INTERACTION BETWEEN FINANCIAL AND REAL DECISIONS IN AN INTERNATIONAL ECONOMY

By

Khang Min Lee

B. Sc. (Economics and Computer Studies) Trent University

M. A. (Economics) University of British Columbia

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Department of Commerce & Business Administration

The University of British Columbia
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Abstract

This thesis examines the interaction between real and financial decisions in a two-country world economy. To understand this interaction, we develop two-country general equilibrium multi-period models of pure exchange and production economies. We model the real decisions of consumption and investment choice and the financial decisions of portfolio choice explicitly under various degrees of financial market integration. In addition, we allow the governments to act strategically in making their policy choice regarding the degree of integration in the international goods and financial markets. Therefore, our models allow us to examine the effect of the interaction between real and financial decisions on policy choice in the goods and financial markets.

The main results in the thesis are presented in Chapters 3, 4 and 5. We first analyse how the optimal tariff decision may vary under different financial market structures. In order to do so, we determine the government's choice of tariff level using a two-good general equilibrium framework where the financial structure in the economy is explicitly modelled. We find that the extent to which of financial markets are integrated affects trade policy decisions in the commodity markets. Specifically, we find an inverse relationship between the Nash equilibrium tariff level and the degree of international financial market integration. The intuition underlying this result is as follows. In our model, the government uses tariffs to cause a favourable change in the terms of trade. However, in the presence of financial markets, households can hedge endowment risks and the change in the terms of trade by using financial contracts. Thus, the favourable terms of trade effect (which is the motivation for a tariff in our model) associated with

a tariff levy is reduced with increasing degrees of financial integration.

Given the influence of financial market structure on endogenous trade policy, we then characterise and numerically compute the welfare gains from financial market integration. We identify the welfare gains from two sources. The direct source is the gain from risk-sharing in the financial markets. The second source is the gain from free trade in the commodity market that results from a government's tariff game in the presence of complete financial integration. We find that the magnitude of the welfare gain due to free trade is substantially greater than that due to increased risk-sharing capabilities under a reasonable calibration of our world economy.

Thus far, we have assumed the financial market segmentation in the economy to be exogenous and our results suggest that the existing financial market structure has important repercussions in the commodity markets. In the third part of our analysis, we analyse the government's choice of financial market structure. To do this, we examine the equilibrium policy choice of financial market segmentation in the absence of trade policy. That is, under what conditions will a country find it optimal to limit access to its own or foreign capital markets? Our results suggest that in the special case in which the production technology exhibits constant returns to scale in capital, each country may choose to deny foreign access to its domestic stock market. In general however, we find that complete financial market integration will be the optimal choice for both countries.

Our main finding is that there are strong interactions between financial markets and goods markets. Consequently, the optimal tariff level can be very different under different financial market structures. Also, the welfare impact of opening financial markets can be large, given the influence of financial market structure on endogenous tariffs in the goods markets. Finally in a production economy, the optimal financial market structure can be related to the nature of the production technology.

Some policy recommendations follow from our work. First, the existing financial market structure in the economy should be considered in making the policy choice of a tariff level: the more integrated the financial markets, the lower the optimal tariffs. Second, the share of capital in a country's production technology is an important factor in the decision of the optimal financial market structure. When the production technology exhibits decreasing returns to scale in capital, the optimal financial structure is complete integration.

Table of Contents

List of Tables

List of Figures

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Chapter 1

Introduction

In this thesis, our objective is to understand the interdependence between the liberalization in the goods and financial markets in international economies. This work is motivated by the policy debate on liberalization of international financial and commodity markets, and also by the academic work done in this area. The importance of our work can be gauged by the discussion of these issues in the European Monetary Union and also by other free-trade agreements such as the General Agreement on Tariffs and Trade (GATT), the Free Trade Agreement (FTA) and the North American Free Trade Agreement (NAFTA). We describe below our contribution to the understanding of these issues.

In the finance literature, the primary role of international financial markets is to provide risk-sharing opportunities for households in a global economy. International trade, on the other hand, allows goods to be exchanged between households in countries. Since the exchange of claims to future deliveries in the financial markets influences the relative prices of goods in the future, households' consumption and investment choices and international trade behaviour is affected by the presence of international financial markets. Conversely, the trading opportunities in the goods markets affect the consumers' portfolio allocation decisions and the determination of the prices of financial assets.

Since the end of World War II, there has been a growing integration of the world economy and globalisation of policy making. Evidence of this can be found in the progress made during the eight rounds of GATT in which tariff barriers were gradually reduced and an attempt was made to reduce non-tariff barriers (NTB). Between 1950 and 1980, the average tariff rate in the industrial countries fell from about 40% to less than 5% (Frenkel, Razin and Sadka (1991)). Concurrently, the International Monetary Fund (IMF), the World Bank, and the Organization for Economic Cooperation and Development (OECD) have worked to remove exchange controls and international capital barriers with success. Halliday (1989) and Gultekin, Gultekin and Penati (1989) report little segmentation in financial markets in the developed countries after 1980.

The interaction between decisions in financial and real markets has been studied extensively. It is established theoretically by Grossman and Razin (1985), Stockman (1987), Cole (1988) and Feeney (1994) that financial market completeness influences real variables including output, consumption, saving, and investment. However, in these models the goods markets are assumed to be frictionless. In the international economy, however, there still exist both tariff and non-tariff barriers to trade (Wei (1996)).

When it is costly to trade commodities internationally, perfect risk sharing is not achieved even in the presence of complete financial markets (see, for example, Uppal (1992)). The presence of trade barriers alters households' financial decisions, which in turn affect real decisions. If the barriers in the goods markets arise from some endogenous trade policy, such as tariffs, the interaction between financial and real decisions will influence the effectiveness of the trade policy and therefore influence trade policy decisions. Helpman and Razin (1978), and Stockman and Dellas (1986) establish that the presence of financial markets alters the effects of tariff policy. In this thesis, we endogenize tariff policy and determine the optimal tariff level under different international financial market structures. We also evaluate the welfare gains that arise from financial market integration.

The modelling approach that we adopt is the following. We develop a general equilibrium model of a two-country, two-good world economy with stochastic endowments where the financial market structure is explicitly modelled. In our model, the international goods markets are segmented by the presence of import tariffs. Domestic households pay a higher price for the foreign good relative to the price that foreign households pay. As both countries are large enough that they are not price takers, the domestic import tariffs affect the relative world price of goods. Unlike previous work examining the interaction between financial markets and tariff policy, we allow governments to choose tariff levels in response to the financial structure in the economy. In our model, the tariff level is determined as a Nash equilibrium of a tariff game between the two governments.

We model the import tariff as a means for the domestic government to extract monopolistic rent by transferring wealth from the foreign country via an improvement in the terms of trade. This is the terms-of-trade argument for the presence of tariffs in the trade literature such as Johnson (1953), Mayer (1981), Kennan and Riezman (1988), Vousden (1990), and many others.[1] The tariff revenue collected by the government is re-distributed to the domestic households as a form of lump-sum transfer.

The presence of international financial markets in our model allows households to hedge endowment risks. We assume financial markets to be frictionless, that is, there are no transactions costs in the trading of financial claims. The segmentation of international financial markets is modelled by imposing restrictions on the types of assets that can

[1]There are other motivations for tariff policy, including protecting infant industries (Meade (1955), Baldwin (1969)), generating revenue to finance government expenditure (Wildasin and Wilson (1991), Gardner and Kimbrough (1992)), providing insurance (Eaton and Grossman (1985), Dixit (1987b, 1989)), and political pressures (Brock and Magee (1978)). However, most of the literature mentioned above concludes that an import tariff is not the optimal policy to use for all purposes except monopolistic rent extraction.

be traded between households across different countries. This approach to modelling financial market segmentation follows the work of Errunza and Losq (1985), Sellin and Werner (1993) and Basak (1996).

The results that we obtain are the following. In the absence of international financial markets, a domestic import tariff increases the world terms of trade (defined as the ratio of the world price of the export good to the world price of the import good) for the domestic country. This is because the import tariff reduces the consumption of the import good in the domestic country and causes the consumption for the good in the foreign country to increase, thereby driving the world price of the good[2] down. When the world terms of trade improves for the domestic country, its wealth increases since it is endowed with a larger amount of the export good relative to the import good. On the other hand, the foreign country is worse off as it is endowed with a larger amount of the import good relative to the export good. This is the terms-of-trade (or wealth) effect associated with a tariff levy. In the presence of international financial markets, however, the risk-sharing equilibrium achieved in financial markets insures households against the changes in the world terms of trade from the levying of import tariffs and influences the effectiveness of tariffs.

Our first objective is to examine the relation between the degree of financial market integration and government's choice of tariff policy. In order to do so, we determine (in Chapter 3) the Nash equilibrium import tariff in the presence of financial markets and analyse how the equilibrium tariff varies with the financial market structure in the economy. We find that the equilibrium tariff level *decreases* with increasing international financial market integration. Under financial market segmentation, the inability

[2]The world price of the import good is the pre-tariff price of the good. It is equivalent to the price of the good in the foreign country, where purchase of the good is not subject to a tariff.

of households to completely insure themselves against future fluctuations in the terms of trade allows the governments to affect the wealth distribution between the two countries via terms of trade manipulation with import tariffs. The Nash equilibrium tariff in this scenario is greater than zero. With perfect financial integration, households' ability to ex-ante completely hedge the changes in the terms of trade with financial claims reduces the wealth effect from the improvement in terms of trade caused by levying of a domestic import tariff. In this case, the welfare loss from the price distortion due to tariffs dominates the favourable terms-of-trade effect, and hence, free trade is the optimal policy.

Our second objective is to include the interaction between financial decisions and the tariff policy decision in assessing the welfare gains from financial market integration. In our model, the presence of international financial markets allows households to pre-position themselves such that free trade is the optimal policy for the government. Therefore, international financial market integration can have a "trade dividend" in our environment. Here, financial market integration generates two sources of benefits. First, it provides an optimal risk-sharing allocation for a given cross-country distribution of endowment shocks. Second, it provides an avenue for households to exploit the classic welfare gains from international commodity trade by affecting the Nash equilibrium tariff policy. This implies that the gains from financial integration in our model are higher than those estimated in models that consider only the direct gains from risk sharing.

So far in our analysis, we have taken the structure of financial markets to be exogenous. Our third objective is to endogenize the choice of financial market segmentation by allowing it to be determined by government policy. To do this, we model a production economy where the investment decisions of firms are affected by their ability to hedge production risks across states and smooth consumption over time using financial markets. In our model, where both financial assets and investment can be used to smooth intertemporal consumption and share production risks, the relative cost and effectiveness of each tool under different financial market structures determines the equilibrium financial market structure. As the capital share in the production technology decreases (that is, as we move away from constant returns to scale toward decreasing returns in capital), investment becomes less effective as a risk-sharing and consumption-smoothing tool, and this makes the presence of financial trade more important. When production is sufficiently away from constant returns to scale in capital, the optimal financial structure is complete integration.

The rest of the thesis is organised as follows. The next chapter provides a literature review on research pertaining to the issues addressed in this thesis. Chapter 3 examines how the Nash equilibrium tariff in a trade policy game between two countries changes under different, exogenously specified, financial market structures. Chapter 4 studies the welfare gains from financial market integration in such an economy with endogenous tariffs. Chapter 5 endogenizes the financial market structure and investigates the Nash equilibrium financial structure that will emerge in a financial policy game between two countries in a production economy. Chapter 6 provides a discussion of the assumptions and modelling approach adopted in this thesis and a summary of the main results.

Chapter 2

Literature Review

We provide a survey of the literature relevant to our study in this chapter. We will also discuss how the literature is related to our work. This chapter is divided into five sections. In the first section, we discuss the literature that highlights the importance of financial and goods markets interaction in modelling. The influence of financial markets on the evaluation of policy effects is described in Section 2. We provide the justification for modelling tariffs by the terms of trade argument in the third section, and survey the literature on welfare gains from financial integration in the fourth section. Finally, we discuss the literature on financial market segmentation.

2.1 Interaction between Financial Markets and Goods Markets

Traditional trade theory is developed from Walrasian-international models where each country is assumed to be a non-strategic economic agent. It also assumes that either intra-national markets are perfect or redundant. Therefore, the structure of financial markets is not an issue in standard trade theory until Helpman and Razin (1978a) used the stock market model developed by Diamond (1967) to analyse some real trade propositions under uncertainty. They show that many of the earlier literature's negative results regarding the extended propositions of Ricardian and Heckscher-Ohlin international trade theories under uncertainty are driven by their assumption that there are no international financial markets. When international financial markets are modelled, most of the traditional trade propositions are robust to uncertainty. This is because the presence of complete financial markets makes the equity-production structure under uncertainty isomorphic to that under certainty. Following this line of research, Dumas (1980) extends most trade theorems for more a general form of uncertainty. However, he finds that the price version of Heckscher-Ohlin theorem can be extended only if scalar uncertainty (which is assumed in Helpman and Razin) is considered.

