratio between the import price  $P_j$  and the world market price  $P_w$ ;  $FEX_j$  is the foreign exchange reserves of the country;  $A = \exp(\vartheta_0 + \vartheta_1 T + \vartheta_2 \Psi)$  is a constant term, where variables  $T$  and  $\Psi$  represent efficiency and shift parameters, respectively.

1.2. Since foreign exchange reserves of the country have negligible influence on the supply of a single imported good, i.e.  $\delta_3 \cong 0$  so that  $FEX_j^{\delta_3} \cong 1$ , then (B-1) becomes

$$(B-2) \quad M_j^s = A (P_w / D_w)^{\delta_1} (P_j / P_w)^{\delta_2}$$

Solve for  $P_j$  to find the inverse import supply schedule:

$$(B-3) \quad P_j = A^{-1/\delta_2} P_w^{(\delta_2 + \delta_1)/\delta_2} D_w^{\delta_1/\delta_2} M^{-1/\delta_2}$$

Unless the importer is a monopsonist, the import price will be given and the relative price elasticity of import supply will approach infinity. The fact that  $\delta_2 \cong \infty$  implies that

(a)  $\delta_1/\delta_2 \cong 0$ , so that  $D_w^{\delta_1/\delta_2} \cong 1$ ;

(b)  $-1/\delta_2 \cong 0$ , so that  $M^{-1/\delta_2} \cong 1$ ;

(c)  $(\delta_2 - \delta_1)/\delta_2 \cong 1$ , so that  $P_w^{(\delta_2 - \delta_1)/\delta_2} \cong P_w$ ;

(d)  $-\exp(\vartheta_0 + \vartheta_1 T + \vartheta_2 \Psi) / \delta_2$  does not necessarily degenerate to zero and from where we can see that the elasticity with respect to the world market price of the commodity is unity:

$$(B-4) \quad P_j = \hat{a}_4 P_w$$

where  $\hat{a}_4 = A^{-1/\delta_2}$ . In the competitive markets, abstracting from tariffs and transportation costs etc, prices of identical goods, expressed in common currency, should be equalised in international trade, implying  $\hat{a}_4 = 1$ .

2. *Export Supply*

2.1. Let the production schedule of the exporter be described by a generalised CES function. The equation of this function is

$$(B-5) \quad X_{ij}^s = B(K^\rho + L^\rho)^{\tau/\rho}$$

where  $X_{ij}^s$  is the quantity of the good exported from country  $i$  to country  $j$ ;  $K$  (= capital) and  $L$  (= labour) represent two factors of production, and  $A$ ,  $\rho$ , and  $\tau$  are three parameters. The parameter  $B = \exp(\theta_0 + \theta_1 T + \theta_2 \Psi)$  is a constant term, which serves as an indicator of the state of technology ( $e^{\theta_1 T}$ ), and major disturbances ( $e^{\theta_2 \Psi}$ ) in the production of commodity export. The parameter  $\rho$  (the substitution parameter) is what determines the value of the constant elasticity of substitution. And the value of  $\tau$  determines returns to scale. When  $\tau = 1$  there is constant returns to scale; when  $\tau > 1$  there are increasing returns to scale; and when  $0 < \tau < 1$  there are decreasing returns to scale.

2.2. If  $P_K$  and  $P_L$  are the constant unit costs of capital and labour, respectively, the cost of production, denoted  $C$ , equals

$$(B-6) \quad C = P_K K + P_L L$$

2.3. Now consider the problem of finding a cost-minimising way to produce a given level of output. The long run cost minimisation problem is thus

$$\begin{aligned} \min C &= \min P_K K + P_L L \\ \text{subject to } &B^{\rho/\tau} K^\rho + B^{\rho/\tau} L^\rho = X^{\rho/\tau} \end{aligned}$$

This constrained minimisation problem is analysed using the method of Lagrange multipliers. The Lagrangian function for this problem is

$$(B-7) \quad \lambda_s = P_K K + P_L L + \lambda (X^{\rho/\tau} - B^{\rho/\tau} K^\rho - B^{\rho/\tau} L^\rho)$$

and the usual first order equations are

$$(B-8a) \quad \frac{\partial \lambda_s}{\partial K} = P_K - \lambda \rho B^{\rho/\tau} K^{\rho-1} = 0$$

$$(B-8b) \quad \frac{\partial \lambda_s}{\partial L} = P_L - \lambda \rho B^{\rho/\tau} L^{\rho-1} = 0$$



$$(B-8c) \quad \frac{\partial l}{\partial \lambda} = X^{\rho/\tau} - B^{\rho/\tau} K^{\rho} - B^{\rho/\tau} L^{\rho} = 0$$

From equations (B-8a) and (B-8b), one gets the rate of technical substitution

$$(B-9) \quad \frac{P_K}{P_L} = \frac{K^{\rho-1}}{L^{\rho-1}}$$

Multiplying through by (K/L),

$$(B-10) \quad \frac{P_K K}{P_L L} = \frac{K^{\rho}}{L^{\rho}}$$

Now add one to both sides of this equation (which adds the denominator of each side to the respective numerator):

$$(B-11) \quad \frac{P_K K + P_L L}{P_L L} = \frac{K^{\rho} + L^{\rho}}{L^{\rho}} \quad \text{or} \quad \frac{C}{P_L L} = \frac{K^{\rho} + L^{\rho}}{L^{\rho}}$$

Multiplying both sides by  $B^{\rho/\tau}$

$$(B-12) \quad \frac{B^{\rho/\tau} C}{P_L L} = \frac{B^{\rho/\tau} K^{\rho} + B^{\rho/\tau} L^{\rho}}{L^{\rho}} = \frac{X^{\rho/\tau}}{L^{\rho}}$$

Solving for  $L$ ,

$$(B-13a) \quad L = B^{\rho/[\tau(1-\rho)]} C^{1/(1-\rho)} X^{\rho/[\tau(\rho-1)]} P_L^{1/(\rho-1)}$$

and by symmetry

$$(B-13b) \quad K = B^{\rho/[\tau(1-\rho)]} C^{1/(1-\rho)} X^{\rho/[\tau(\rho-1)]} P_K^{1/(\rho-1)}$$

Therefore

$$(B-14a) \quad P_L L = B^{\rho/[\tau(1-\rho)]} C^{1/(1-\rho)} X^{\rho/[\tau(\rho-1)]} P_L^{\rho/(\rho-1)}$$

and

$$(B-14b) \quad P_K K = B^{\rho/[\tau(1-\rho)]} C^{1/(1-\rho)} X^{\rho/[\tau(\rho-1)]} P_K^{\rho/(\rho-1)}$$

Adding produces total cost; therefore

$$(B-15) \quad C = P_K K + P_L L = B^{\rho/[\tau(1-\rho)]} C^{1/(1-\rho)} X^{\rho/[\tau(\rho-1)]} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]$$

and solve for C to derive the cost schedule:

$$(B-16) \quad C = B^{-1/\tau} X^{1/\tau} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho}$$

Thus the average cost schedule is

$$(B-17) \quad AC = C/X = B^{-1/\tau} X^{1/\tau-1} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho}$$

and the marginal cost schedule is

$$(B-18) \quad MC = \frac{\partial C}{\partial X} = \frac{1}{\tau} B^{-1/\tau} X^{1/\tau-1} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho}$$

2.4. The quantity of the product that the exporting country will supply is determined by the first-order condition of the profit maximisation objective of the producers. Since in a competitive market each exporter takes the price of output as being given and outside of their control, the profit maximisation problem is

$$(B-19) \quad \max \pi = \max PX - C(X)$$

which has first-order condition

$$\frac{\partial \pi}{\partial X} = P - \frac{\partial C}{\partial X} = 0$$

This is equivalent to

$$(B-20) \quad P - \frac{1}{\tau} B^{-1/\tau} X^{1/\tau-1} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho} = 0$$

Solving for X

$$(B-21) \quad X = B^{1/(1-\tau)} \tau^{\tau/(1-\tau)} P^{\tau/(1-\tau)} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho}]^{\tau/(1-\tau)}$$

Noting that the parameter  $B = \exp(\theta_0 + \theta_1 T + \theta_2 \Psi)$ , the solution for  $X$  leads to the following export supply schedule

$$(B-22) \quad X^s = \hat{a}_s \left( \frac{P}{D} \right)^\gamma \exp(\varphi_1 T + \varphi_2 \Psi)$$

where  $P/D$  is the real price  $P$  (in the currency of the exporting country) of the good exported,  $D = (P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)})^{(\rho-1)/\rho}$  is the deflator; and  $\hat{a}_s = \exp[\theta_0 / (\tau - 1)] \tau^{\tau/(1-\tau)}$  is a constant.

The parameter  $\gamma = \tau/(1-\tau)$  is the price elasticity of export supply, which defines the percentage change in export supply brought by a 1 per cent change in the real price of the commodity. The other parameters have the following definitions:  $\varphi_1 = \theta_1/(1-\tau)$ ;  $\varphi_2 = \theta_2/(1-\tau)$ .