Stockman (1987) provides an overview of the interactions between goods and financial markets in open economies. In a world without uncertainty, the role of financial markets is to provide opportunities for intertemporal trade. In this case, the presence of financial markets affects labour and investment decisions, which are imperfect substitutes of financial assets for smoothing consumption over time. With uncertainty, financial assets are used to smooth consumption over time and also across states. Risk sharing across states will affect the allocation and prices of goods across the different states of nature. At the same time, the imperfections in commodity markets affect consumers' incentives to hedge and influence their portfolio choice. In this thesis, we look at a multi-period economy with uncertainty.

Cole (1988) extends the work of Helpman and Razin to a general equilibrium two-good, two-country model of international trade where labour is the only input to production and production is subjected to random shocks. Agents work for the first period of their lives, but consume in both periods. They choose to invest their labour between a short-term project and a long-term project. The role of financial markets is two-fold in this model: first, they allow agents to separate the timing of their consumption and production activities and second, they provide risk sharing. Financial market completeness increases the agents' ability to diversify the risk associated with their production shocks. The insurance provided by financial markets reduces the direct wealth effects of idiosyncratic shocks on an agent's production and hence, affects the agent's labour and consumption decisions.

Feeney (1994) examines the link between financial markets and international trade in goods by focusing on the risk sharing function of financial markets. She constructs a model of a small, open two-good production economy with different degrees of market completeness. Labour is the only production input and production is subjected to both industry- and country-specific shocks. Here, trade in financial claims and labour decisions substitute for each other as a means of reducing variance in real income and consumption across states. As the financial market is more efficient in providing insurance than the labour market, labour is free to be allocated efficiently across production in the presence of financial market. More efficient labour allocation implies a higher degree of specialisation and more international trade in the goods market. In this sense, the financial and goods markets complement each other.

The literature in this area points to the existence of cross-effects between financial and goods markets. Therefore, the presence of financial markets is important in the analysis of international trade: the effectiveness of trade policies (which depends on trade behaviour) will be affected by the structure of financial markets. The importance of the interaction between real and financial decisions suggested by the existing literature described in this section provides the motivation for this thesis.

2.2 The Effect of Financial Markets on Policy

In addressing on the role of international financial markets on policy evaluation, Stockman (1988) describes how research into policy issues has changed with the development of more sophisticated international financial markets and concludes that the effects of policy with redistributive wealth consequences may be affected substantially by the households' ability to insure against income risks by trading in the financial markets. Motivated by Stockman's argument, we examine the effects of an import tariff, which alters the wealth distribution between two countries. In particular, we incorporate the interaction between the goods markets and the financial markets in our analysis of the tariff policy decision. We describe below the literature that evaluates tariff policy effects.

The evaluation of tariff policy under the influence of financial markets has been examined by Helpman and Razin (1978d) in a partial equilibrium framework. Before the resolution of uncertainty, agents choose a portfolio in the stock market. After the state is known, agents receive the proceeds from their portfolio and purchase goods in the commodity market. Helpman and Razin find that a tariff does not necessarily protect the import-competing industry in a small open economy (which is a well known result in a deterministic economy) when there is no international trade in securities. This is because resource allocation depends on the relative commodity prices, as well as the relative equity prices. The import tariff increases the price of the import good and worsens the internal terms of trade, which lead to a resource flow from the export industry to the import industry. On the other hand, the rise in the price of the import good increases the return on the stock that pays out the import good as dividends, so households can hold either a smaller or larger proportion of this stock depending on their marginal propensities to spend, import volumes and risk aversion. It is possible to obtain a negative portfolio effect such that households hold a smaller amount of the "import stock", thus causing resources to move from the import industry to the export industry. Moreover, the negative portfolio effect could outweigh the direct commodity effect of a tariff levy such that the the net effect is a flow of resource from the import industry to the export industry. However, when international trading in equities is possible, the import tariff will increase the price of the "import stock" to eliminate arbitrage opportunities. In this case, there is an unambiguous movement of resource from the export industry to the import industry.

Stockman and Dellas (1986) use a symmetric, two-country, two-good, stochastic general equilibrium model with complete asset markets to show the importance of financial markets in analysing the effects of an import tariff on consumption. In their model, consumers can hedge the price changes due to tariffs by purchasing or selling state contingent claims in the financial markets to smooth their wealth across states. In equilibrium, consumers will take a smaller long position in claims that pay out the import good in the states in which the domestic government levies a tariff and a smaller short position in claims that pay out the export good in states in which the foreign government levies a tariff. Therefore, the ex-ante trading in the financial markets allows consumers to substitute away from the more expensive goods ex-post. This means that the domestic consumption of the import good is lower ex-post in the states in which a domestic tariff is levied. Due to the ability of households to perfectly insure against the possibility of a tariff levy via asset markets, domestic consumption increases with lower domestic tariffs or higher foreign tariffs. This relation is obtained despite the improvement in the terms of trade with domestic import tariffs and Stockman and Dellas' finding is opposite to that derived in a static model without asset markets.

The work of Helpman and Razin and Stockman and Dellas shows the importance of considering financial markets in evaluating policy effects. However, because the tariff in question is exogenous in these models, they cannot be used to examine the interaction between the existing financial structure and the government's tariff decision. Barari and Lapan (1993) extend Stockman and Dellas work by allowing the government to choose an optimal tariff. In their economy, consumers trade in state contingent claims on the import good ex-ante, and trade in the goods market ex-post. Under the assumption of perfect foresight, markets are complete in their economy. Their work also differs from Stockman and Dellas by including export tariffs as part of the government's policy menu which is necessary in their model because import tariffs create positive wealth effects in both assets and goods markets in their economy. They assume the foreign government to be passive in their analysis, and only examine the home government's tariff choice in two extreme economies; namely financial autarky and complete financial markets. They find that Stockman and Dellas result is sensitive to the tariff structure and that the presence of asset markets could reduce welfare if only import tariffs are used.

Our work differs from Barari and Lapan in two ways. First, we endogenize the tariff decision in the form of a Nash government's tariff game. By permitting the governments to behave strategically, we do not require the use of export tariffs. The focus of our analysis on import tariff allows us to isolate the wealth distribution effect associated with a tariff levy. Hence, we are able to provide a detailed examination of how the tariff effect in the goods market is influenced by the existing financial market structure in the economy. Second, we determine the Nash equilibrium tariff in an intermediate economy where financial markets are partially segmented. Therefore, our model allows us to better address the question of how financial market structure affects a government's choice of an import tariff level.

2.3 Optimal Tax Policy

The objective of our thesis is not to explain why a tariff policy is used to restrict trade between two countries. We assume that tariffs are used to extract monopolistic rent in our model, and we will provide a brief account of the motivation for a tariff levy to justify our modelling approach of tariff. There are three different areas of literature which explain why tariffs exist. We will present the three areas in the following order: policy literature, terms-of-trade literature, and political literature.

In the policy literature, the motivation for tariffs is to attain certain policy goals such as infant industry protection, industry output or employment maintenance, wealth distribution or government revenue. The traditional infant-industry argument has been criticised by Baldwin (1969) who shows that the argument cannot justify government intervention. Empirical evidence against the infant-industry argument is provided by Krueger and Tuncer (1982) who use detailed data on Turkish manufacturing industries to show that protected industries do not have higher growth of output per unit of input than less protected industries. The competitive tax literature (Wildasin and Wilson (1991), Gardner and Kimbrough (1992)) that examines the financing of government expenditure with tax revenues do not find tariffs to be the optimal means of generating government revenue for inter-sectoral transfer. In general, tariffs are inefficient at achieving most policy goals and are often dominated by other policies in a deterministic world. In contrast to the policy literature for tariffs, we model the tariff revenue as a form of lump-sum transfer that is redistributed to the domestic households without any inter-sectoral redistribution implication.

Work that considers the role of tariffs in the presence of uncertainty includes Eaton and Grossman (1985), Grossman and Horn (1988) and Dixit (1987b, 1989). Eaton and

Grossman develop a model where tariffs provide insurance in a world with incomplete markets. In the economy they consider, households have two factors of production, namely labour and capital. Labour is perfectly mobile across production activities, while capital has to be locked into a specific activity before uncertainty is resolved. They show that tariff dominates free trade in providing insurance for households by distributing wealth from rich households with low marginal utility of wealth to poor households with high marginal utility of wealth. Grossman and Horn examine whether the existence of informational barriers to entry provides a valid reason for temporarily protecting infant industries and conclude that there might be benefits from a permanent tariff. Dixit points out a problem with the "tariff as insurance" argument put forth by Eaton and Grossman. He argues that such government-provided insurance will be subject to moral hazard and adverse selection problems that need to be modelled explicitly. He uses a moral hazard model and an adverse selection model to examine the effectiveness of tariffs in providing insurance for an economy with asymmetric information and finds that tariffs are not in the set of optimal instruments consistent with the constrained information structure. The competitive equilibrium that arises in these two models are informationally constrained Pareto optimal. Since the consumers face world prices in the competitive equilibrium, Dixit concludes that policies that are welfare maximizing should not include any tariffs. Hence, we choose not to model tariffs as insurance-providing instruments. As well, these models do not consider the presence of risk sharing opportunities in the financial markets. In this aspect, our work differs from this literature by explicitly modelling the presence of financial markets to address the issue of tariff choice.

In the terms-of-trade literature, tariffs are instruments of international redistribution. They are used by governments to increase domestic welfare at the expense of other countries. Johnson (1953) pioneered the use of the terms-of-trade argument in explaining the presence of a tariff in a two-good two-country model. In his model, the countries are big enough not to be price takers and they levy a tariff to manipulate the relative world prices of the two goods. In this setting, the equilibrium tariff in a country equals the inverse of its elasticity of demand for imports. In later work, Kennan and Riezman (1988) approach the same problem from first principles and obtain explicit solutions in terms of endowments. The tariff problem in our model is similar to the setup in Kennan and Riezman, but unlike their deterministic economy, the endowments in our model are stochastic. Most of the models of pure strategic tariff interactions between governments (including McMillan (1986) and Dixit (1987a)) do not consider a world with uncertainty. According to Dixit (1987a), the main conclusion of the standard theory where firms are perfectly competitive and the government is the only active agent in policy making is that interference with free trade is justified only for a large country wanting to improve its terms of trade.

The political literature on tariffs analyse the effect of voters on politicians when voters explicitly lobby for protectionism (Magee, Brock and Young (1989)). The optimal tariff is the level that maximizes votes for the political party supporting protectionism. However, Mayer and Riezman (1987) argue that political economy models cannot explain why tariffs are preferred as redistributive mechanisms over factor or production subsidies since tariffs are inefficient relative to subsidies. As the objective of this thesis is not on the politics of tariffs, we will not elaborate on this area of literature in this chapter.

In conclusion, the literature on tariff choice shows that the terms of trade argument for tariffs (Vousden (1990), Mayer and Riezman(1987)) is subject to the least criticism and does not require stringent assumptions from the modelling point of view. This is the motivation for tariffs in our model.

2.4 Welfare Gains from Financial Market Integration

There has been an increasing amount of work done on the study of welfare gains from international financial markets. However, no consensus has been reached on whether financial markets integration is economically significant in improving the welfare of the countries involved. Estimates of potential welfare gain from international risk sharing can be extremely low, to the point of almost zero, as in Cole and Obstfeld (1991), Tesar (1995) and Mendoza (1995), a moderate 7% and 12% in Van Wincoop (1996) and Lewis (1996), respectively, and an extreme of over 100% in Obstfeld (1994). The findings depend on the model specification. In models where the role of international financial markets is purely risk sharing, the improvement in welfare from risk sharing might not be economically significant if other less-than-perfect endogenous risk sharing mechanisms are present in the economy.

The benchmark model used for estimating the welfare gain computes the additional wealth needed to make the utility level under financial autarky equal to the the utility level under perfect international financial market integration. In this thesis, we extend the literature by accounting for the welfare gains from the indirect effects of financial integration on endogenous trade policy.

Our work on welfare analysis is most closely related to is Cole and Obstfeld (1991). In their model, the endogenous response of the terms of trade to country-specific productivity shocks allows for a lot of endogenous risk sharing, even in the absence of international financial markets. The main point of their paper is that fluctuations in the international terms of trade play an important role in automatically pooling national output risks. In the case where countries are completely specialised in their endowments, the international financial markets have no role at all. All the risk sharing is achieved through the endogenous terms of trade fluctuations in the goods markets, because a positive (negative) shock in the domestic endowment will be reflected by a lower (higher) relative price of the domestic good with respect to the foreign good, thereby causing the relative wealth of the domestic country (which is the value of the domestic endowment relative to the value of the foreign endowment) to remain unchanged across states. Their calibration results show that the gains from international financial markets are very small, with the highest being at 0.49% of output with a relative risk aversion of 30. The innovation in our work is to endogenize tariff policy, which the government could use to affect the terms of trade, and compute the welfare gain in this scenario.

Broadly similar conclusions regarding small benefits from risk sharing have been drawn by Tesar (1995) and Mendoza (1995). Tesar considers three extensions to the benchmark model. In the first extension, she restricts the set of financial assets to non-contingent bonds and finds that risk sharing ability is very much reduced in this environment when there are persistent shocks in the endowment process. By including non-traded goods in the second extension, she shows that gains from risk sharing are higher than in the one-good model when the non-traded good is a complement of the traded good. Lastly, she allows households to smooth production shocks by adjusting the level of investment in a production economy. Minimal welfare gains are obtained from international financial markets in this economy. In general, she finds that gains from risk sharing for large countries are less than half a percent of lifetime consumption, while that for small countries lie between 0%-2% of lifetime consumption. Mendoza introduces terms of trade uncertainty and non-traded goods into his model and finds that the gains from international financial markets are still negligible: 0.011% for G7 countries and 0.016% for developing countries.

However, there are other findings in the literature that suggest economically significant welfare gains from international financial markets. Lewis (1996) investigates the differences in the estimates of welfare gains from international risk sharing that comes about from using stock-return-based models versus consumption-based models. She observes that when the consumption stream is highly variable (as measured by stock returns), the welfare gains are high. On the other hand, when aggregate consumption data (which has low variability) is used, the welfare costs are economically insignificant. When she matches the risk-aversion parameter that the households must have in order to generate the equity premium on an international diversified portfolio in the data, she finds that the implied gains from risk sharing measured using aggregate consumption data is comparable to that when using stock return data. In other words, the gains from risk sharing is economically significant even in consumption-based models when the risk-aversion parameter is adjusted to match the equity premium.

Van Wincoop (1996) examines the factors that can affect estimated welfare gains. These factors include: type and parameterization of preferences, consumption measure, horizon and type of autarky consumption process, as well as the non-separability between traded and non-traded goods. By calibrating the benchmark model under a realistic set of parameterization, Van Wincoop reports welfare gains of 1%-7%. Obstfeld (1994) shows very large gains from financial markets by allowing households to shift their portfolio from low-risk, low-return assets to high-risk, high return assets. The portfolio shift allows physical capital to move into riskier production technologies uses that generate higher output and makes everyone better off.

In this thesis, we use a consumption-based (instead of a stock-return-based) model to compute the welfare gains from international financial markets. By endogenizing the choice of trade policy in our model, our estimate of welfare gains from financial market integration are significantly higher. We show that by explicitly considering the interaction between real and financial decisions, the benchmark model is capable of generating economically significant estimates of welfare gains from international financial markets.

2.5 The Choice of Financial Market Structure

In conjunction with the literature on the welfare analysis of financial markets, there is a class of literature that finds that complete financial market integration might not be welfare improving for all the countries involved. Generally, these models make use of the characteristic that financial market integration increases the world risk-free rate, and that the higher rate could have a negative effect on economies that are net borrowers in world capital markets.

The inverse relationship between the risk-free rate and financial market integration is derived in Sellin and Werner (1993). They develop a two-country model with production and show analytically that the equilibrium interest rate is higher when there is a restriction on either the fraction of domestic equity held by foreign investors or on the amount of foreign equity held by domestic investors in the financial markets. Their analytical results are obtained by assuming logarithmic preferences and constant returns to scale of production in capital. In this thesis, we allow for more general preferences and production technologies, and we also separate the decisions of portfolio holdings and investment allocation. We focus on the effects of financial market segmentation on the welfare of each individual household instead of just on interest rates and investment decisions. However, with these extensions, we cannot solve our model analytically and have to rely on numerical methods.

The following models show that financial market integration to be welfare-reducing for some economies. Devereux and Smith (1994) introduce an externality into the competitive economy by assuming the effective labour to be a function of knowledge stock and human labour, where the knowledge stock equals aggregate capital stock. The externality causes the social return to capital to exceed the private return to capital. They show that savings is reduced with financial market integration because consumers do not need to save as much to diversify their income risks. Due to the positive externality of capital on production, reduced savings implies lower production and welfare.

Devereux and Saito (1997) develop a general equilibrium production model to compare the welfare under three financial market structures: financial autarky, complete financial markets and the existence of only bond markets. They show that if a stationary wealth distribution exists, a small country may be better off in a regime with only bond trading rather than one with complete financial markets. This is because the small country can take advantage of the lower risk-free rate in the bond regime to borrow and invest more in its technology, which is more productive than the technology in the big country. If the big country gains access to the small country's technology, the big country is less willing to lend since it can invest directly in the small country's productive technology. This will increase the risk-free rate at which the small country can borrow and hence, make it worse off.

Basak (1996) uses a portfolio mean-variance approach to examine the welfare gain from changing the degrees of financial market segmentation. He extends work by Errunza and Losq (1985) and Eun and Janakiramanan (1986) by allowing for intertemporal consumption choice in the consumer's problem. Although the approach used by Basak is very different from Devereux and Saito's, their results are qualitatively similar. Basak finds the risk-free rate to monotonically increase with financial market integration and finds that a country might be worse off with financial market integration if it is a borrower.

The main message from this area of research is that complete financial integration might not be optimal when there is intertemporal consumption smoothing or an externality in the economy. In this thesis, we examine the optimal financial market structure for each country by allowing the degree of financial market segmentation to be a choice variable of the government's policy. In contrast to the findings of Basak and Devereux and Saito, we find that when production exhibits decreasing returns to scale in capital, the optimal policy will be complete financial integration.

Chapter 3

Tariff Choice Under Alternative Financial Market Structures

3.1 Introduction

The objective of this chapter is to examine the relationship between the degree of financial market integration and a government's tariff level. In our model, the presence of international financial markets allows households to hedge the changes in terms of trade arising from the levy of import tariffs. Our contribution is to find the government's optimal choice of import tariff in the presence of financial markets, and to analyse how the endogenous tariff varies with the financial market structure in the economy. The main result of this chapter is that increasing financial market integration tends to reduce the Nash import tariff level in a tariff game between national governments.

We determine the Nash equilibrium tariff in a general equilibrium model of a two-country world economy with stochastic endowment for three financial market structures: in the first case, financial markets are perfectly integrated and markets are complete; in the second case, financial markets are perfectly segmented, that is, there are no international financial markets; and in the last case, financial markets are partially segmented. We consider partial financial market segmentation by closing down certain asset markets.[1] As mentioned in the previous chapter, the domestic import tariff in our model affects the relative world prices of goods, and the role of the tariff is to transfer wealth from the

[1] This approach to financial segmentation follows the classification in Basak (1996).

foreign country via an improvement in the terms of trade.

In the presence of complete financial markets, households have the ability to ex-ante hedge perfectly with financial contracts their endowment risks and the changes in terms of trade. This ability to hedge reduces the wealth effect from the improvement in terms of trade due to the levying of a domestic import tariff. In this economy, the welfare loss from the price distortion due to tariffs dominates the favourable terms-of-trade effect; thus, under perfect integration of financial markets, each government's optimal tariff is zero. The equilibrium tariffs in an otherwise identical economy under financial autarky are found to be strictly positive. In the economy with partial financial segmentation, the chosen tariffs are lower than those obtained in the absence of international financial markets, but higher than those in complete financial markets. Therefore, there is a clear ranking: the Nash equilibrium tariffs decrease as financial market integration increases.

Our work differs from the existing models that examine the influence of financial market structure on tariff policy in two ways. First, we allow both governments to behave strategically when they choose the tariff level in a Nash game. Second, we explicitly model the household's portfolio decisions in our framework. This modelling approach allows us to determine the optimal tariff level in a partially segmented financial market structure by shutting down certain asset markets. Previous analyses are done only under two extreme financial market structures, namely complete financial markets and financial autarky.

This chapter is organised as follows. Our model of a world economy is described in the next section of this chapter. The Nash equilibrium tariff in an economy with complete asset markets is presented in Section 3, and it is compared to that obtained in an otherwise identical economy with no international financial markets in Section 4. In Section 5, the existence of partial financial market segmentation is considered and its impact on the chosen tariff is analysed. Section 6 concludes. Proofs for all the propositions and a description of the method used in our numerical analysis are provided in Appendix A.

3.2 Model Description

The economy we consider is an extension of Lucas (1982) and builds on the work of Sercu, Uppal, and Van Hulle (1995). In the two-country exchange economy considered by Lucas, the agents in both countries are identical and are subject to endowment shocks. Being risk averse, the agents in that model pool the endowment risks by trading financial securities. Sercu et. al. extends the Lucas model to include an exogenous cost for shipping a tradable good internationally. The shipping cost is modelled as a waste of resources so that when one unit of the good is shipped, only $\frac{1}{1+\tau}$ unit is received. Instead of treating the cost as an exogenous parameter as in Sercu et. al., we model the cost of shipping as an import tariff that is determined endogenously. We now describe the endowment process, preferences, commodity markets, and the government in this economy.

We assume that the economy has two periods. The home and foreign country ($i = 1$ and 2, respectively) are each endowed with two non-storable goods ($j = 1$ and 2) in both periods. The stochastic endowment quantities are denoted by $y_{ij}(s)$. State $s = 0$ denotes the initial period with no uncertainty. Goods 1 and 2 are homogenous commodities that are traded between the two countries. We assume the endowment of good 1 in country 1 to be relatively higher than that in country 2, while the reverse is true for good 2. Therefore, good 1 is typically exported by country 1 and good 2 is typically exported by country 2.[2] The endowment process of each good is exogenous and is assumed to follow

[2]Implicitly, country 1 is assumed to have a comparative advantage in producing good 1, while the same is true for country 2 regarding good 2.

an identical binomial distribution.[3] The initial endowment is assumed to be symmetric across the two countries; that is, $y_{11}(0) = y_{22}(0)$ and $y_{12}(0) = y_{21}(0)$.

Both countries are assumed to be populated with an equal number of infinitely-lived households with identical preferences that are state and time separable. For analytical tractability and clarity of presentation, the representative household in each country is assumed to have logarithmic preferences defined over the consumption of the two goods. However, the assumption of logarithmic preferences is not necessary for the results. The proof of the propositions for a general form of constant relative risk aversion (CRRA) utility is provided in the Appendix. We denote $c_{ij}(s)$ as the units of the good j consumed by household i. The preferences of household i are represented by

$$U_i[c_{i1}(s), c_{i2}(s)] \equiv \sum_{j=1}^{2} \ln[c_{ij}(s)]. \tag{3.1}$$

At time 0, the government in each country precommits to a tariff for the next period, without the possibility of reneging on its decision.[4] This assumption is made in an attempt to represent the real-world scenario in which the negotiations of tariff agreements precede the actual implementation of the trade barrier. A tariff, τ_{21}, is levied on the import of good 1 in country 2 and, similarly, the tariff on good 2 in country 1 is τ_{12}. The tariff revenue is redistributed to the domestic households in the form of a lump-sum transfer and it is denoted by $\bar{z}_i(s)$. While we model trade protection by a tariff, we think of this as representing the total degree of protection imposed by the home country, encompassing non-tariff barriers.

In solving its optimization problem, the representative households take the tariff level and lump-sum transfer as exogenous parameters. Each household chooses its initial asset

[3]This assumption is made to characterise the Nash equilibrium tariff levels in Section 5. It is not necessary for the analytical solutions in Sections 3 and 4.

[4]With this restriction, the government cannot alter its tariff level after the state is realised even if its ex-ante choice is not ex-post optimal.

holdings in the financial markets and its consumption in the goods markets to maximize its ex-ante expected utility. The ability of the household to trade assets in the initial period allows it to hedge its future endowment risks and the changes in the terms of trade from the levying of tariffs. The budget constraints faced by the household in each country depend on the existing financial market structure and they will be described in the subsequent sections. The three different financial market structures in the economies that we consider are:

E(1): complete and perfect financial markets,

E(2): financial autarky, and

E(3): partial financial market segmentation.

In the subsequent sections, we refer to the economy with a particular financial market structure as **E**(#), where # refers to the type of financial market structure described above.

The solution to the household's problem is a competitive equilibrium, which gives a vector of optimal state-contingent consumption levels, $[c^I_{i1}(s), c^I_{i2}(s)]$, $i = 1, 2$, as a function of both domestic and foreign tariffs. In the Nash tariff game, the home government chooses the tariff level to maximize the indirect expected utility of its household given a tariff level chosen by the foreign government and the knowledge of the households' ability to hedge the changes in terms of trade with financial contracts. The households' and the governments' maximization problems are solved simultaneously.

3.3 Perfect and Complete International Financial Markets

In this section, we study the Nash equilibrium tariff characterised by economy $\mathbf{E}(1)$. Households in this economy can trade state-contingent claims in the initial period to achieve a Pareto efficient allocation in all states at any future time. However, the equilibrium goods allocation will be constrained Pareto optimal due to the segmentation in the commodity markets caused by the tariff levy. The state-contingent claims are in zero net supply and trading of these claims takes place in the initial period. The exchange of goods in the spot market occurs in the subsequent period. We let the numeraire good in this economy be good 1 in country 1.