The value of  $\tau$ , which measures returns to scale, must satisfy the constraint  $0 < \tau < 1$ , implying  $\gamma > 0$ . Hence the exporter will experience decreasing returns to scale, and accordingly, the export supply schedule is upward sloping.

## Appendix

## Appendix C: Impact of an export subsidy

C.1

1. A government export subsidy reduces the marginal cost of the exported commodity and, as a result, increases a country's exports. This effect can be shown in the first-order condition for foreign exchange earnings, in which country  $i$  exports the amount at which its marginal cost equals to its marginal revenue.

2. Consider the marginal cost function derived in (B-18)

$$MC = \frac{\partial C}{\partial X} = \frac{1}{\tau} B^{-1/\tau} X^{1/\tau-1} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho}$$

Now add a subsidy, denoted  $S$ , to this equation. The subsidy lowers the per-unit cost of the commodity export and reduces the marginal cost of exports to

$$(C-1) \quad MC^{subsidy} = \frac{\partial C}{\partial X} - S = \frac{1}{\tau} B^{-1/\tau} X^{1/\tau-1} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho} - S$$

The quantity of the product that the exporting country  $i$  will supply is determined by the first-order condition of the profit maximisation objective. Hence, the country will export at the level at which marginal revenue equals marginal cost. Substitution of the equation (C-1) for the marginal cost into the first-order condition of the profit maximisation objective of the exporter  $i$  in (B-20) and rearranging the variables gives

$$(C-2) \quad P_i + S = \frac{1}{\tau} B^{-1/\tau} X_i^{1/\tau-1} [P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)}]^{(\rho-1)/\rho}$$

Solving for  $X$  to obtain the amount that will be supplied with a subsidy

$$(C-3) \quad X_i = B^{1/(1-\tau)} \tau^{\tau/(1-\tau)} \left[ \frac{P_i + S}{(P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)})^{(\rho-1)/\rho}} \right]^{\tau/(1-\tau)}$$

Substituting  $B = \exp(\theta_0 + \theta_1 T + \theta_2 \Psi)$ , yields the following export supply schedule

$$(C-4) \quad X_i^s = \hat{a}_i^s \left( \frac{P_i + S}{D_i} \right)^\gamma \exp(\varphi_1 T + \varphi_2 \Psi)$$

where  $P_i$  is the price of the good exported from country  $i$  in the currency of the exporting country,  $D_i = (P_K^{\rho/(\rho-1)} + P_L^{\rho/(\rho-1)})^{(\rho-1)/\rho}$  is the deflator; the parameter  $\gamma = \tau/(1-\tau)$  is the

price elasticity of export supply, the other parameters are defined as  $\varphi_1 = \frac{\theta_1}{1-\tau}$ ,  $\varphi_2 = \frac{\theta_2}{1-\tau}$ , and the constant  $\hat{a}_5 = \exp[\theta_0(\tau-1)/\tau] \tau^{\tau/(1-\tau)}$ .

3. In order to find the effect of a change in a subsidy on export volume and price, the export demand is set equal to the export supply, and solved for price. Then the solution for price is substituted into the export demand or supply function to obtain the amount exported (by taking the partial derivative of  $X$  with respect to  $s$  and dividing by  $X/s$ )

The export demand schedule from (A-20a) is

$$(C-5) \quad X_i^d = \hat{a}_2 M \left( \frac{P_i}{P} \right)^{\varepsilon_x^d}$$

Now the export demand (C-5) is set equal to the export supply schedule in (C-4). However, since the price  $P_i$  of the good imported from country  $i$  is given in (C-5) in the currency of the importing country, an additional term  $ER_i$  to represent the exchange rate of currency of the exporting country (in per unit of currency of the importing country) is added in the export supply equation (C-4). This transformation yields the following equality:

$$\hat{a}_2 M \left( \frac{P_i}{P} \right)^{\varepsilon_x^d} = \hat{a}_5 \left( \frac{(1+s)P_i * ER_i}{D_i} \right)^{\gamma} \exp(\varphi_1 T + \varphi_2 \Psi)$$

where  $s$  denotes the subsidy rate ( $=S/P_i$ ).

**Appendix D: Reporting the regression results of model equations**

There are various ways of reporting the results of regression analysis, but in the Appendices from E to H the following format is used, employing the EU import demand equation for palm oil as an illustration:

$$\Delta \ln M_{EU,t} = +0.63 \Delta \ln Y_{EU,t} - 0.12 \ln Y_{EU,t-1} - 0.27 \ln \Delta \left( \frac{P_{EU}}{D_{EU}} \right)_t - 0.15 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_{t-1} - 0.31 \text{ECM}$$

(1.1)                      (-1.4)                      (-4.8)                      (-3.1)                      (-3.0)

$$- 0.22 \text{D67} - 0.18 \text{D87\_88} + 0.25 \text{D98} + 4.44 \text{const}$$

(-2.8)                      (-3.2)                      (3.1)                      (3.7)

In the equation the figures in the parentheses below the coefficient estimate are the estimated *t* values. A test of significance is performed and only those coefficient, which are significantly different from zero at the 5 per cent level of significance are reported.

Dummy variables (D67, D87\_88 etc.) that account for major random disturbances in dependent variable have been included in the estimated equations and are also reported. Each of these dummy variables uses a binary series in which a value of one has been assigned to the year(s) in which a disturbance in dependent variable occurred and of zero to all other years. Unusual or unexplained developments are a significant part of commodity market modelling. These circumstances are largely connected with weather developments, which add considerable volatility particularly to the supply side of most agricultural commodity models. But certain other developments such as strikes, political upheavals, and changes in government economic policy fall into this category as do speculative fluctuations. Dummy variables are useful in the regression models if the unexplained variation would "spoil" the other coefficients of the model when it is not taken into account.

The various diagnostic checks appear below the equations and follow standard notations:

R2	Adjusted square of the multiple correlation coefficient
DW	Durbin-Watson d test statistic
d.o.f	Degrees of freedom, which means the number of independent observations in a sum of squares
J-B.NORM (X <sup>2</sup> (2))	The Jarque-Bera Chi-Square(X <sup>2</sup> )-test of normality with two degrees of freedom
LM(X <sup>2</sup> (n))	Lagrange multiplier Chi-Square(X <sup>2</sup> )-test for serial correlation with <i>n</i> degree of freedom
LB(X <sup>2</sup> (n))	Ljung-Box (LB) Chi-Square(X <sup>2</sup> )-test with <i>n</i> degrees of freedom
B-P-G (X <sup>2</sup> (n))	The Breuch-Pagan-Godfrey Chi-Square(X <sup>2</sup> )-test to detect the presence of heteroskedasticity with <i>n</i> degrees of freedom
ARCH (X <sup>2</sup> (1))	ARCH Chi-Square(X <sup>2</sup> )-test for autoregressive conditional heteroskedasticity in error processes with one degree of freedom
RESET (F <sub>n,m</sub> )	Ramsey's RESET F-test to detect equation specification errors for <i>m</i> and <i>n</i> degrees of freedom
CHOW (F <sub>m,n</sub> )	The Chow F-test for parameter constancy for <i>m</i> and <i>n</i> degrees of freedom

**Appendix E: Regression results of import demand equations<sup>1</sup>**

E.1

**Table E1. Classical regression model for the import demand for cassava in the EU.**

$$\ln M_{EU,t} = +0.85 \ln Y_{EU,t} - 0.79 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_t + 0.57 \ln M_{EU,t-1} + 2.60 \text{ const}$$

(2.9)                      (-4.1)                      (6.2)                      (5.1)

R2 = 0.82	DW = 2.06	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 1.03
LM(X <sup>2</sup> (1)) = 0.30	LM(X <sup>2</sup> (2)) = 1.15	LB(X <sup>2</sup> (12)) = 6.66	B-P-G (X <sup>2</sup> (7)) = 7.07
ARCH (X <sup>2</sup> (1)) = 0.02	RESET (F <sub>1,30</sub> ) = 0.03	CHOW (F <sub>6,27</sub> ) = 1.25	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,30</sub>=4.17, F<sub>6,27</sub>=2.46

**Table E2. Error-correction model for the import demand for cocoa in the EU.**

$$\Delta \ln M_{EU,t} = +0.43 \Delta \ln Y_{EU,t} - 0.48 \ln Y_{EU,t-1} - 0.14 \ln \Delta \left( \frac{P_{EU}}{D_{EU}} \right)_t - 1.07 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_{t-1} - 0.84 \text{ ECM}$$

(1.0)                      (-4.4)                      (-2.7)                      (-5.8)                      (-5.9)

$$+0.11 \text{ D62}_66 + 0.20 \text{ D96} + 11.60 \text{ const}$$

(2.3)                      (3.2)                      (5.6)