The representative household in country 1 chooses the amount of state-contingent claims, represented by $\omega_{ij}^1(s)$, to purchase at time 0, and the amount of goods to consume at time 0 and 1. The objective is to maximize its expected utility:

$$\max_{c_{1j}(s),\omega_{ij}^1(s)} \sum_{j=1}^{2} \ln[c_{1j}(0)] + \beta E_0 \left[\sum_{j=1}^{2} \ln[c_{1j}(s)] \right], \tag{3.2}$$

subject to the following feasibility constraints at time 0 and 1, respectively,

$$\sum_{j=1}^{2} p_{1j}(0)c_{1j}(0) + \sum_{s\in S}\sum_{i=1}^{2}\sum_{j=1}^{2} q_{ij}(s)\omega_{ij}^1(s) = \sum_{j=1}^{2} p_{1j}(0)y_{1j}(0), \tag{3.3}$$

$$\sum_{j=1}^{2} p_{1j}(s)c_{1j}(s) = \sum_{j=1}^{2} p_{1j}(s)y_{1j}(s) + \sum_{i=1}^{2}\sum_{j=1}^{2} p_{ij}(s)\omega_{ij}^1(s) + \bar{z}_1(s), \tag{3.4}$$

$$\bar{z}_1(s) \equiv \tau_{12}p_{22}(s)m_{12}(s), \tag{3.5}$$

where $q_{ij}(s)$ is the time 0 price of an Arrow-Debreu security that pays one unit of good j in country i in state s, $p_{ij}(s)$ is the spot market price of good j in country i after state s is realized, and $m_{ij}(s)$ is the import of good j by household i. The bar on the lump-sum transfer of tariff revenue $\bar{z}_1(s)$ means that it is not a choice variable for the household. The import prices $p_{12}(s)$ and $p_{21}(s)$ are functions of the import tariffs, τ_{12} and τ_{21}, respectively.[5]

The left-hand side of constraint (3.3) describes the value of the consumption bundle and state-contingent claims that are traded at time 0. The right-hand side describes the value of the household's initial endowment. Constraint (3.4) shows that the household's consumption of goods at time 1 (on the left-hand side) is financed by its endowment at time 1, the payout from its state-contingent claim holdings and the lump-sum revenue transfer.

The first-order conditions for the maximization problem (3.2) are:

$$\begin{aligned} \frac{1}{c^I_{1j}(0)} &= \lambda_1(0)p_{1j}(0) \qquad\qquad j = 1, 2, && (3.8) \\ \beta\pi(s)\frac{1}{c^I_{1j}(s)} &= \lambda_1(s)p_{1j}(s) && (3.9) \\ \lambda_1(0)q_{ij}(s) &= \lambda_1(s)p_{ij}(s). && (3.10) \end{aligned}$$

The superscript "I" denotes the constrained optimal solutions in the economy with *integrated* financial markets, $\mathbf{E}(1)$. The Lagrange multipliers of constraints (3.3) and (3.4) are denoted by $\lambda_1(0)$ and $\lambda_1(s)$, respectively. The probability of state s occurring in period t is denoted by $\pi(s)$ and both households in this economy are assumed to have homogeneous beliefs on the state space. A similar set of necessary conditions is derived from the foreign household's maximization problem.

The allocation of goods between the two countries is also subject to a market-clearing

[5] Due to the import tariff on good 2, the import price of good 2 in country 1 is the export price of the good grossed up by the import tariff at time 1. The same is true for the price of good 1 in country 2. Therefore, the price relations are given as:

$$\begin{aligned} p_{12}(s) &= (1+\tau_{12})p_{22}(s), && (3.6) \\ p_{21}(s) &= (1+\tau_{21})p_{11}(s). && (3.7) \end{aligned}$$

where $s \neq 0$.

condition in each market. These conditions are:

$$c_{11}(s) + c_{21}(s) = y_{11}(s) + y_{21}(s), \tag{3.11}$$

$$c_{12}(s) + c_{22}(s) = y_{12}(s) + y_{22}(s). \tag{3.12}$$

The financial market clears at $\omega_{ij}^1(s) = -\omega_{ij}^2(s)$.

In the absence of tariffs, the households would choose to trade to a point where the marginal utility of consumption for each good is the same across the two countries. However, the transfers of goods 1 and 2 are subject to a tariff, which creates a wedge in the marginal utility for goods 1 and 2 across the two countries and causes the consumption of the same good to differ across the two countries. The constrained optimal consumption rules for the household in country 1 are

$$c_{11}^I(s) = \frac{1+\tau_{21}}{2+\tau_{21}}(y_{11}(s) + y_{21}(s)), \tag{3.13}$$

$$c_{12}^I(s) = \frac{1}{2+\tau_{12}}(y_{12}(s) + y_{22}(s)). \tag{3.14}$$

To determine the Nash equilibrium tariff, τ_{12}^I, the household's consumption rules in (3.13) and (3.14) are substituted back into the household's utility function given by (3.2). The resulting indirect expected utility is the objective function of the government's maximization problem in the tariff game. The government's maximization problem is therefore described as:

$$\max_{\tau_{12}} V_1^I(\tau_{12}, \tau_{21}^I) \equiv E_0 \left[\sum_{j=1}^{2} \ln c_{1j}^I(s) \right], \tag{3.15}$$

where $c_{1j}^I(s)$ are given by equations (3.13) and (3.14).

The partial derivative of the objective function with respect to τ_{12} is given by:

$$\frac{\partial V_1^I}{\partial \tau_{12}} = E_0 \left[\frac{1}{c_{12}^I(s)} \left(\frac{\partial c_{12}^I(s)}{\partial \tau_{12}} \right) \right]. \tag{3.16}$$

The marginal cost of the tariff is represented on the right-hand side of (3.16). It is the product of the household's marginal utility of the import good and the (negative) effect of the tariff on the consumption of this good. The government chooses a tariff that minimizes the marginal cost in the import good sector.

Proposition 3.1: *The Nash equilibrium import tariff in an economy with complete and perfect financial markets is zero.*

The reason for this result is that the presence of complete financial markets offsets the terms-of-trade effect associated with the levying of a tariff and, thus nullifies the presence of a positive tariff. The mechanism by which a tariff can generate a terms-of-trade effect is explained as follows. A positive tariff reduces the demand for the import good in the domestic country and increases the consumption of the same good in the foreign country. The rise in consumption of the import good in the foreign country drives down the world price of the import good[6] relative to the world price of the export good in the domestic country. Therefore, the world terms of trade improves for the domestic country. Since the domestic country is endowed with a larger quantity of its export good relative to its import good, the improvement in its terms of trade increases the value of its endowment and creates a positive wealth effect. On the other hand, the domestic import tariff causes the foreign country to face a less favourable terms of trade and generates a negative wealth effect in that country. In essence, the domestic government channels wealth from the foreign country via terms of trade improvement with the levying of import tariffs. This transfer of wealth is referred to as the terms-of-trade effect in the standard trade literature.

We can also interpret the wealth transfer as the extraction of monopolistic rent by the

[6]The world price of the import good is the price of the good net of the import tariff, which is the price of the good in the foreign country.

government in each country. Here, the country which has a relatively larger endowment of a good is considered a monopolist of that good. In our framework, country 1 has monopoly power over good 1 and country 2, over good 2. Since the government in each country is a monopolist of its export good, it levies a domestic tariff in an attempt to increase the relative price of that good and extract monopoly rent. As we do not model production explicitly, we will refer to the wealth transfer as the terms-of-trade effect for the rest of the chapter.

We now show the offset in terms-of-trade effect from the levying of a domestic tariff in an economy with complete asset markets. First, we establish that the terms of trade improves for a country when its government increases the domestic tariff. The relative world price of good 2 to good 1 is:

$$\frac{p_{22}(s)}{p_{11}(s)} = \left(\frac{2+\tau_{12}}{1+\tau_{12}}\right)\left(\frac{1+\tau_{21}}{2+\tau_{21}}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{y_{22}(s)+y_{12}(s)}\right). \tag{3.17}$$

The derivative of the above price ratio in (3.17) with respect to τ_{12} is:

$$\frac{\partial \frac{p_{22}(s)}{p_{11}(s)}}{\partial \tau_{12}} = -\left(\frac{1}{1+\tau_{12}}\right)^2\left(\frac{1+\tau_{21}}{2+\tau_{21}}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{y_{22}(s)+y_{12}(s)}\right) < 0. \tag{3.18}$$

That the derivative is negative implies that the price of good 1 relative to good 2 (given by the inverse of the above ratio) increases with τ_{12}. This means that the terms of trade for country 1 improves with an increasing domestic tariff since country 1 is the exporter of good 1 and the importer of good 2. Next, we demonstrate that the household's state-contingent claim holdings reduce the terms-of-trade effect associated with the levying of a domestic tariff. The time-1 total wealth (in terms of the numeraire good) of the household in country 1 is given by:

$$\begin{aligned} W_1^I(s) &\equiv e_1^I(s) + w_1^I(s) + \bar{z}_1(s), & (3.19)\\ e_1^I(s) &= y_{11}(s) + \frac{p_{12}(s)}{p_{11}(s)} y_{12}(s), & (3.20) \end{aligned}$$

$$w_1^I(s) = \sum_{i=1}^{2}\sum_{j=1}^{2}\frac{p_{ij}(s)}{p_{11}(s)}\omega_{ij}^1(s), \tag{3.21}$$

$$\bar{z}_1(s) = \tau_{12}\frac{p_{22}(s)}{p_{11}(s)}m_{12}^I(s), \tag{3.22}$$

where $W_1^I(s)$ is the total real wealth of the household in country 1 and is comprised of the real value of the household's endowment, $e_1^I(s)$, the real value of the household's state-contingent claim holdings, $w_1^I(s)$[7], and the lump-sum tariff revenue transfer, $\bar{z}_1(s)$[8]. Therefore, the total terms-of-trade effect can be separated into three components: the endowment effect, the state-contingent-claims effect, and the tariff-revenue effect. The endowment effect is:

$$\frac{\partial e_1^I(s)}{\partial \tau_{12}} = \left(\frac{1+\tau_{21}}{2+\tau_{21}}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{y_{22}(s)+y_{12}(s)}\right)y_{12}(s). \tag{3.23}$$

The state-contingent-claims effect is:

$$\frac{\partial w_1^I(s)}{\partial \tau_{12}} = -\left(\frac{1}{1+\tau_{12}}\right)^2\left(\frac{1+\tau_{21}}{2+\tau_{21}}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{y_{22}(s)+y_{12}(s)}\right)y_{22}(s). \tag{3.24}$$

The tariff-revenue effect is:

$$\frac{\partial \bar{z}_1(s)}{\partial \tau_{12}} = \left(\frac{1+\tau_{21}}{2+\tau_{21}}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{y_{22}(s)+y_{12}(s)}\right)\left[\left(\frac{1}{1+\tau_{12}}\right)^2 y_{22}(s) - y_{12}(s)\right]. \tag{3.25}$$

Hence, the total terms-of-trade effect on the wealth of the home household is given by the sum of these three effects:

$$\frac{\partial W_1^I(s)}{\partial \tau_{12}} = \frac{\partial e_1^I(s)}{\partial \tau_{12}} + \frac{\partial w_1^I(s)}{\partial \tau_{12}} + \frac{\partial \bar{z}_1(s)}{\partial \tau_{12}}. \tag{3.26}$$

The sum of the endowment effect and the tariff-revenue effect can be interpreted as the wealth effect of tariff on the household's future exogenous income and is positive. On the other hand, the trade in state-contingent claims allows the household to ex-ante

[7]The state-contingent claim holdings are derived in the Appendix.

[8]The optimal import quantities of goods 1 and 2 are derived in the Appendix.

substitute between the import good and the export good in response to the relative price change caused by tariffs. Thus, the state-contingent-claims effect can be interpreted as the substitution effect of tariffs. As the positive wealth effect is offset by the negative substitution effect, the total terms-of-trade effect is reduced. Therefore, the ability of households to trade in ex-ante state-contingent claims in the financial markets reduces the gains from terms of trade improvement in the ex-post goods market.[9]

In the presence of complete financial markets, each household insures itself against the future states of the world in the initial period by holding state-contingent claims which will pay out a positive amount of wealth in the bad states and a negative amount of wealth in the good states. This follows directly from the budget constraint. For the home household, the budget constraint (3.4) can be simplified to the following:

$$p_{22}(s)m_{12}(s) = p_{11}(s)x_{11}(s) + \sum_{i=1}^{2}\sum_{j=1}^{2} p_{ij}(s)\omega_{ij}^{1}(s). \tag{3.27}$$

In the bad states when the value of imports exceeds the value of exports for the home household, the value of the payouts from its holdings of all state-contingent claims, $\omega_{ij}^{1}(s)$, for $i, j = 1, 2$, must be positive to satisfy the budget constraint (3.27). The converse is true in the good states when the value of home country's exports exceeds the value of its imports. In order to attain the risk-sharing arrangement described above, each household must hold a short position in the state-contingent claims that pay out in terms of its own endowment goods and a long position in the state-contingent claims that pay out in terms of the endowment goods in the other country. It is this risk-sharing ability to transfer wealth across future states of the world in the initial period that offsets the terms-of-trade

[9] Under the assumption of logarithmic preference, the terms-of-trade effect on the value of endowment and tariff revenue is totally offset by the negative state-contingent-claims effect. This is because wealth effect equals substitution effect for logarithmic preferences. When the household has a relative risk aversion greater than one (more risk averse than a logarithmic agent), the wealth effect dominates the substitution effect and the total terms-of-trade effect is positive. Conversely, when the household has a relative risk aversion less than one (less risk averse than a logarithmic agent), the substitution effect dominates the wealth effect and the total terms-of-trade effect is negative.

effect associated with a tariff levy.