R2 = 0.63	DW = 1.80	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 1.56
LM(X <sup>2</sup> (1)) = 0.82	LM(X <sup>2</sup> (2)) = 2.91	LB(X <sup>2</sup> (12)) = 14.15	B-P-G (X <sup>2</sup> (7)) = 8.12
ARCH (X <sup>2</sup> (1)) = 1.15	RESET (F <sub>1,30</sub> ) = 2.96	CHOW (F <sub>6,27</sub> ) = 2.62	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,30</sub>=4.17, F<sub>6,27</sub>=2.46

**Table E3. Error-correction model for the import demand for coconut oil in the EU.**

$$\Delta \ln M_{EU,t} = -0.27 \ln \Delta \left( \frac{P_{EU}}{D_{EU}} \right)_t - 0.06 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_{t-1} - 0.83 \text{ ECM}$$

(-5.2)                      (-1.6)                      (-10.2)

$$-0.81 \text{ D75} + 0.57 \text{ D78}_00 + 0.35 \text{ D98} + 7.00 \text{ const}$$

(-7.7)                      (7.8)                      (3.8)                      (9.0)

R2 = 0.88	DW = 2.06	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 0.03
LM(X <sup>2</sup> (1)) = 0.25	LM(X <sup>2</sup> (2)) = 0.81	LB(X <sup>2</sup> (12)) = 8.47	B-P-G (X <sup>2</sup> (7)) = 5.43
ARCH (X <sup>2</sup> (1)) = 0.10	RESET (F <sub>1,31</sub> ) = 0.02	CHOW (F <sub>4,31</sub> ) = 1.63	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,31</sub>=4.15, F<sub>4,31</sub>=2.68

<sup>1</sup> For an explanation of the regression results (test statistics, dummy variables etc.) of the model equations, see Appendix D.

Table E4. Error-correction model for the import demand for palm oil in the EU.

$$\Delta \ln M_{EU,t} = +0.63 \Delta \ln Y_{EU,t} - 0.12 \ln Y_{EU,t-1} - 0.27 \ln \Delta \left( \frac{P_{EU}}{D_{EU}} \right)_t - 0.15 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_{t-1} - 0.31 \text{ECM}$$

(1.1)                      (-1.4)                      (-4.8)                      (-3.1)                      (-3.0)

$$- 0.22 \text{D67} - 0.18 \text{D87}_{88} + 0.25 \text{D98} + 4.44 \text{const}$$

(-2.8)                      (-3.2)                      (3.1)                      (3.7)

R2 = 0.67	DW = 1.98	d.o.f. = 29	J-B.NORM (X <sup>2</sup> (2)) = 0.20
LM(X <sup>2</sup> (1)) = 0.04	LM(X <sup>2</sup> (2)) = 1.12	LB(X <sup>2</sup> (11)) = 11.31	B-P-G (X <sup>2</sup> (8)) = 5.37
ARCH (X <sup>2</sup> (1)) = 1.81	RESET (F <sub>1,28</sub> ) = 0.21	CHOW (F <sub>6,26</sub> ) = 2.04	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(8)=15.51, X<sup>2</sup>(11)=19.68  
 F<sub>1,28</sub>=4.20, F<sub>6,26</sub>=2.48

Table E5. Error-correction model for the import demand for pepper in the EU.

$$\Delta \ln M_{EU,t} = +0.83 \Delta \ln Y_{EU,t} - 0.10 \ln Y_{EU,t-1} - 0.04 \ln \Delta \left( \frac{P_{EU}}{D_{EU}} \right)_t - 0.04 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_{t-1} - 0.88 \text{ECM}$$

(3.1)                      (-3.2)                      (-1.2)                      (-1.9)                      (-7.8)

$$+ 0.06 \text{D69}_{71} + 0.09 \text{D}_{78} + 0.10 \text{D}_{89} - 0.23 \text{D}_{98} - 0.19 \text{const}$$

(2.4)                      (3.0)                      (2.5)                      (-5.8)                      (-1.4)

R2 = 0.82	DW = 1.98	d.o.f. = 29	J-B.NORM (X <sup>2</sup> (2)) = 1.33
LM(X <sup>2</sup> (1)) = 0.21	LM(X <sup>2</sup> (2)) = 0.99	LB(X <sup>2</sup> (12)) = 4.78	B-P-G (X <sup>2</sup> (9)) = 7.54
ARCH (X <sup>2</sup> (1)) = 3.58	RESET (F <sub>1,28</sub> ) = 0.20	CHOW (F <sub>6,27</sub> ) = 0.75	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(9)=16.92, X<sup>2</sup>(12)=21.03  
 F<sub>1,28</sub>=4.20, F<sub>6,27</sub>=2.46

Table E6. Error-correction model for the import demand for rubber in the EU.

$$\Delta \ln M_{EU,t} = - 0.34 \ln Y_{EU,t-1} - 0.10 \ln \left( \frac{P_{EU}}{D_{EU}} \right)_{t-1} - 0.34 \text{ECM}$$

(-3.3)                      (-2.4)                      (-3.0)

$$- 0.13 \text{D78} - 0.11 \text{D91} - 0.16 \text{D93} + 0.05 \text{D98}_{00} + 5.31 \text{const}$$

(-2.6)                      (-2.1)                      (-3.2)                      (1.5)                      (3.4)

R2 = 0.54	DW = 1.99	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 0.32
LM(X <sup>2</sup> (1)) = 0.02	LM(X <sup>2</sup> (2)) = 0.50	LB(X <sup>2</sup> (11)) = 6.11	B-P-G (X <sup>2</sup> (7)) = 16.77
ARCH (X <sup>2</sup> (1)) = 7.34	RESET (F <sub>1,30</sub> ) = 0.11	CHOW (F <sub>4,31</sub> ) = 1.40	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(11)=19.68  
 F<sub>1,30</sub>=4.17, F<sub>4,31</sub>=2.68



**Appendix F: Regression results of export demand equations<sup>1</sup>**

F.1

**Table F1. Classical regression model for the EU export demand for Indonesian cassava.**

$$\ln X_{IN,t} = +0.62 \ln X_{IN,t-1} + 0.29 \ln M_{EU,t} - 1.56 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_t + 0.25 \text{ const}$$

(4.6)                      (1.5)                      (-1.9)                      (0.1)

R2 = 0.83	DW = 1.35	d.o.f. = 35	J-B.NORM (X <sup>2</sup> (2)) = 12.44
LM(X <sup>2</sup> (1)) = 2.00	LM(X <sup>2</sup> (2)) = 0.99	LB(X <sup>2</sup> (12)) = 8.7	B-P-G (X <sup>2</sup> (3)) = 8.55
ARCH (X <sup>2</sup> (1)) = 8.10	RESET (F <sub>1,34</sub> ) = 3.48	CHOW(F <sub>4,31</sub> ) = 2.79	G-Q (F <sub>4,31</sub> ) = 0.26

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(3)=7.81, X<sup>2</sup>(12)=21.03, F<sub>1,34</sub>=4.13, F<sub>4,31</sub>=2.68

**Table F2. Classical regression model for the EU export demand for Thai cassava.**

$$\ln X_{TH,t} = +0.90 \ln X_{TH,t-1} + 0.99 \ln M_{EU,t} - 0.90 \ln M_{EU,t-1} - 0.02 \text{ const}$$

(9.6)                      (26.9)                      (-8.7)                      (-0.1)

R2 = 0.99	DW = 2.25	d.o.f. = 35	J-B.NORM (X <sup>2</sup> (2)) = 33.97
LM(X <sup>2</sup> (1)) = 0.98	LM(X <sup>2</sup> (2)) = 0.17	LB(X <sup>2</sup> (12)) = 13.81	B-P-G (X <sup>2</sup> (3)) = 8.26
ARCH (X <sup>2</sup> (1)) = 0.22	RESET (F <sub>1,34</sub> ) = 0.84	CHOW(F <sub>4,31</sub> ) = 3.09	G-Q (F <sub>4,31</sub> ) = 0.27

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(3)=7.81, X<sup>2</sup>(12)=21.03, F<sub>1,34</sub>=4.13, F<sub>4,31</sub>=2.68

**Table F3. Error-correction model for the EU export demand for Indonesian cocoa.**

$$\Delta \ln X_{IN,t} = -2.29 \ln \Delta \left( \frac{P_{IN}}{P_{EU}} \right)_t - 2.98 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_{t-1} - 0.41 \text{ ECM}$$

(-4.8)                      (-3.3)                      (-3.2)

$$+ 0.41 \text{ D94} - 0.45 \text{ D96} + 0.63 \text{ D00} - 1.78 \text{ const}$$

(1.8)                      (-3.1)                      (2.8)                      (-3.0)

R2 = 0.74	DW = 1.96	d.o.f. = 22	J-B.NORM (X <sup>2</sup> (2)) = 2.65
LM(X <sup>2</sup> (1)) = 0.09	LM(X <sup>2</sup> (2)) = 0.11	LB(X <sup>2</sup> (8)) = 5.11	B-P-G (X <sup>2</sup> (6)) = 10.69
ARCH (X <sup>2</sup> (1)) = 0.01	RESET (F <sub>1,21</sub> ) = 3.55	CHOW(F <sub>4,21</sub> ) = 3.72	G-Q (F <sub>4,21</sub> ) = 0.13

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(8)=15.51, F<sub>1,21</sub>=4.32, F<sub>4,21</sub>=2.84

<sup>1</sup> For an explanation of the regression results (test statistics, dummy variables etc.) of the model equations, see Appendix D.

Table F4. Error-correction model for the EU export demand for Malaysian cocoa.

$$\Delta \ln X_{MA,t} = -4.68 \ln \Delta \left( \frac{P_{MA}}{P_{EU}} \right)_t - 3.38 \ln \left( \frac{P_{MA}}{P_{EU}} \right)_{t-1} - 0.36 \text{ ECM}$$

(-5.2)
(-2.6)
(-2.7)

$$+ 0.71 \text{ D89} - 0.85 \text{ D96} - 1.75 \text{ const}$$

(2.5)
(-4.7)
(-2.7)

R2 = 0.75	DW = 2.18	d.o.f. = 22	J-B.NORM (X <sup>2</sup> (2)) = 3.78
LM(X <sup>2</sup> (1)) = 1.69	LM(X <sup>2</sup> (2)) = 0.67	LB(X <sup>2</sup> (8)) = 3.37	B-P-G (X <sup>2</sup> (5)) = 5.42
ARCH (X <sup>2</sup> (1)) = 0.06	RESET (F <sub>1,21</sub> ) = 5.59	CHOW (F <sub>4,20</sub> ) = 1.01	G-Q (F <sub>4,20</sub> ) = 0.05

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(5)=11.07, X<sup>2</sup>(8)=15.51  
 F<sub>1,21</sub>=4.32, F<sub>4,20</sub>=2.87

Table F5. Error-correction model for the EU export demand for Indonesian coconut oil.

$$\Delta \ln X_{IN,t} = +2.05 \Delta \ln M_{EU,t} - 2.80 \ln M_{EU,t-1} - 6.97 \ln \Delta \left( \frac{P_{IN}}{P_{EU}} \right)_t - 5.58 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_{t-1} - 0.68 \text{ ECM}$$

(2.7)
(-3.3)
(-3.1)
(-1.5)
(-3.8)

$$- 2.40 \text{ D84} - 38.27 \text{ const}$$

(-2.2)
(-3.3)

R2 = 0.73	DW = 1.91	d.o.f. = 22	J-B.NORM (X <sup>2</sup> (2)) = 20.6
LM(X <sup>2</sup> (1)) = 0.28	LM(X <sup>2</sup> (2)) = 0.68	LB(X <sup>2</sup> (8)) = 7.71	B-P-G (X <sup>2</sup> (6)) = 15.59
ARCH (X <sup>2</sup> (1)) = 0.27	RESET (F <sub>1,21</sub> ) = 3.32	CHOW (F <sub>6,17</sub> ) = 1.90	G-Q (F <sub>6,17</sub> ) = 0.20

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(8)=15.51  
 F<sub>1,21</sub>=4.32, F<sub>6,17</sub>=2.70

Table F6. Error-correction model for the EU export demand for the Philippine coconut oil.

$$\Delta \ln X_{PH,t} = +1.08 \Delta \ln M_{EU,t} - 0.79 \ln \Delta \left( \frac{P_{PH}}{P_{EU}} \right)_t - 0.93 \ln \left( \frac{P_{PH}}{P_{EU}} \right)_{t-1} - 0.46 \text{ ECM}$$

(8.9)
(-2.4)
(-2.8)
(-3.7)

$$+ 0.29 \text{ D81} + 0.52 \text{ D86} - 0.29 \text{ const}$$

(1.6)
(2.6)
(-3.6)

R2 = 0.81	DW = 2.08	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 2.10
LM(X <sup>2</sup> (1)) = 0.52	LM(X <sup>2</sup> (2)) = 0.37	LB(X <sup>2</sup> (12)) = 7.22	B-P-G (X <sup>2</sup> (6)) = 4.70
ARCH (X <sup>2</sup> (1)) = 0.27	RESET (F <sub>1,31</sub> ) = 0.01	CHOW (F <sub>5,29</sub> ) = 1.93	G-Q (F <sub>5,29</sub> ) = 0.62

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(12)=21.03  
 F<sub>1,31</sub>=4.15, F<sub>5,29</sub>=2.55

Table F7. Error-correction model for the EU export demand for Indonesian palm oil .

$$\Delta \ln X_{IN,t} = 0.89 \Delta \ln M_{EU,t} - 0.86 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_{t-1} - 0.75 \text{ECM}$$

(5.1)                      (-1.3)                      (-6.2)

$$+ 0.49 \text{D79}_80 + 0.57 \text{D82} + 0.72 \text{D86}_00 - 1.37 \text{const}$$

(4.0)                      (4.5)                      (5.6)                      (-6.6)

R2 = 0.76	DW = 2.33	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 8.19
LM(X <sup>2</sup> (1)) = 1.36	LM(X <sup>2</sup> (2)) = 1.08	LB(X <sup>2</sup> (12)) = 11.95	B-P-G (X <sup>2</sup> (6)) = 6.76
ARCH (X <sup>2</sup> (1)) = 1.29	RESET (F <sub>1,31</sub> ) = 5.08	CHOW (F <sub>4,31</sub> ) = 2.63	G-Q (F <sub>4,31</sub> ) = 0.40

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(12)=21.03  
F<sub>1,31</sub>=4.15, F<sub>4,31</sub>=2.68

Table F8. Error-correction model for the EU export demand for Malaysian palm oil .

$$\Delta \ln X_{MA,t} = + 1.05 \Delta \ln M_{EU,t} + 0.29 \ln M_{EU,t-1} - 3.47 \ln \Delta \left( \frac{P_{MA}}{P_{EU}} \right)_t - 3.22 \ln \left( \frac{P_{MA}}{P_{EU}} \right)_{t-1} - 0.53 \text{ECM}$$

(6.0)                      (3.7)                      (-4.7)                      (-3.9)                      (-4.8)

$$+ 0.16 \text{D75}_81 - 0.43 \text{D85} - 38.27 \text{const}$$

(2.2)                      (-2.9)                      (3.9)

R2 = 0.74	DW = 2.23	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 1.51
LM(X <sup>2</sup> (1)) = 1.01	LM(X <sup>2</sup> (2)) = 0.93	LB(X <sup>2</sup> (12)) = 14.95	B-P-G (X <sup>2</sup> (7)) = 9.74
ARCH (X <sup>2</sup> (1)) = 0.71	RESET (F <sub>1,30</sub> ) = 3.71	CHOW (F <sub>6,27</sub> ) = 1.69	G-Q (F <sub>6,27</sub> ) = 0.67

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,30</sub>=4.17, F<sub>6,27</sub>=2.46

Table F9. Error-correction model for the EU export demand for Indonesian pepper.

$$\Delta \ln X_{IN,t} = + 0.29 \Delta \ln M_{EU,t} - 0.95 \ln \Delta \left( \frac{P_{IN}}{P_{EU}} \right)_t - 0.58 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_{t-1} - 0.51 \text{ECM}$$

(2.2)                      (-10.3)                      (-5.3)                      (-9.2)

$$- 0.90 \text{D70} + 0.32 \text{D91} - 0.51 \text{const}$$

(-14.5)                      (6.4)                      (-7.6)

R2 = 0.96	DW = 1.92	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 0.22
LM(X <sup>2</sup> (1)) = 0.11	LM(X <sup>2</sup> (2)) = 0.26	LB(X <sup>2</sup> (12)) = 11.92	B-P-G (X <sup>2</sup> (6)) = 2.64
ARCH (X <sup>2</sup> (1)) = 0.03	RESET (F <sub>1,31</sub> ) = 0.21	CHOW (F <sub>5,29</sub> ) = 2.40	G-Q (F <sub>5,29</sub> ) = 10.87

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(12)=21.03  
F<sub>1,31</sub>=4.15, F<sub>5,29</sub>=2.55

**Table F10. Error-correction model for the EU export demand for Malaysian pepper.**

$$\Delta \ln X_{MA,t} = +0.93 \Delta \ln M_{EU,t} - 0.70 \ln \Delta \left( \frac{P_{MA}}{P_{EU}} \right)_t - 1.06 \ln \left( \frac{P_{MA}}{P_{EU}} \right)_{t-1} - 0.67 \text{ECM}$$

(4.8)                      (-3.7)                      (-7.0)                      (-9.8)

$$+ 0.79 \text{D81} + 0.58 \text{D97}_{99} - 0.51 \text{const}$$

(8.3)                      (8.6)                      (-9.7)