In order to examine how the reduced terms-of-trade effect impacts on the change in consumption of the traded goods due to tariffs, we separate the consumption effect of the tariff into two parts: the price effect and the wealth effect. These effects are represented by:

$$\frac{\partial c_{11}^I(s)}{\partial \tau_{12}} = \left[\left(\frac{\partial c_{11}^I(s)}{\partial p_{12}(s)}\right)\left(\frac{\partial p_{12}(s)}{\partial \tau_{12}}\right)\right] + \left[\left(\frac{\partial c_{11}^I(s)}{\partial W_1^I(s)}\right)\left(\frac{\partial W_1^I(s)}{\partial \tau_{12}}\right)\right], \tag{3.28}$$

$$\frac{\partial c_{12}^I(s)}{\partial \tau_{12}} = \left[\left(\frac{\partial c_{12}^I(s)}{\partial p_{12}(s)}\right)\left(\frac{\partial p_{12}(s)}{\partial \tau_{12}}\right)\right] + \left[\left(\frac{\partial c_{12}^I(s)}{\partial W_1^I(s)}\right)\left(\frac{\partial W_1^I(s)}{\partial \tau_{12}}\right)\right]. \tag{3.29}$$

The terms in the first square parentheses on the right-hand side of (3.28) and (3.29) represent the price effect from an improvement in the terms of trade due to a domestic tariff levy (given a particular income level). The terms in the second square parentheses represent the income effect from an improvement in the terms of trade. Since the total terms-of-trade effect is zero in (3.26) under the assumption of logarithmic preferences, the levying of a domestic tariff only has price effects. For the export good, the cross-price effect is zero under the assumption of Cobb-Douglas utility functions. Since a domestic tariff increases the relative price of the import good and the own-price effect of the import good is negative, the total price effect of a tariff on the import good is negative. This negative price effect contributes to the marginal cost of tariff described on the right-hand side of (3.16).[10]

Now we relate the result in Proposition 3.1 to that obtained in Stockman and Dellas (1986). In their model, consumers hedge the price changes due to tariffs by purchasing or selling state-contingent claims in the financial markets. In equilibrium, households

[10]When the household is more risk averse than a logarithmic agent, the gains from a positive total terms-of-trade effect is dominated by the negative substitution effect of the price distortion on good 2. Therefore, even when the total terms-of-trade effect is positive in the economy with perfect and complete financial markets, the marginal cost of the price distortion still outweighs the marginal benefit of the terms-of-trade effect.

own a smaller amount of claims that pay out the import good in the states in which the domestic government levies a tariff and sell a smaller amount of claims that pay out the export good in states in which the foreign government levies a tariff. Hence, households substitute away from the more expensive goods ex-post by trading ex-ante in the financial markets. This implies that the domestic ex-post consumption level of the import good is lower in the states in which a domestic tariff is levied. The hedging opportunity in the financial markets explains the result in Stockman and Dellas that the domestic country is better off ex-post in the states of the world in which domestic tariffs are absent. Thus, if the tariff policy were to be chosen in their model, it would be optimal for a benevolent government to choose not to levy any tariff, the same result obtained in our model.

The result in this section suggests that the presence of complete financial markets makes it possible for the households to undo the terms-of-trade effect associated with a tariff levy by holding state-contingent claims. Therefore, a domestic tariff does not generate any net marginal gain for the domestic household via the terms-of-trade effect. To investigate how a positive tariff can have a dominating terms-of-trade effect in the economy, we study a world without international capital markets in the next section.

3.4 Completely Segmented Financial Markets

In the previous section, we studied an economy with complete and perfect financial markets. In the next two sections, we examine the Nash equilibrium tariff in an economy with financial market segmentation: in this section, we consider the case of financial autarky, $\mathbf{E}(2)$. In this case, each household must hold the entire claim to its future endowment. This is the economy that is usually studied in the traditional or classic trade literature on tariffs.

In the absence of international financial markets, the household's maximization problem has to satisfy the ex-post budget constraint at time 1 in each state. In this case, the budget constraint for the home household is:

$$\sum_{j=1}^{2} p_{1j}(s)c_{1j}(s) = \sum_{j=1}^{2} p_{1j}(s)y_{1j}(s) + \bar{z}_1(s). \tag{3.30}$$

Compared to (3.4), the right-hand side of (3.30) differs only in that it does not include any asset payout. All consumption levels at time 1 have to be financed by the ex-post endowment, that is, households cannot share their endowment risks when the financial markets are completely segmented. In this case, solving the household's optimization problem ex-ante is identical to choosing an optimal consumption policy ex-post after the state of nature is realized. The home representative household maximizes (3.2) subject to the budget constraint (3.30) in every state s.

Under financial autarky, the first-order condition for the home household's maximization problem (3.2) is:

$$\frac{\alpha_j}{c_{1j}^A(s)} = \lambda_1(s)p_{1j}(s) \qquad j = 1,2, \tag{3.31}$$

where $\lambda_1(s)$ is the Lagrange multiplier of the ex-post feasibility constraint. The superscript "A" denotes the constrained optimal solutions under financial *autarky*, $\mathbf{E}(2)$. The market-clearing conditions remain the same as those described in equations (3.11) and (3.12) in the previous section. The consumption rules for the home household are derived as:

$$c_{11}^A(s) = (1+\tau_{12})\left[\frac{g_1(s)}{(2+\tau_{12})y_{22}(s)+(1+\tau_{12})(1+\tau_{21})y_{12}(s)}\right], \tag{3.32}$$

$$c_{12}^A(s) = \frac{g_1(s)}{(2+\tau_{21})y_{11}(s)+(1+\tau_{12})(1+\tau_{21})y_{21}(s)}, \tag{3.33}$$

where

$$g_1(s) = y_{11}(s)[y_{22}(s)+(2+\tau_{21})y_{12}(s)] + (1+\tau_{21})y_{12}(s)y_{21}(s). \tag{3.34}$$

In the tariff game, the maximization problem of the home government is:

$$\max_{\tau_{12}} \quad V_1^A(\tau_{12}, \tau_{21}) \equiv E_0 \left[\sum_{j=0}^{2} \ln[c_{1j}^A(s)] \right], \tag{3.35}$$

where $c_{1j}^A(s)$ are defined by equations (3.32)-(3.33). The home government's reaction function is given by the first-order condition to the above maximization problem and is described by:

$$E_0 \left[\left(\frac{1}{c_{11}^A(s)} \right) \left(\frac{\partial c_{11}^A(s)}{\partial \tau_{12}} \right) + \left(\frac{1}{c_{12}^A(s)} \right) \left(\frac{\partial c_{12}^A(s)}{\partial \tau_{12}} \right) \right] = 0. \tag{3.36}$$

The maximization problem of the foreign government also yields a reaction function similar to (3.36). The Nash equilibrium tariffs are obtained by solving the two reaction functions simultaneously. As each condition is a polynomial in τ_{12} and τ_{21}, it is not possible to obtain an exact analytical solution for the Nash equilibrium tariff level. However, we can still show analytically that the Nash equilibrium tariff is strictly positive in an economy with no international financial markets.

Proposition 3.2: *The Nash equilibrium tariff in an economy with no international financial markets is strictly positive.*

In the absence of financial markets, households can neither hedge the endowment risks in goods 1 and 2 nor the changes in terms of trade associated with the tariffs. The consumption of goods 1 and 2 in state s by each household is determined by the relative prices of the goods and the endowment, after the state s is realized. Since the home country has a higher endowment of good 1 relative to good 2, its wealth increases when the relative world price of good 1 to good 2 (which is also the terms of trade for the home country) rises. Therefore, the home government has an incentive to choose a high import tariff on good 2. On the other hand, the foreign country has a higher endowment of good

2 relative to good 1, and the foreign government will be induced to choose a high import tariff on good 1. Consequently, both governments end up choosing a positive tariff.

We now show that the terms-of-trade effect from the levying of a tariff is positive in an economy under financial autarky. Here, the relative world price of good 2 to good 1 is:

$$\frac{p_{22}(s)}{p_{11}(s)} = \frac{(2+\tau_{21})y_{11}(s) + (1+\tau_{21})(2+\tau_{12})y_{21}(s)}{(2+\tau_{12})y_{22}(s) + (1+\tau_{12})(2+\tau_{21})y_{12}(s)}. \tag{3.37}$$

The derivative of the relative price in (3.37) with respect to τ_{12} is given by:

$$\frac{\partial \frac{p_{22}(s)}{p_{11}(s)}}{\partial \tau_{12}} = -(2+\tau_{21})\left\{\frac{y_{11}(s)y_{22}(s) + y_{12}(s)[(1+\tau_{21})y_{21}(s) + (2+\tau_{21})y_{11}(s)]}{[(2+\tau_{12})y_{22}(s) + (1+\tau_{12})(2+\tau_{21})y_{12}(s)]^2}\right\} < 0. \tag{3.38}$$

As in the economy with perfect financial market integration ($\mathbf{E}(1)$), an increasing domestic tariff in the economy under financial autarky ($\mathbf{E}(2)$) improves the terms of trade for the home country. The time-1 real wealth of the home household under financial autarky is given by:

$$W_1^A(s) \equiv e_1^A(s) + \bar{z}_1(s). \tag{3.39}$$

In contrast to the wealth expression (3.19) in $\mathbf{E}(1)$, equation (3.39) shows that the wealth of the home household in economy $\mathbf{E}(2)$ has one less component, because there are no asset holdings. Due to the absence of asset holdings, a domestic tariff levy in $\mathbf{E}(2)$ does not have a negative substitution effect. Therefore, the following partial derivative shows that the total effect (which consists only of the wealth effect) of a tariff on future income is positive:

$$\begin{aligned} \frac{\partial W_1^A(s)}{\partial \tau_{12}} &= \frac{y_{12}(s)}{2+\tau_{12}}\left[(1-\tau_{12})\frac{p_{22}(s)}{p_{11}(s)} + \frac{(1+\tau_{12})(1+\tau_{21})y_{21}(s)}{(2+\tau_{12})y_{22}(s) + (1+\tau_{12})(2+\tau_{21})y_{12}(s)}\right] \\ &\quad + \frac{2y_{11}(s)}{(2+\tau_{12})^2} > 0, \end{aligned} \tag{3.40}$$

where the price ratio is given by (3.37). Therefore, the terms-of-trade effect is always greater in an economy under financial autarky than in an economy with complete financial markets.

The total terms-of-trade effect will influence the consumption of goods via the income effect and is given in the following equations:

$$\frac{\partial c_{11}^A(s)}{\partial \tau_{12}} = \left[\left(\frac{\partial c_{11}^A(s)}{\partial p_{12}(s)}\right)\left(\frac{\partial p_{12}(s)}{\partial \tau_{12}}\right)\right] + \left[\left(\frac{\partial c_{11}^A(s)}{\partial W_1^A(s)}\right)\left(\frac{\partial W_1^A(s)}{\partial \tau_{12}}\right)\right], \tag{3.41}$$

$$\frac{\partial c_{12}^A(s)}{\partial \tau_{12}} = \left[\left(\frac{\partial c_{12}^A(s)}{\partial p_{12}(s)}\right)\left(\frac{\partial p_{12}(s)}{\partial \tau_{12}}\right)\right] + \left[\left(\frac{\partial c_{12}^A(s)}{\partial W_1^A(s)}\right)\left(\frac{\partial W_1^A(s)}{\partial \tau_{12}}\right)\right]. \tag{3.42}$$

In contrast to the zero income effect of a tariff on the consumption of goods in (3.28) and (3.29) in $\mathbf{E}(1)$, the income effect in $\mathbf{E}(2)$, in (3.41) and (3.42), is positive. Since the cross-price effect is zero for the export good, the positive income effect from the positive terms-of-trade effect will increase the consumption of the good. This is reflected in the marginal gain from a domestic tariff levy represented by the term $\left(\frac{1}{c_{11}^A(s)}\right)\left(\frac{\partial c_{11}^A(s)}{\partial \tau_{12}}\right)$ in equation (3.36).

Therefore, in the absence of financial markets, the import tariff generates a favourable terms-of-trade effect, which can improve the utility of the domestic household through higher consumption of the export good. Although the wealth effect is also positive for the import good in (3.42), the negative price effect dominates the positive wealth effect and causes the consumption of the import good to fall. This is the marginal cost of a domestic tariff levy and is represented by the term $\left(\frac{1}{c_{12}^A(s)}\right)\left(\frac{\partial c_{12}^A(s)}{\partial \tau_{12}}\right)$ in equation (3.36).

We now explain how the absence of financial markets in the economy affects the Nash equilibrium tariff level by relating the result in Proposition 3.2 to that obtained in the previous section. In the presence of complete asset markets, the home household would have sold some state-contingent claims that pay out in terms of its own endowment goods and bought some claims that pay out in terms of the foreign endowment goods in the initial period. At the same time, the foreign household would have taken the opposite position. Hence, when the state of the world is realized at time 1, the home household has to transfer its domestic goods to the foreign household and vice versa, as required by the state-contingent contract agreed upon by both households at time 0. In this case, the governments have a reduced ability to generate a terms-of-trade effect via the levying of a domestic tariff because the amount of wealth transfer in all possible states has been determined by the ex-ante trade in contingent claims.

In the economy under financial autarky, the households have no means to share their endowment risks in the financial markets and they hold the entire claim to their future endowment. Thus, they are totally exposed to the governments' ability to employ a positive tariff to affect the wealth distribution between the two countries in the future period. In order to examine how the presence of some financial markets can reduce the effectiveness of a tariff as a government's instrument to create a favourable terms-of-trade effect, we now study an intermediate economy with partial financial market segmentation.

3.5 Partial Financial Market Segmentation

Our results in the two extreme economies, $\mathbf{E}(1)$ and $\mathbf{E}(2)$, suggest a negative relationship between the degree of financial market integration and the Nash equilibrium tariff level. To verify that this relationship is not an artifact of the extreme economies we consider, we now look at an intermediate case, $\mathbf{E}(3)$, characterised by partial financial market segmentation. We consider several different types of segmentation in which households are denied access to certain asset markets.

Under the assumption that each endowment process follows a binomial distribution, five tradable assets with linearly independent payouts are sufficient to complete the markets.[11] We consider an economy with four stocks and four bonds in the financial markets, where claims can be written on the stochastic and fixed payments of each endowment process, respectively.

We now describe the notation used in this section. Stock (i,j), where $i,j = \{1,2\}$, is a claim to the endowment process of good j in country i and pays out $y_{ij}(s)$ as its dividend in each state s. Hence, the value of its dividend payout in each state s is $p_{ij}(s) \cdot y_{ij}(s)$. The time-0 prices of these stocks are represented by $S_{ij}(0)$. The number of shares chosen by household n in the initial period is denoted by $\delta^n_{ij}(0)$, where the total number of shares outstanding equals one. Bond (i,j) is a claim to one unit of good j in country i in every state at time 1, and the value of its payout is given by $p_{ij}(s) \cdot 1$. The number of bonds chosen by household n at time 0 is denoted by $\gamma^n_{ij}(0)$, where the bonds are in zero net supply. The prices of these bonds are denoted by $B_{ij}(0)$. At time 0, each household is endowed with both domestic stocks.

The general budget constraints that the home household faces in both periods are given by the following. At time 0:

$$\sum_{j=1}^{2}\left[p_{1j}(0)c_{1j}(0) + \sum_{i=1}^{2}\left(\delta^1_{ij}(0)S_{ij}(0) + \gamma^1_{ij}(0)B_{ij}(0)\right)\right] = \sum_{j=1}^{2}[p_{1j}(0)y_{1j}(0) + S_{1j}(0)], \quad (3.43)$$

and at time 1:

$$\sum_{j=1}^{2} p_{1j}(s)c_{1j}(s) = \sum_{i=1}^{2}\sum_{j=1}^{2}\left[\delta^1_{ij}(0)p_{ij}(s)y_{ij}(s) + \gamma^1_{ij}(0)p_{ij}(s)\right]. \quad (3.44)$$

The price relations of goods 1 and 2 between the two countries and the market-clearing conditions in the commodity markets remain the same as those in the previous economies, and are given by equations (3.6)-(3.7) and (3.11)-(3.12), respectively. The financial market clears at $\delta^1_{ij}(0) + \delta^2_{ij}(0) = 1$ and $\gamma^1_{ij}(0) + \gamma^2_{ij}(0) = 0$, where $i,j = 1,2$.

[11] In the economy we consider, there are four stochastic endowment processes. Using He's (1990) technique, we generate (4+1)-nomial processes using symmetric initial endowments. In this case, five assets are sufficient to complete the market.

The home household maximizes its expected utility subject to the budget constraints in (3.43) and (3.44), for given values of τ_{12} and τ_{21}. The competitive equilibrium is obtained by imposing the market-clearing conditions. Then, the government chooses the tariff level given the households' consumption rule in the competitive equilibrium.

Our objective is to investigate the Nash equilibrium tariff level in an economy with partial financial market segmentation. In order to show that our analysis is not sensitive to any particular assumption about the financial market structure we have specified, we consider different types of partial financial market segmentation. The set of partial financial market segmentation classifications that we consider is by no means comprehensive but is selected to represent a number of plausible cases in the real world. We consider the following *types* of increasing financial market segmentation:

T(0). Complete financial market integration

Both households can trade in the home and foreign stock and bond markets.

T(1). Integrated stock markets but segmented bond markets

Both households can trade in the home and foreign stock markets, but not in the bond markets, $\gamma_{ij}^n = 0$.

T(2). Asymmetric stock markets segmentation

The home household can trade in the bond markets of both countries but not the foreign stock market. The foreign household can trade in both home and foreign stock markets and bond markets, $\delta_{2j}^1 = 0$ and $\delta_{2j}^2 = 1$.

T(3). Integrated bond markets and segmented stock markets

Both households can trade in the home and foreign bond markets, but not in the stock market of the other country, $\delta_{ij}^n = 1$ when $n = i$ and $\delta_{ij}^n = 0$ when $n \neq i$.

T(4). Asymmetric stock and bond market segmentation

The home household can trade in neither the foreign bond market nor the foreign stock market. The foreign household can trade in both home and foreign stock markets and bond markets, $\delta_{2j}^1 = \gamma_{2j}^1 = 0$ and $\delta_{2j}^2 = 1$.

T(5). Asymmetric stock market segmentation and segmented bond markets

The home household cannot trade in the foreign stock market. Neither household can trade in the bond market of other country, $\delta_{2j}^1 = \gamma_{2j}^1 = \gamma_{1j}^2 = 0$ and $\delta_{2j}^2 = 1$.

T(6). Financial autarky

Neither household can trade in the bond and stock markets of the other country, $\delta_{ij}^n = \gamma_{ij}^n = 0$ when $n \neq i$ and $\delta_{ij}^n = 1$ when $n = i$.

We will denote the *type* of financial market segmentation by $\mathbf{T}(\#)$ described above.

With complete financial market integration described in $\mathbf{T}(0)$, all households can trade in foreign and home stocks as well as borrow from and lend to each other. In this economy, the financial markets are complete and frictionless and the solution to this problem is identical to the one obtained in the economy described in Section 3, where households trade in state-contingent claims.[12] Each household holds a fraction (which is a function of the foreign and domestic tariffs) of each stock and no bonds. Households are able to share their endowment risks and hedge the terms-of-trade effect associated

[12]The equivalence of the two economies is shown in Appendix A.

with tariffs efficiently by transacting only in the stock markets and so do not choose to hold any bond.

When there is free access to the stock markets, the solution in Appendix A shows that bond markets are redundant. This implies that closing the bond markets in this economy will affect neither risk-sharing opportunities nor the choice of tariff. Therefore, if financial market segmentation of type $\mathbf{T}(1)$ exists in the economy, the Nash equilibrium tariff in this economy will be identical to that obtained in an economy with perfect and complete financial markets described in Section 3, $\mathbf{E}(1)$, and also under $\mathbf{T}(0)$.

With segmented (and less than complete) financial markets, consumption smoothing over time may be compromised to hedge endowment risks across states. This permits the government in each country to shift wealth between the two countries over time via its tariff. Thus, the Nash equilibrium tariff in an economy with partial financial market segmentation differs from that obtained under perfect financial markets and financial autarky. In particular, it lies between the Nash equilibrium tariff obtained in the two extreme economies described in Sections 3 and 4.[13]

Proposition 3.3: *In an economy with partial financial market segmentation of* types $\mathbf{T}(2)$-$\mathbf{T}(5)$, *the Nash equilibrium tariff for both countries is higher than that in an economy with international stock markets* $\mathbf{T}(0)$-$\mathbf{T}(1)$, *but lower than that in an economy with complete financial market segmentation* $\mathbf{T}(6)$. *That is,* $\tau_{ij}^{I} < \tau_{ij}^{P} < \tau_{ij}^{A}$, *where the superscript "P" denotes the Nash equilibrium tariff in an economy with partial financial market segmentation.*

Table 3.1 reports the ranking of the Nash equilibrium tariffs across $\mathbf{E}(1)$, $\mathbf{E}(2)$ and $\mathbf{E}(3)$. We find that the Nash equilibrium tariff in $\mathbf{E}(3)$ is not very sensitive to the types

[13] As analytical results cannot be obtained for the household's problem with partial financial market segmentation, the results in this section are obtained with numerical analysis.

of financial market segmentation, $\mathbf{T}(2)$-$\mathbf{T}(5)$. This result suggests that in the absence of complete markets, the ability of the households to hedge the changes in the terms of trade is not sensitive to the type of instruments that they can use so long as they are able borrow or lend from each other using some asset in the international financial markets.

We now explain the intuition behind the ranking of tariffs across $\mathbf{E}(1)$ to $\mathbf{E}(3)$ by relating the result in this section to the findings in the two previous sections. Under segmentation of types $\mathbf{T}(2)$-$\mathbf{T}(5)$, the imperfect risk-sharing equilibrium causes a tariff levy to have a lower substitution effect (from asset holdings) relative to an equilibrium with perfect risk-sharing. Therefore, the magnitude of the total terms-of-trade effect in an economy with partial segmentation lies between that in an economy under financial autarky and that in an economy with complete financial markets. The magnitude of the terms-of-trade effect associated with an increase in domestic tariff in the three economies is the important factor in the determination of the relative level of the Nash equilibrium tariff in our model. Figure 3.1 shows that a rise in tariff improves the terms of trade in $\mathbf{E}(1)$ to $\mathbf{E}(3)$. However, the comparison of the terms-of-trade effect in country 1 across the economies in Figure 3.2 - 3.4 indicates that an increasing degree of integration in financial markets reduces the terms-of-trade effect. This negative relationship between terms-of-trade effect and financial market integration explains the ranking of tariffs across the three financial structures stated in Proposition 3.3. This ranking is illustrated in Figure 3.5.

The analysis in this section shows that the ability of households to share their endowment risks in the financial markets influences the government's choice of tariff. The result suggests that the effectiveness of a tariff as an instrument to affect wealth distribution is reduced by the presence of international financial markets. Therefore, the consideration of financial structure is important in designing a tariff policy.

3.6 Conclusion

The main result of this chapter is the finding that the Nash equilibrium tariff levels in an economy decreases with increasing international financial market integration. This is explained by the terms-of-trade effect associated with tariffs. Although a domestic tariff improves the terms of trade for the domestic country regardless of the financial structure in the economy, the terms of trade effect differs across financial structures. The terms-of-trade effect is reduced as the degree of international financial market integration increases. This explains the inverse relationship between the Nash equilibrium tariff and degree of financial market integration. With complete financial markets, the Nash equilibrium tariff is zero because the households can undo the terms-of-trade effect in the financial markets such that the marginal benefit from the terms-of-trade effect is dominated by the marginal cost of the price distortion caused by tariffs.

In conclusion, our analysis shows that the structure of international financial markets is pertinent in determining the effectiveness of policies in the commodity markets, in this case, tariff policy. Therefore, it is important for policy-makers to take into account the risk-sharing opportunities available in international financial markets when they decide on trade policies.

$\frac{y_{11}(0)}{y_{21}(0)} = \frac{y_{22}(0)}{y_{12}(0)}$		Financial Market Structure		
		Complete Markets T(0)-T(1)	Partially Segmented T(2)-T(5)	Perfectly Segmented T(6)
1.5	$\eta = 0.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.13$	$\tau_{12} = \tau_{21} = 0.22$
	$\eta = 1$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.16$	$\tau_{12} = \tau_{21} = 0.22$
	$\eta = 1.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.18$	$\tau_{12} = \tau_{21} = 0.22$
	$\eta = 2$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.19$	$\tau_{12} = \tau_{21} = 0.22$
	$\eta = 2.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.19$	$\tau_{12} = \tau_{21} = 0.22$
2	$\eta = 0.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.22$	$\tau_{12} = \tau_{21} = 0.41$
	$\eta = 1$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.28$	$\tau_{12} = \tau_{21} = 0.41$
	$\eta = 1.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.31$	$\tau_{12} = \tau_{21} = 0.41$
	$\eta = 2$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.33$	$\tau_{12} = \tau_{21} = 0.41$
	$\eta = 2.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.34$	$\tau_{12} = \tau_{21} = 0.41$
2.5	$\eta = 0.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.26$	$\tau_{12} = \tau_{21} = 0.58$
	$\eta = 1$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.37$	$\tau_{12} = \tau_{21} = 0.58$
	$\eta = 1.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.40$	$\tau_{12} = \tau_{21} = 0.58$
	$\eta = 2$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.43$	$\tau_{12} = \tau_{21} = 0.58$
	$\eta = 2.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.45$	$\tau_{12} = \tau_{21} = 0.58$
3	$\eta = 0.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.33$	$\tau_{12} = \tau_{21} = 0.73$
	$\eta = 1$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.43$	$\tau_{12} = \tau_{21} = 0.73$
	$\eta = 1.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.49$	$\tau_{12} = \tau_{21} = 0.73$
	$\eta = 2$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.52$	$\tau_{12} = \tau_{21} = 0.73$
	$\eta = 2.5$	$\tau_{12} = \tau_{21} = 0$	$\tau_{12} = \tau_{21} = 0.54$	$\tau_{12} = \tau_{21} = 0.73$

Table 3.1: **Changes in Nash equilibrium tariffs with the ratio of initial endowment of good i in home and foreign countries, for i=1,2, and the relative risk aversion η.** The comparison of the Nash equilibrium tariffs across the types of financial market segmentation shows that the Nash equilibrium tariff decreases with increasing financial market integration. The Nash equilibrium tariff also increases when the difference in the endowment of the export and import good between the two countries increases. In addition, the Nash equilibrium tariff increases with relative risk aversion.