R2 = 0.89	DW = 1.98	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 21.2
LM(X <sup>2</sup> (1)) = 0.08	LM(X <sup>2</sup> (2)) = 0.18	LB(X <sup>2</sup> (12)) = 6.04	B-P-G (X <sup>2</sup> (6)) = 9.43
ARCH (X <sup>2</sup> (1)) = 0.01	RESET (F <sub>1,31</sub> ) = 1.25	CHOW (F <sub>5,29</sub> ) = 2.41	G-Q (F <sub>5,29</sub> ) = 0.45

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(12)=21.03  
 F<sub>1,31</sub>=4.15, F<sub>5,29</sub>=2.55

**Table F11. Error-correction model for the EU export demand for Indonesian rubber.**

$$\Delta \ln X_{IN,t} = +0.87 \Delta \ln M_{EU,t} - 0.97 \ln \Delta \left( \frac{P_{IN}}{P_{EU}} \right)_t - 0.25 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_{t-1} - 0.07 \text{ECM}$$

(4.6)                      (-2.4)                      (-1.2)                      (-3.3)

$$+ 0.29 \text{D83} - 0.16 \text{D95} + 0.25 \text{D97} - 0.13 \text{const}$$

(4.0)                      (-2.3)                      (3.6)                      (-2.5)

R2 = 0.73	DW = 2.00	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 40.4
LM(X <sup>2</sup> (1)) = 0.05	LM(X <sup>2</sup> (2)) = 0.36	LB(X <sup>2</sup> (12)) = 12.56	B-P-G (X <sup>2</sup> (7)) = 5.98
ARCH (X <sup>2</sup> (1)) = 0.01	RESET (F <sub>1,30</sub> ) = 1.64	CHOW (F <sub>5,29</sub> ) = 1.97	G-Q (F <sub>5,29</sub> ) = 0.11

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
 F<sub>1,30</sub>=4.17, F<sub>5,29</sub>=2.55

**Table F12. Error-correction model for the EU export demand for Malaysian rubber.**

$$\Delta \ln X_{MA,t} = +0.82 \Delta \ln M_{EU,t} - 0.47 \ln \Delta \left( \frac{P_{MA}}{P_{EU}} \right)_t - 0.20 \ln \left( \frac{P_{MA}}{P_{EU}} \right)_{t-1} - 0.08 \text{ECM}$$

(5.4)                      (-3.1)                      (-1.2)                      (-2.2)

$$+ 0.20 \text{D76}_{79} + 0.16 \text{D84} - 0.08 \text{D96} - 0.51 \text{const}$$

(7.3)                      (2.9)                      (-1.5)                      (-3.1)

R2 = 0.81	DW = 2.22	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 0.70
LM(X <sup>2</sup> (1)) = 0.80	LM(X <sup>2</sup> (2)) = 1.19	LB(X <sup>2</sup> (12)) = 7.86	B-P-G (X <sup>2</sup> (7)) = 8.20
ARCH (X <sup>2</sup> (1)) = 3.03	RESET (F <sub>1,30</sub> ) = 0.05	CHOW (F <sub>5,29</sub> ) = 1.91	G-Q (F <sub>5,29</sub> ) = 1.42

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
 F<sub>1,30</sub>=4.17, F<sub>5,29</sub>=2.55

Table F13. Error-correction model for the EU export demand for Thai rubber.

$$\Delta \ln X_{TH,t} = + 0.71 \Delta \ln M_{EU,t} - 0.92 \ln \Delta \left( \frac{P_{TH}}{P_{EU}} \right)_t - 1.47 \ln \left( \frac{P_{TH}}{P_{EU}} \right)_{t-1} - 0.42 \text{ ECM}$$

(4.6)                      (-2.4)                      (-1.2)                      (-3.3)

$$- 0.97 \text{ D72}_{84} - 0.26 \text{ D94}_{00} - 0.80 \text{ const}$$

(-5.0)                      (1.7)                      (-3.4)

R2 = 0.63	DW = 1.89	d.o.f. = 22	J-B.NORM (X <sup>2</sup> (2)) = 5.03
LM(X <sup>2</sup> (1)) = 0.30	LM(X <sup>2</sup> (2)) = 0.91	LB(X <sup>2</sup> (12)) = 14.48	B-P-G (X <sup>2</sup> (7)) = 10.00
ARCH (X <sup>2</sup> (1)) = 1.43	RESET (F <sub>1,21</sub> ) = 0.04	CHOW (F <sub>5,19</sub> ) = 0.28	G-Q (F <sub>5,29</sub> ) = 8.51

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(8)=15.51  
F<sub>1,21</sub>=4.32, F<sub>5,19</sub>=2.74

Table F14. Error-correction model for the EU export demand for Indonesian tea.

$$\Delta \ln X_{IN,t} = + 1.47 \Delta \ln M_{EU,t} + 0.86 \ln M_{EU,t-1} - 1.37 \ln \Delta \left( \frac{P_{IN}}{P_{EU}} \right)_t - 1.77 \ln \left( \frac{P_{IN}}{P_{EU}} \right)_{t-1} - 0.47 \text{ ECM}$$

(5.5)                      (2.6)                      (-4.3)                      (-4.5)                      (-4.1)

$$+ 0.41 \text{ D84} + 0.13 \text{ D96}_{97} - 12.21 \text{ const}$$

(3.2)                      (1.3)                      (-2.8)

R2 = 0.74	DW = 1.69	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 1.79
LM(X <sup>2</sup> (1)) = 1.17	LM(X <sup>2</sup> (2)) = 0.51	LB(X <sup>2</sup> (12)) = 11.21	B-P-G (X <sup>2</sup> (7)) = 11.08
ARCH (X <sup>2</sup> (1)) = 0.30	RESET (F <sub>1,30</sub> ) = 0.02	CHOW (F <sub>6,27</sub> ) = 2.98	G-Q (F <sub>6,27</sub> ) = 0.11

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,31</sub>=4.15, F<sub>6,27</sub>=2.46

**Appendix G: Regression results of import supply equations<sup>1</sup>**

G.1

**Table G1. Error-correction model for the import supply for cassava in the EU.**

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$$\Delta \ln P_{EU,t} = 0.56 \Delta \ln P_{W,t} - 0.19 \text{ ECM} - 0.02 \text{ const}$$

(6.8)                      (-2.2)                      (-1.1)

R2 = 0.58	DW = 1.38	d.o.f. = 35	J-B.NORM (X <sup>2</sup> (2)) = 0.16
LM(X <sup>2</sup> (1)) = 2.10	LM(X <sup>2</sup> (2)) = 0.18	LB(X <sup>2</sup> (11)) = 9.27	B-P-G (X <sup>2</sup> (2)) = 1.09
ARCH (X <sup>2</sup> (1)) = 0.18	RESET (F <sub>1,34</sub> ) = 1.30	CHOW (F <sub>3,32</sub> ) = 2.54	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(11)=19.68, F<sub>1,33</sub>=4.14, F<sub>3,31</sub>=2.91

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**Table G2. Error-correction model for the import supply for cocoa in the EU.**

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$$\Delta \ln P_{EU,t} = 0.93 \Delta \ln P_{W,t} - 0.17 \text{ ECM} - 0.01 \text{ const}$$

(14.8)                      (-1.8)                      (-1.0)

R2 = 0.86	DW = 1.28	d.o.f. = 34	J-B.NORM (X <sup>2</sup> (2)) = 0.25
LM(X <sup>2</sup> (1)) = 2.67	LM(X <sup>2</sup> (2)) = 0.20	LB(X <sup>2</sup> (11)) = 20.08	B-P-G (X <sup>2</sup> (2)) = 4.17
ARCH (X <sup>2</sup> (1)) = 8.40	RESET (F <sub>1,33</sub> ) = 0.93	CHOW (F <sub>3,31</sub> ) = 0.35	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(11)=19.68, F<sub>1,33</sub>=4.14, F<sub>3,31</sub>=2.91

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**Table G3. Error-correction model for the import supply for coconut oil in the EU.**

---

$$\Delta \ln P_{EU,t} = 1.05 \Delta \ln P_{W,t} - 0.25 \text{ ECM} - 0.02 \text{ const}$$

(18.8)                      (-2.2)                      (-1.3)

R2 = 0.92	DW = 1.60	d.o.f. = 35	J-B.NORM (X <sup>2</sup> (2)) = 1.26
LM(X <sup>2</sup> (1)) = 1.57	LM(X <sup>2</sup> (2)) = 0.03	LB(X <sup>2</sup> (11)) = 12.54	B-P-G (X <sup>2</sup> (2)) = 1.22
ARCH (X <sup>2</sup> (1)) = 1.60	RESET (F <sub>1,34</sub> ) = 0.38	CHOW (F <sub>3,32</sub> ) = 0.19	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(11)=19.68, F<sub>1,33</sub>=4.14, F<sub>3,31</sub>=2.91

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**Table G4. Error-correction model for the import supply for palm oil in the EU.**

---

$$\Delta \ln P_{EU,t} = 1.05 \Delta \ln P_{W,t} - 0.17 \text{ ECM} - 0.03 \text{ const}$$

(13.2)                      (-1.7)                      (-1.3)

R2 = 0.85	DW = 1.51	d.o.f. = 35	J-B.NORM (X <sup>2</sup> (2)) = 0.18
LM(X <sup>2</sup> (1)) = 1.81	LM(X <sup>2</sup> (2)) = 0.34	LB(X <sup>2</sup> (11)) = 18.73	B-P-G (X <sup>2</sup> (2)) = 2.79
ARCH (X <sup>2</sup> (1)) = 2.80	RESET (F <sub>1,34</sub> ) = 0.02	CHOW (F <sub>3,32</sub> ) = 0.20	

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(11)=19.68, F<sub>1,33</sub>=4.14, F<sub>3,31</sub>=2.91

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<sup>1</sup> For an explanation of the regression results (test statistics, dummy variables etc.) of the model equations, see Appendix D.

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Table G5. Error-correction model for the import supply for pepper in the EU.

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$$\Delta \ln P_{EU,t} = 0.96 \Delta \ln P_{W,t} - 0.50 \text{ ECM} - 0.06 \text{ const}$$

(34.6)                      (-3.9)                      (-3.6)

R2 = 0.98	DW = 2.03	d.o.f. = 34	J-B.NORM (X <sup>2</sup> (2)) = 0.45
LM(X <sup>2</sup> (1)) = 0.69	LM(X <sup>2</sup> (2)) = 0.04	LB(X <sup>2</sup> (11)) = 13.73	B-P-G (X <sup>2</sup> (2)) = 0.53
ARCH (X <sup>2</sup> (1)) = 3.38	RESET (F <sub>1,33</sub> ) = 0.31	CHOW (F <sub>3,31</sub> ) = 1.24	

---

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(11)=19.68, F<sub>1,33</sub>=4.14, F<sub>3,31</sub>=2.91

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Table G6. Error-correction model for the import supply for rubber in the EU.

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$$\Delta \ln P_{EU,t} = 0.87 \Delta \ln P_{W,t} - 0.23 \text{ ECM} - 0.02 \text{ const}$$

(13.8)                      (-2.3)                      (-1.1)

R2 = 0.85	DW = 1.59	d.o.f. = 35	J-B.NORM (X <sup>2</sup> (2)) = 0.26
LM(X <sup>2</sup> (1)) = 1.64	LM(X <sup>2</sup> (2)) = 0.29	LB(X <sup>2</sup> (11)) = 12.55	B-P-G (X <sup>2</sup> (2)) = 5.95
ARCH (X <sup>2</sup> (1)) = 2.36	RESET (F <sub>1,34</sub> ) = 0.02	CHOW (F <sub>3,32</sub> ) = 1.17	

---

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(11)=19.68, F<sub>1,33</sub>=4.14, F<sub>3,31</sub>=2.91

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**Appendix H: Regression results of export supply equations<sup>1</sup>**

H.1

**Table H1. Regression model for the export supply of Indonesian cassava to the EU.**

$$\Delta \ln X_{IN,t} = -0.40 \ln X_{IN,t-1} + 1.65 \ln \Delta \left( \frac{P_{IN}}{D_{IN}} \right)_t + 1.62 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_t - 0.06 T$$

(-2.6)                      (3.0)                      (2.6)                      (-3.4)

$$-1.44 D69_{73} - 1.68 D83 + 0.82 D84_{85} - 2.82 \text{ const}$$

(-2.8)                      (-2.7)                      (1.9)                      (-1.0)

R2 = 0.55	DW = 1.95	d.o.f. = 24	J-B.NORM (X <sup>2</sup> (2)) = 2.88
LM(X <sup>2</sup> (1)) = 0.01	LM(X <sup>2</sup> (2)) = 1.68	LB(X <sup>2</sup> (9)) = 6.83	B-P-G (X <sup>2</sup> (7)) = 12.55
ARCH (X <sup>2</sup> (1)) = 2.83	RESET (F <sub>1,23</sub> ) = 1.24	CHOW(F <sub>5,22</sub> ) = 1.92	G-Q (F <sub>5,22</sub> ) = 0.72

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(9)=16.92  
F<sub>1,23</sub>=4.28, F<sub>5,22</sub>=2.66

**Table H2. Regression model for the export supply of Thai cassava to the EU.**

$$\Delta \ln X_{TH,t} = -0.71 \ln X_{TH,t-1} + 0.95 \ln \Delta \left( \frac{P_{TH}}{D_{IN}} \right)_t + 0.68 \ln \left( \frac{P_{TH}}{D_{TH}} \right)_{t-1} + 0.01 T$$

(-6.7)                      (4.5)                      (3.9)                      (1.6)

$$-0.88 D69_{76} - 0.51 D89 - 0.67 D95 + 8.05 \text{ const}$$

(-5.0)                      (-3.1)                      (-4.1)                      (5.7)

R2 = 0.80	DW = 2.34	d.o.f. = 24	J-B.NORM (X <sup>2</sup> (2)) = 3.42
LM(X <sup>2</sup> (1)) = 1.23	LM(X <sup>2</sup> (2)) = 1.86	LB(X <sup>2</sup> (9)) = 6.40	B-P-G (X <sup>2</sup> (7)) = 4.23
ARCH (X <sup>2</sup> (1)) = 0.07	RESET (F <sub>1,23</sub> ) = 0.31	CHOW(F <sub>5,22</sub> ) = 1.65	G-Q (F <sub>5,16</sub> ) = 0.96

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(9)=16.92  
F<sub>1,23</sub>=4.28, F<sub>5,22</sub>=2.66

**Table H3. Regression model for the export supply of Indonesian cocoa to the EU.**

$$\Delta \ln X_{IN,t} = -0.87 \ln X_{IN,t-1} + 0.53 \ln \Delta \left( \frac{P_{IN}}{D_{IN}} \right)_{t-3} + 0.31 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-4} + 0.10 T$$

(-5.3)                      (1.9)                      (1.5)                      (4.3)

$$-1.47 D94 - 0.44 D96 - 1.41 D00 + 3.46 \text{ const}$$

(1.8)                      (-3.1)                      (2.8)                      (-3.0)

R2 = 0.72	DW = 1.36	d.o.f. = 18	J-B.NORM (X <sup>2</sup> (2)) = 1.04
LM(X <sup>2</sup> (1)) = 1.76	LM(X <sup>2</sup> (2)) = 2.06	LB(X <sup>2</sup> (7)) = 22.06	B-P-G (X <sup>2</sup> (7)) = 14.70
ARCH (X <sup>2</sup> (1)) = 0.86	RESET (F <sub>1,17</sub> ) = 3.92	CHOW(F <sub>5,16</sub> ) = 2.33	G-Q (F <sub>5,16</sub> ) = 0.32

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(8)=15.51  
F<sub>1,17</sub>=4.45, F<sub>5,16</sub>=2.85

<sup>1</sup> For an explanation of the regression results (test statistics, dummy variables etc.) of the model equations, see Appendix D.



Table H4. Regression model for the export supply of Malaysian cocoa to the EU.

$$\Delta \ln X_{MA,t} = -0.24 \ln X_{MA,t-1} + 0.95 \ln \Delta \left( \frac{P_{MA}}{D_{MA}} \right)_{t-3} + 1.12 \ln \left( \frac{P_{MA}}{D_{MA}} \right)_{t-4} - 0.27 T$$

(-2.9)                      (2.6)                      (4.1)                      (-1.3)

$$- 1.28 D71_{83} - 0.38 D90 - 0.83 D99 - 6.04 \text{ const}$$

(-4.2)                      (-1.0)                      (-2.4)                      (-2.3)

R2 = 0.71	DW = 1.91	d.o.f. = 18	J-B.NORM (X <sup>2</sup> (2)) = 3.32
LM(X <sup>2</sup> (1)) = 0.14	LM(X <sup>2</sup> (2)) = 2.19	LB(X <sup>2</sup> (7)) = 6.17	B-P-G (X <sup>2</sup> (7)) = 6.49
ARCH (X <sup>2</sup> (1)) = 0.11	RESET (F <sub>1,17</sub> ) = 0.36	CHOW(F <sub>5,16</sub> ) = 2.35	G-Q (F <sub>5,16</sub> ) = 0.72

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(8)=15.51  
F<sub>1,17</sub>=4.45, F<sub>5,16</sub>=2.85

Table H5. Regression model for the export supply of Indonesian coconut oil to the EU.

$$\Delta \ln X_{IN,t} = -1.10 \ln X_{IN,t-1} + 0.47 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-1} + 0.21 \ln \Delta \left( \frac{P_{IN}}{D_{IN}} \right)_{t-6} + 0.29 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-7} + 0.29 T$$

(-7.4)                      (1.1)                      (1.9)                      (4.1)                      (5.8)

$$- 3.37 D84 - 1.16 D99_{00} - 2.23 \text{ const}$$

(-5.1)                      (-1.8)                      (-0.7)