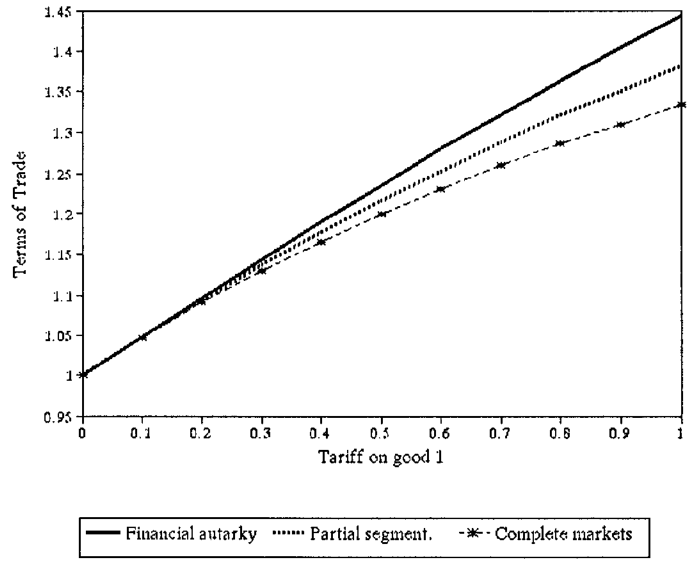

Figure 3.1: **Plot of terms of trade in country 1 against domestic tariff.** The household is assumed to have logarithmic preference. The expected terms of trade for country 1 is given by $E_0\left[\frac{p_{11}(s)}{p_{22}(s)}\right]$ and is computed taking $\tau_{21} = 0$ as given. The figure shows that an increase in the domestic tariff improves the terms of trade in all three economies $\mathbf{E}(1)$-$\mathbf{E}(3)$. The improvement in terms of trade is also greater when the degree of financial market segmentation is higher.

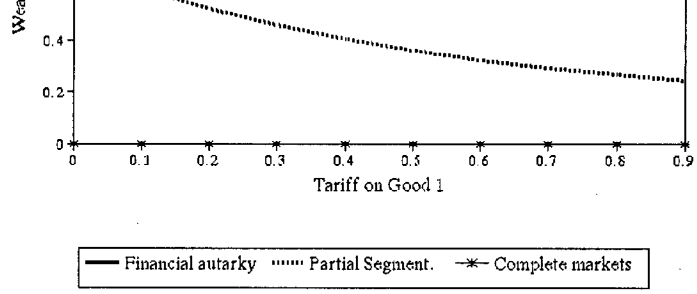

Figure 3.2: **Plot of terms-of-trade effect in country 1 against domestic tariff.** The expected terms-of-trade effect at time 1 is computed from the term $E_0\left[\frac{\partial w^1(s)}{\partial \tau_{12}}\right]$, where $w^1(s) \equiv \sum_{j=1}^{2} p_{1j}(s)c_{1j}(s)$. The foreign tariff is taken as given at $\tau_{21} = 0$. The household is assumed to have logarithmic preferences. The magnitude of the terms-of-trade effect decreases with the degree of financial market integration and it is zero when financial markets are perfectly integrated in economy $\mathbf{E}(1)$.

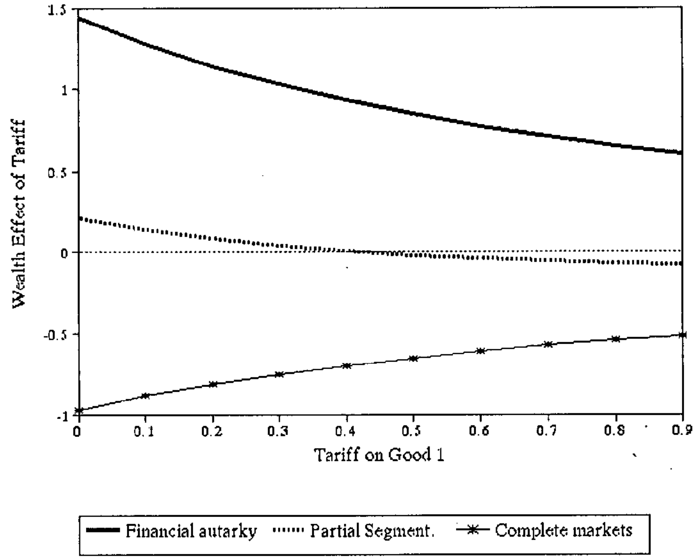

Figure 3.3: **Plot of terms-of-trade effect in country 1 against domestic tariff.** The expected terms-of-trade effect at time 1 is computed from the term $E_0\left[\frac{\partial w^1(s)}{\partial \tau_{12}}\right]$, where $w^1(s) \equiv \sum_{j=1}^{2} p_{1j}(s)c_{1j}(s)$. The foreign tariff is taken as given at $\tau_{21} = 0$. The household is assumed to have a relative risk aversion (η) of 0.5. The magnitude of the terms of trade effect decreases with the degree of financial market integration.

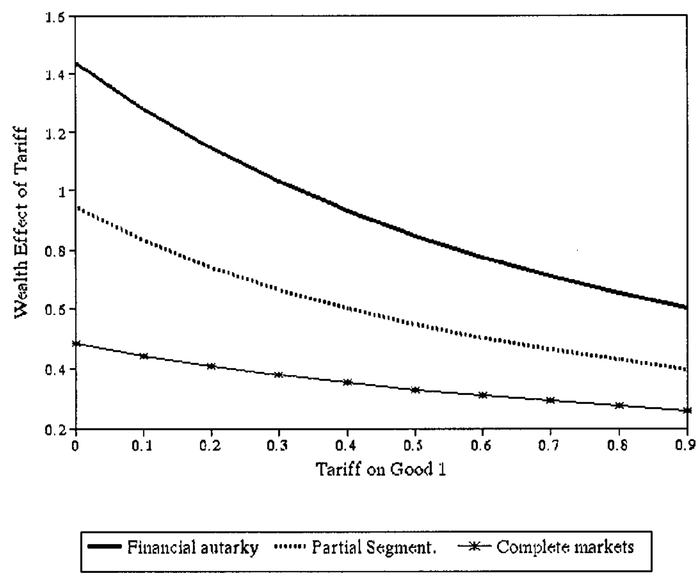

Figure 3.4: **Plot of terms-of-trade effect in country 1 against domestic tariff.** The expected terms-of-trade effect at time 1 is computed from the term $E_0\left[\frac{\partial w^1(s)}{\partial \tau_{12}}\right]$, where $w^1(s) \equiv \sum_{j=1}^{2} p_{1j}(s)c_{1j}(s)$. The foreign tariff is taken as given at $\tau_{21} = 0$. The household is assumed to have a relative risk aversion (η) of 2. The magnitude of the terms of trade effect decreases with the degree of financial market integration.

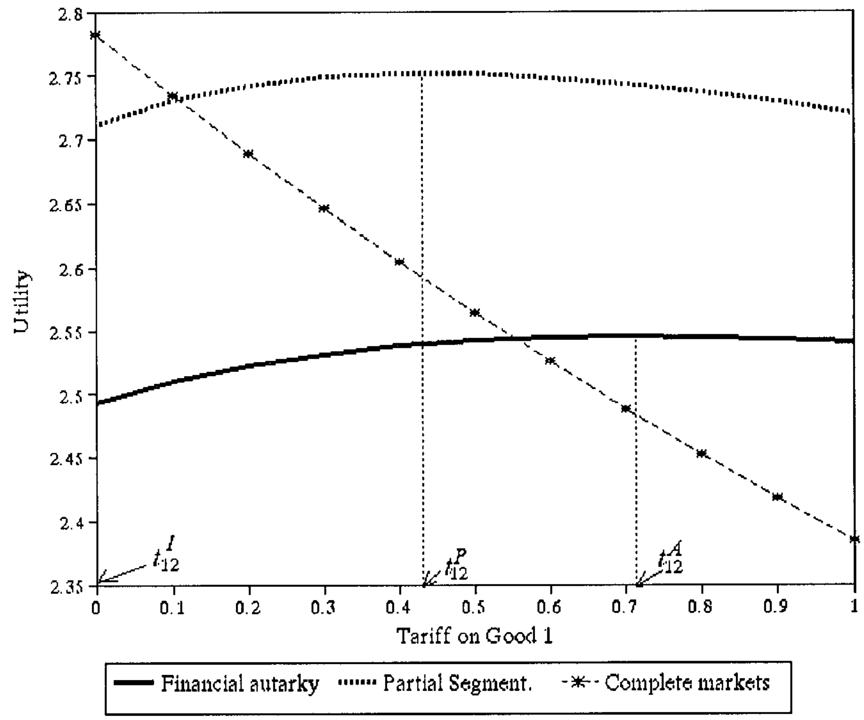

Figure 3.5: **Plot of household's expected utility in country 1 against domestic tariff.** The household is assumed to have logarithmic preferences and its expected utility is computed given τ_{21}. In economy $\mathbf{E}(1)$ with complete markets, $\tau_{21} = \tau_{21}^{I} = 0$, in economy $\mathbf{E}(2)$ with segmented financial markets of type $\mathbf{T}(2)$-$\mathbf{T}(5)$, $\tau_{21} = \tau_{21}^{P} = 0.43$, and in economy $\mathbf{E}(3)$ under financial autarky, $\tau_{21} = \tau_{21}^{A} = 0.73$. The figure shows the ranking of the Nash equilibrium tariff levels in the respective economies $\mathbf{E}(1)$-$\mathbf{E}(3)$.

Chapter 4

Welfare Gains from Integration of International Financial Markets

4.1 Introduction

This chapter tries to evaluate the quantitative importance of the integration of international financial markets. The fact that financial markets have repercussions for endogenous tariff policy (discussed in the previous chapter) has a direct implication for the assessment of the welfare gains from international financial markets. In our environment, where tariff levels are endogenous, international financial market integration can have a "trade dividend". Not only does financial market integration allow for an optimal degree of risk sharing for a given cross-country distribution of production shocks, but through the secondary impacts of endogenous trade policy, it allows for an exploitation of the classic welfare gains from international commodity trade. This implies that the welfare gains from financial market integration are higher than those estimated in a model where trade policy is held constant.

We provide a quantitative assessment of the extent of these secondary welfare gains. In principle, these gains may be considerably larger than the direct gains from risk sharing. Under a reasonable calibration to observed measures of trade protection, we find that these secondary welfare gains are about 15 times the magnitude of the direct gains from risk sharing. The higher welfare gains result we obtain is similar to Obstfeld (1994) where he finds large secondary welfare gains from financial market integration by allowing physical capital to move into riskier, high-return production technologies.

While full international portfolio diversification can lead to an endogenous drop in equilibrium protection, the presence of financial markets alone may not achieve this. We find that in an environment where international financial markets operate with endogenous trade policy, there are in fact multiple equilibria. One equilibrium is as described above: full international portfolio diversification with zero tariffs. There are other equilibria, however, where even in the presence of open financial markets, portfolios are not fully diversified and tariffs are positive.

The reason for multiple equilibria is simple. In an economy with endogenous terms of trade movement, commodity trade is a partial substitute for financial market trade. Thus, there is an indeterminacy as to how much of each type of trade will be used in equilibrium. However, endogenous equilibrium tariffs will depend critically upon the breakdown between the commodity trade and the financial market trade used by the households. As a result, while there is an equilibrium with full diversification and zero tariffs, there are also equilibria with limited insurance and positive tariffs. These equilibria can be Pareto ranked. It is, in fact, possible to have equilibria with financial markets and endogenous trade policy that are *inferior* to financial market autarky, in terms of welfare.

This chapter is structured as follows. The next section spells out the model. Section 3 looks at the effects of financial markets on equilibrium trade policy. Section 4 provides a quantitative assessment of the impact of financial markets in the model. Section 5 illustrates the presence of multiple equilibria. Section 6 concludes. The proof for the proposition are provided in Appendix B.