R2 = 0.85	DW = 1.31	d.o.f. = 21	J-B.NORM (X <sup>2</sup> (2)) = 1.64
LM(X <sup>2</sup> (1)) = 2.04	LM(X <sup>2</sup> (2)) = 0.63	LB(X <sup>2</sup> (8)) = 10.44	B-P-G (X <sup>2</sup> (7)) = 10.04
ARCH (X <sup>2</sup> (1)) = 0.01	RESET (F <sub>1,20</sub> ) = 7.75	CHOW(F <sub>6,17</sub> ) = 1.67	G-Q (F <sub>6,17</sub> ) = 14.40

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(8)=15.51  
F<sub>1,20</sub>=4.35, F<sub>6,17</sub>=2.70

Table H6. Regression model for the export supply of the Philippine coconut oil to the EU.

$$\Delta \ln X_{PH,t} = -0.66 \ln X_{PH,t-1} + 0.97 \ln \Delta \left( \frac{P_{PH}}{D_{PH}} \right)_t + 1.37 \ln \left( \frac{P_{PH}}{D_{PH}} \right)_{t-1} + 0.02 T$$

(-5.1)                      (2.4)                      (2.4)                      (1.3)

$$- 1.09 D61_{75} + 0.71 D86 - 0.42 D97 + 4.05 \text{ const}$$

(2.4)                      (-1.5)                      (-4.6)                      (2.0)

R2 = 0.66	DW = 2.22	d.o.f. = 25	J-B.NORM (X <sup>2</sup> (2)) = 10.49
LM(X <sup>2</sup> (1)) = 0.86	LM(X <sup>2</sup> (2)) = 1.56	LB(X <sup>2</sup> (10)) = 10.36	B-P-G (X <sup>2</sup> (7)) = 9.56
ARCH (X <sup>2</sup> (1)) = 0.12	RESET (F <sub>1,24</sub> ) = 0.35	CHOW(F <sub>5,23</sub> ) = 3.42	G-Q (F <sub>5,23</sub> ) = 0.98

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(10)=18.31  
F<sub>1,24</sub>=4.26, F<sub>5,23</sub>=2.64

Table H7. Regression model for the export supply of Indonesian palm oil to the EU.

$$\Delta \ln X_{IN,t} = -0.82 \ln X_{IN,t-1} + 0.16 \ln \Delta \left( \frac{P_{IN}}{D_{IN}} \right)_t + 0.15 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-1} + 0.07 T$$

(-5.8)
(1.3)
(1.1)
(5.9)

$$-0.32 D78 - 0.94 D84 - 0.34 D96_{00} + 7.73 \text{ const}$$

(-1.7)
(-4.8)
(2.6)
(6.0)

R2 = 0.76	DW = 2.33	d.o.f. = 26	J-B.NORM (X <sup>2</sup> (2)) = 15.52
LM(X <sup>2</sup> (1)) = 1.44	LM(X <sup>2</sup> (2)) = 1.69	LB(X <sup>2</sup> (11)) = 10.08	B-P-G (X <sup>2</sup> (7)) = 8.95
ARCH (X <sup>2</sup> (1)) = 0.17	RESET (F <sub>1,25</sub> ) = 0.55	CHOW(F <sub>5,24</sub> ) = 0.62	G-Q (F <sub>5,24</sub> ) = 0.18

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(11)=19.68  
 F<sub>1,25</sub>=4.24, F<sub>5,24</sub>=2.62

Table H8. Regression model for the export supply of Malaysian palm oil to the EU.

$$\Delta \ln X_{MA,t} = -0.60 \ln X_{MA,t-1} + 0.37 \ln \Delta \left( \frac{P_{MA}}{D_{MA}} \right)_t + 0.52 \ln \Delta \left( \frac{P_{IN}}{D_{IN}} \right)_{t-1} + 0.06 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-7} + 0.04$$

(-5.9)
(2.4)
(3.5)
(3.8)
(5.3)

$$+ 0.29 D75_{81} - 0.75 D85 + 2.25 \text{ const}$$

(3.0)
(-4.9)
(1.6)

R2 = 0.68	DW = 2.13	d.o.f. = 30	J-B.NORM (X <sup>2</sup> (2)) = 0.12
LM(X <sup>2</sup> (1)) = 0.61	LM(X <sup>2</sup> (2)) = 1.42	LB(X <sup>2</sup> (10)) = 11.40	B-P-G (X <sup>2</sup> (7)) = 7.96
ARCH (X <sup>2</sup> (1)) = 0.16	RESET (F <sub>1,29</sub> ) = 0.05	CHOW(F <sub>6,26</sub> ) = 2.43	G-Q (F <sub>5,16</sub> ) = 0.55

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(10)=18.31  
 F<sub>1,29</sub>=4.18, F<sub>6,26</sub>=2.48

Table H9. Regression model for the export supply of Indonesian pepper to the EU.

$$\Delta \ln X_{IN,t} = -0.71 \ln X_{IN,t-1} + 0.08 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-1} + 0.02 T$$

(-8.3)
(1.8)
(6.6)

$$-1.02 D70 - 0.34 D91 + 1.00 \text{ const}$$

(-1.7)
(-4.8)
(2.6)

R2 = 0.84	DW = 1.82	d.o.f. = 33	J-B.NORM (X <sup>2</sup> (2)) = 6.72
LM(X <sup>2</sup> (1)) = 0.22	LM(X <sup>2</sup> (2)) = 0.32	LB(X <sup>2</sup> (12)) = 1.91	B-P-G (X <sup>2</sup> (5)) = 5.94
ARCH (X <sup>2</sup> (1)) = 0.03	RESET (F <sub>1,32</sub> ) = 3.11	CHOW(F <sub>4,31</sub> ) = 0.54	G-Q (F <sub>4,31</sub> ) = 2.45

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(5)=11.07, X<sup>2</sup>(12)=21.03  
 F<sub>1,32</sub>=4.14, F<sub>4,31</sub>=2.68

Table H10. Regression model for the export supply of Malaysian pepper to the EU.

$$\Delta \ln X_{MA,t} = -0.74 \ln X_{MA,t-1} + 0.11 \ln \left( \frac{P_{MA}}{D_{MA}} \right)_{t-1} + 0.03 T$$

(-8.0)                      (2.4)                      (6.9)

$$+ 0.75 D81 + 0.41 D89 - 0.59 D00 + 0.14 \text{ const}$$

(6.9)                      (3.7)                      (-5.0)                      (2.2)

R2 = 0.83	DW = 2.49	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 5.04
LM(X <sup>2</sup> (1)) = 1.99	LM(X <sup>2</sup> (2)) = 0.52	LB(X <sup>2</sup> (12)) = 9.53	B-P-G (X <sup>2</sup> (6)) = 10.77
ARCH (X <sup>2</sup> (1)) = 10.66	RESET (F <sub>1,31</sub> ) = 4.42	CHOW(F <sub>4,31</sub> ) = 2.41	G-Q (F <sub>4,31</sub> ) = 0.50

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(12)=21.03  
F<sub>1,31</sub>=4.15, F<sub>4,31</sub>=2.68

Table H11. Regression model for the export supply of Indonesian rubber to the EU.

$$\Delta \ln X_{IN,t} = -0.51 \ln X_{IN,t-1} + 0.14 \ln \Delta \left( \frac{P_{IN}}{D_{IN}} \right)_t + 0.07 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-1}$$

(-3.7)                      (3.0)                      (2.6)

$$+ 0.26 D83 - 0.23 D95 + 0.326 D97 - 0.26 D99 + 0.06 \text{ const}$$

(4.2)                      (-3.6)                      (4.3)                      (-3.7)                      (0.2)

R2 = 0.80	DW = 2.37	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 2.89
LM(X <sup>2</sup> (1)) = 1.28	LM(X <sup>2</sup> (2)) = 0.88	LB(X <sup>2</sup> (12)) = 17.64	B-P-G (X <sup>2</sup> (7)) = 5.87
ARCH (X <sup>2</sup> (1)) = 0.73	RESET (F <sub>1,30</sub> ) = 1.16	CHOW(F <sub>4,31</sub> ) = 3.62	G-Q (F <sub>4,31</sub> ) = 0.26

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,30</sub>=4.17, F<sub>4,31</sub>=2.68

Table H12. Regression model for the export supply of Malaysian rubber to the EU.

$$\Delta \ln X_{MA,t} = -0.07 \ln X_{MA,t-1} + 0.29 \ln \Delta \left( \frac{P_{MA}}{D_{MA}} \right)_t + 0.07 \ln \left( \frac{P_{MA}}{D_{MA}} \right)_{t-1} + 0.02 T$$

(-1.3)                      (4.5)                      (1.5)                      (1.3)

$$+ 0.25 D84 - 0.10 D90 - 0.15 D93_94 + 0.27 \text{ const}$$

(3.3)                      (-2.1)                      (-2.7)                      (0.4)

R2 = 0.62	DW = 1.83	d.o.f. = 31	J-B.NORM (X <sup>2</sup> (2)) = 7.07
LM(X <sup>2</sup> (1)) = 0.49	LM(X <sup>2</sup> (2)) = 1.61	LB(X <sup>2</sup> (12)) = 9.13	B-P-G (X <sup>2</sup> (7)) = 5.68
ARCH (X <sup>2</sup> (1)) = 0.90	RESET (F <sub>1,30</sub> ) = 1.18	CHOW(F <sub>5,29</sub> ) = 1.63	G-Q (F <sub>5,24</sub> ) = 0.31

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(7)=14.07, X<sup>2</sup>(12)=21.03  
F<sub>1,30</sub>=4.17, F<sub>5,29</sub>=2.55

Table H13. Regression model for the export supply of Thai rubber to the EU.

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$$\Delta \ln X_{TH,t} = -0.65 \ln X_{TH,t-1} + 0.68 \ln \Delta \left( \frac{P_{TH}}{D_{TH}} \right)_t + 0.34 \ln \left( \frac{P_{TH}}{D_{TH}} \right)_{t-1} + 0.08 T$$

(-5.9)
(3.0)
(1.4)
(4.3)

$$- 0.32 D78 + 7.73 \text{ const}$$

(-5.5)
(1.8)

R2 = 0.75	DW = 1.94	d.o.f. = 22	J-B.NORM (X <sup>2</sup> (2)) = 6.45
LM(X <sup>2</sup> (1)) = 0.04	LM(X <sup>2</sup> (2)) = 1.51	LB(X <sup>2</sup> (8)) = 7.96	B-P-G (X <sup>2</sup> (5)) = 6.09
ARCH (X <sup>2</sup> (1)) = 0.02	RESET (F <sub>1,21</sub> ) = 0.08	CHOW(F <sub>5,18</sub> ) = 1.46	G-Q (F <sub>5,24</sub> ) = 6.43

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(5)=11.07, X<sup>2</sup>(8)=15.51  
 F<sub>1,21</sub>=4.32, F<sub>5,18</sub>=2.77

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Table H14. Regression model for the export supply of Indonesian tea to the EU.

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$$\Delta \ln X_{IN,t} = -0.21 \ln X_{IN,t-1} + 0.05 \ln \left( \frac{P_{IN}}{D_{IN}} \right)_{t-1} + 0.01 T$$

(-1.7)
(0.7)
(1.2)

$$+ 0.21 D70 - 0.31 D78 + 0.53 D84 + 1.00 \text{ const}$$

(1.2)
(-1.8)
(2.9)
(1.1)

R2 = 0.41	DW = 2.30	d.o.f. = 32	J-B.NORM (X <sup>2</sup> (2)) = 0.80
LM(X <sup>2</sup> (1)) = 1.61	LM(X <sup>2</sup> (2)) = 0.19	LB(X <sup>2</sup> (12)) = 13.48	B-P-G (X <sup>2</sup> (6)) = 9.77
ARCH (X <sup>2</sup> (1)) = 0.81	RESET (F <sub>1,31</sub> ) = 0.81	CHOW(F <sub>4,31</sub> ) = 4.18	G-Q (F <sub>4,31</sub> ) = 0.28

Critical values at the 5 per cent level for the test above: X<sup>2</sup>(1)=3.84, X<sup>2</sup>(2)=5.99, X<sup>2</sup>(6)=12.59, X<sup>2</sup>(12)=21.03  
 F<sub>1,31</sub>=4.15, F<sub>4,31</sub>=2.68

**Appendix I: Derivation of dynamic equilibrium solution for the equations**

I.1

In order to derive the long-run dynamic equilibrium properties of the relationship between the dependent variable and its explanatory variable, the approach used by Currie (1981) is adopted here. The long-run dynamic solution of a single-equation system generates a steady-state response in which growth occurs at a constant rate, say  $g$ , and all transient responses have disappeared. For the dynamic specification of the import demand relationship described by

$$(I-1) \quad \ln M_j^d = \ln \hat{a}_1 + \epsilon_m^y \ln Y_j + \epsilon_m^p \ln \left( \frac{P_j}{D_j} \right),$$

if  $g_1$  is defined as the steady-state growth rate of domestic economic activity  $Y$ , and  $g_2$  corresponds to the steady-state growth rate of the import demand  $M$ , then  $\Delta \ln Y_{jt} = g_1$  and  $\Delta \ln M_{jt} = g_2$  in dynamic equilibrium.

The first step is to find the relationship between the rate of change of the dependent variable and that of its explanatory variable. Given the systematic dynamics of the general stochastic difference equation

$$(I-2) \quad \ln M_{jt} = a_0 + a_1 \ln Y_{jt} + a_2 \ln Y_{j,t-1} + a_3 \ln \left( \frac{P_j}{D_j} \right)_t + a_4 \ln \left( \frac{P_j}{D_j} \right)_{t-1} + a_5 \ln M_{j,t-1} + v_{jt}$$

the first difference of that equation is

$$(I-3) \quad \Delta \ln M_{jt} = a_1 \Delta \ln Y_{jt} + a_2 \ln \Delta Y_{j,t-1} + a_3 \Delta \ln \left( \frac{P_j}{D_j} \right)_t + a_4 \Delta \left( \frac{P_j}{D_j} \right)_{t-1} + a_5 \ln \Delta (M_j)_{t-1}$$

Since in dynamic equilibrium  $\Delta \ln Y_{jt} = g_1$  and  $\Delta \ln M_{jt} = g_2$ , it follows that

$$g_2 = a_1 g_1 + a_2 g_1 + 0 + 0 + a_5 g_2.$$

Therefore

$$(1 - a_5) g_2 = a_1 g_1 + a_2 g_1 + 0 + 0 + a_5 g_2$$

and hence

$$g_2 = \left( \frac{a_1 + a_2}{1 - a_5} \right) g_1$$

Consider now the ECM specification of import demand equation, where  $\ln M_{EU}$  has a steady-state response to  $\ln Y_{EU}$ , but a transient response to  $\ln P_j/D_j$ :

(I-4)

$$\Delta \ln M_{jt} = \alpha_0 + \alpha_1 \Delta \ln Y_{jt} + \alpha_2 \ln Y_{j,t-1} + \alpha_3 \Delta \ln \left( \frac{P_j}{D_j} \right)_t + \alpha_4 \left( \frac{P_j}{D_j} \right)_{t-1} + \alpha_5 \ln \left( \frac{M_j}{Y_j} \right)_{t-1} + v_{jt}$$

Since  $\Delta \ln Y_{jt} = g_1$  and  $\Delta \ln M_{jt} = g_2$ , the long-run dynamic equilibrium solution is

$$(I-5) \quad g_2 = \alpha_0 + \alpha_1 g_1 + \alpha_2 \ln Y_j + \alpha_4 \ln \left( \frac{P_j}{D_j} \right) + \alpha_5 \ln \left( \frac{M_j}{Y_j} \right)$$

The substitution of  $g_2$  for its expression in terms of  $g_1$  in (I-5) yields

$$\left( \frac{\alpha_1 + \alpha_2}{1 - \alpha_5} \right) g_1 = \left( \frac{\alpha_1 + \alpha_2}{\alpha_5} \right) g_1 = \alpha_0 + \alpha_1 g_1 + \alpha_2 \ln Y_j + \alpha_4 \ln \left( \frac{P_j}{D_j} \right) + \alpha_5 \ln M_j - \alpha_5 \ln Y_j$$

and rearrangement of the terms yields

$$\alpha_5 \ln M_j = -\alpha_0 - \left( \frac{\alpha_1 + \alpha_2}{\alpha_5} \right) g_1 + \alpha_1 g_1 + (\alpha - \alpha_2) \ln Y_j + \alpha_4 \ln \left( \frac{P_j}{D_j} \right).$$

Now solve for  $M$ :

$$(I-6) \quad \ln M_j = -\frac{\alpha_0}{\alpha_5} + \left( \frac{1 - \alpha_1}{\alpha_5} \right) g_1 + \left( 1 - \frac{\alpha_2}{\alpha_5} \right) \ln Y_j - \left( \frac{\alpha_4}{\alpha_5} \right) \ln \left( \frac{P_j}{D_j} \right)$$

or, in terms of the original (anti-logarithmic) values of the variable,

$$(I-7) \quad M_j = \hat{a}_1^* Y_j^{1 - (\alpha_2/\alpha_5)} \left( \frac{P_j}{D_j} \right)^{-\alpha_4/\alpha_5}$$

where  $\hat{a}_1^* = \exp \{ [-\alpha_0 + (1 - \alpha_1)g_1]/\alpha_5 \}$ . Equation (I-6) encompasses the static equilibrium solution when  $g_1 = 0$ . The income elasticity of import demand is expressed as  $\epsilon_m^y = 1 - (\alpha_2/\alpha_5)$ . The price elasticity of import demand is  $\epsilon_m^p = -\alpha_4/\alpha_5$ .