4.2 The Model

In this section we sketch out a simple two-period model in which the main results are derived. It is shown below that the results extend readily to an infinite horizon framework and our numerical computations are based on this. This model is very similar to the one developed in the previous chapter, where the financial decisions are made ex-ante and the consumption choice are made ex-post. The main difference is that the tariff choice is made after the state of nature is revealed while, in the previous chapter, the tariff choice is made ex-ante before the state of nature is revealed. Modelling tariff as an ex-post decision variable corresponds to an environment where governments lack power to commit in advance to particular levels of protection.[1] Therefore, the tariff level in the previous chapter is non-stochastic while the tariff level in this chapter is state-dependent.[2] In order to derive analytical results we rely on strong symmetry and functional-form assumptions.[3]

For clarity, we will describe again the model in this chapter, even though it is very similar to the model presented in the previous chapter. As in the model in the previous chapter, there are two countries, home and foreign, with a representative household in each country. Each country produces two goods, good 1 and good 2. Good 1 (2) is the exportable good for the home (foreign) country, and good 2 (1) is the importable for the home (foreign) country. Households desire to maximize expected utility, which is a function of the consumption of both goods. Home country residents have the following

[1] The importance of this in other contexts has been noted by Staiger and Tabellini (1987).

[2] If governments are allowed to renege on their tariff announcement in the previous chapter, they will make adjustments to the announced non-stochastic tariff after the state of nature is revealed in attempt to make the tariff level ex-post optimal.

[3] These are also relaxed in the numerical computations.

expected utility function:

$$EU = E[\ln c_{11}(s) + \ln c_{12}(s)]. \tag{4.1}$$

Preferences of foreign residents are exactly the same. As in the previous chapter, there is no production and outputs (or endowments) in each country are determined exogenously. We denote output levels of goods 1 and 2 in state s in the home and foreign countries as:

$$\text{home country}: \quad y_{11}(s) \quad y_{12}(s),$$

$$\text{foreign country}: \quad y_{21}(s) \quad y_{22}(s).$$

The opportunity sets of countries are entirely symmetric. It is assumed that the joint distribution of world endowment processes is such that households in each country will face ex-ante identical budget constraints.

The probability distribution of shocks is also restricted so that in the equilibrium without financial markets the home (foreign) country always exports good 1 (good 2) and imports good 2 (good 1). For this we need $\frac{y_{11}(s)}{y_{12}(s)} > 1$ and $\frac{y_{22}(s)}{y_{21}(s)} > 1$, for each s. Since the welfare gain is evaluated based on the movement from financial autarky to financial market integration, the base economy is described as one without financial markets. Thus, we will first present the equilibrium in the base economy.

4.2.1 The Economy with No International Financial Markets

We will characterise the equilibrium without international financial markets in this subsection. For state s, home households face the following budget constraint:

$$c_{11}(s) + [1 + \tau_{12}(s)]p(s)c_{12}(s) = y_{11}(s) + [1 + \tau_{12}(s)]p(s)y_{12}(s) + \bar{z}_1(s), \tag{4.2}$$

where $p(s)$ represents the world price of the foreign country's exportable good (good 2), $\tau_{12}(s)$ represents the tariff rate levied on the importable good 2. In this chapter, we simplify the notation by setting the world price of good 1 (the numeraire good) to unity. As in the previous chapter, $\bar{z}_1(s)$ is a lump-sum transfer given by the home government to the home household, which is the rebated tariff revenue, $\tau_{12}(s)p(s)(c_{12}(s) - y_{12}(s))$, and is taken as exogenous by the home household.

Foreign households face an analogous budget constraint where the foreign tariff is levied on imports of good 1 from the home country. The competitive equilibrium of the household's problem is the same as that derived in the previous chapter. Optimal consumption of home and foreign households in state s is:

$$c_{11}(s) = \frac{1+\tau_{12}(s)}{2+\tau_{12}(s)}[y_{11}(s) + p(s)y_{12}(s)], \tag{4.3}$$

$$c_{12}(s) = \frac{1+\tau_{12}(s)}{2+\tau_{12}(s)}\left(\frac{y_{11}(s) + p(s)y_{12}(s)}{[1+\tau_{12}(s)]p(s)}\right), \tag{4.4}$$

$$c_{21}(s) = \frac{1}{2+\tau_{21}(s)}[y_{21}(s) + p(s)y_{22}(s)], \tag{4.5}$$

$$c_{22}(s) = \frac{1+\tau_{21}(s)}{2+\tau_{21}(s)}p(s)[y_{21}(s) + p(s)y_{22}(s)]. \tag{4.6}$$

In a competitive equilibrium of the world economy for state s, the relative price of good 2, $p(s)$[4], is determined as:

$$p(s) = \frac{[2+\tau_{21}(s)]y_{11}(s) + [1+\tau_{21}(s)][2+\tau_{12}(s)]y_{21}(s)}{[1+\tau_{12}(s)][2+\tau_{21}(s)]y_{12}(s) + [2+\tau_{12}(s)]y_{22}(s)}. \tag{4.7}$$

Using (4.1), equations (4.3)-(4.7) give the indirect utility as a function of tariffs: $V_1(s, \tau_{12}(s), \tau_{21}(s))$ and $V_2(s, \tau_{12}(s), \tau_{21}(s))$. A Nash equilibrium of the tariff game between governments under financial autarky is defined as the values $\tau_{12}^A(s)$ and $\tau_{21}^A(s)$ which solve:

$$\max_{\tau_{12}(s)} \; V_1(s, \tau_{12}(s)\tau_{21}^A(s)); \qquad \max_{\tau_{21}(s)} \; V_2(s, \tau_{12}^A(s), \tau_{21}(s)). \tag{4.8}$$

[4]The price function is the same as that in (3.37) in the previous chapter. The only difference is that the tariffs are state contingent in this chapter, while they are deterministic in the previous chapter.

Appendix B shows that the Nash equilibrium values of $\tau_{12}^A(s)$ and $\tau_{21}^A(s)$ are:

$$\tau_{12}^A(s) = \sqrt{\left(\frac{y_{22}(s)}{y_{22}(s)+y_{12}(s)}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{y_{21}(s)}\right)} - 1, \tag{4.9}$$

$$\tau_{21}^A(s) = \sqrt{\left(\frac{y_{11}(s)}{y_{11}(s)+y_{21}(s)}\right)\left(\frac{y_{12}(s)+y_{22}(s)}{y_{12}(s)}\right)} - 1. \tag{4.10}$$

The important result to note is that the level of tariffs will depend upon the degree of specialisation in international output. The greater the share of the home country in the total output of good 1 at state s, the higher is the home country tariff, as equation (4.9) makes clear. The same holds true for the foreign country's tariff with respect to good 2. Intuitively, the smaller is the foreign country's share of world output of good 1, in any state of the world, the greater the increase in the world relative price of good 1 (rise in the home country terms of trade) and the larger the improvement in the home country's welfare. In the limit, as $\frac{y_{21}(s)}{y_{11}(s)+y_{21}(s)} \to 0$, the home-country tariff goes to infinity.

4.2.2 International Financial Markets

Now we introduce international financial markets. Households in each country can trade in state contingent commodities prior to the realisation of uncertainty. A state contingent financial contract stipulates that the owner will receive one unit of good 1 or 2 in a particular state. State contingent contract prices are determined in competitive markets.

The home household now faces the following budget constraints:

$$\sum_s q_1(s)\omega_1^1(s) + \sum_s q_2(s)\omega_2^1(s) = 0, \tag{4.11}$$

$$\begin{aligned} c_{11}(s) + [1+\tau_{12}(s)]p(s)c_{12}(s) &= y_{11}(s) + \omega_1^1(s) + p(s)\{[1+\tau_{12}(s)]y_{12}(s) + \omega_2^1(s)\} \\ &\quad + \tilde{z}_1(s), \end{aligned} \tag{4.12}$$

$$\tilde{z}_1(s) = \tau_{12}(s)p(s)[c_{12}(s) - y_{12}(s)]. \tag{4.13}$$

In these equations, $\omega_1^i(s)$ represents the quantity of good 1 that the household in country i is delivered in state s and $\omega_2^i(s)$ is the delivery of good 2. These contracts are purchased at world state prices $q_1(s)$ and $q_2(s)$.[5, 6]

In Appendix B, it is shown that an optimal choice of $\omega_j^i(s)$ for $i, j = 1, 2$, allows equations (4.11), (4.12) and (4.13) to be collapsed to the following constraint:

$$\sum_s q_2(s)\{c_{11}(s) + [1 + \tau_{12}(s)]p(s)c_{12}(s)\} = \sum_s q_2(s)\{y_{11}(s) + [1 + \tau_{12}(s)]p(s)y_{12}(s) + \bar{z}_1(s)\}. \tag{4.14}$$

Using the same procedure for the foreign country, its constraint is:

$$\sum_s q_2(s)\{[1 + \tau_{21}(s)]c_{21}(s) + p(s)c_{22}(s)\} = \sum_s q_2(s)\{[1 + \tau_{21}(s)]y_{21}(s) + p(s)y_{22}(s) + \bar{z}_2(s)\}. \tag{4.15}$$

Home households maximize expected utility subject to (4.14), while foreign households maximize expected utility subject to (4.15). The first-order conditions are:

$$\pi(s) = \lambda_1 c_{11}(s), \tag{4.16}$$

$$\pi(s) = \lambda_1[1 + \tau_{12}(s)]p(s)c_{12}(s), \tag{4.17}$$

$$\pi(s) = \lambda_2[1 + \tau_{21}(s)]c_{21}(s), \tag{4.18}$$

$$\pi(s) = \lambda_2 p(s)c_{22}(s), \tag{4.19}$$

[5]Note that good 2 deliveries are assumed not to be subject to the home import tariff. Were this to be the case, arbitrage opportunities arise since the ex-ante cost of good 1 is the same for all households, equal to $\frac{q_1(s)}{q_2(s)}$, but the benefit, in terms of ex-post delivery of goods, is $\frac{1}{1+\tau_{12}(s)}$ for the home country and $[1 + \tau_{21}(s)]$ for the foreign country. Thus, the relative cost cannot equal the relative benefit for both countries. One or both of the countries then has an arbitrage opportunity. To avoid this, we either have to allow for delivery of the goods exempt from tariffs or have tariffs levied also on the purchase of state contingent commodities. We take the former approach. One way to interpret it is that a tariff is equivalent to a production subsidy and a consumption tax on the import good. In this environment, the production subsidy is not offered to the delivery of importable goods.

[6]In the previous chapter, we identify the contingent claims by good and country of origin. In that case, we have four types of claims that command different prices and the deliveries of the import goods ex-post are subject to tariffs. The two representations of contingent claims yield the same equilibrium solution.

where $\pi(s)$ is the probability of state s occurring and $c_{1j}(s)$ and $c_{2j}(s)$, for $j = 1, 2$, represent the optimal home and foreign consumption allocations, respectively, with financial markets.

Given the symmetric distributional assumptions on endowment and assuming (as will be the case) that this leads to symmetry in endogenous tariff setting, home and foreign households face identical ex-ante budget constraints (4.14) and (4.15). It therefore follows that $\lambda_1 = \lambda_2$. Thus, the first-order conditions above imply that:

$$\begin{aligned} c_{11}(s) &= [1 + \tau_{21}(s)]c_{21}(s), && (4.20) \\ c_{22}(s) &= [1 + \tau_{12}(s)]c_{12}(s). && (4.21) \end{aligned}$$

The presence of stochastic tariffs imposes a wedge between foreign and home consumption. To determine the actual state consumption allocations we only need to combine equations (4.20) and (4.21) with the ex-post world resource constraints:

$$\begin{aligned} c_{11}(s) + c_{21}(s) &= y_{11}(s) + y_{21}(s), && (4.22) \\ c_{12}(s) + c_{22}(s) &= y_{12}(s) + y_{22}(s), && (4.23) \end{aligned}$$

which gives the solutions (3.13) and (3.14) reported in the previous chapter. For convenience, we report these solutions again:

$$\begin{aligned} c_{11}(s) &= \frac{1 + \tau_{21}(s)}{2 + \tau_{21}(s)}[y_{11}(s) + y_{21}(s)], && (4.24) \\ c_{12}(s) &= \frac{1}{2 + \tau_{12}(s)}[y_{12}(s) + y_{22}(s)], && (4.25) \\ c_{21}(s) &= \frac{1}{2 + \tau_{21}(s)}[y_{11}(s) + y_{21}(s)], && (4.26) \\ c_{22}(s) &= \frac{1 + \tau_{12}(s)}{2 + \tau_{12}(s)}[y_{12}(s) + y_{22}(s)]. && (4.27) \end{aligned}$$

Note that the equations (4.24)-(4.27) indicate that the presence of time-varying tariffs limits the degree of international risk sharing, even with complete financial markets.

These consumption allocations are supported by the optimal state contingent deliveries of goods 1 and 2 such that the ex-post budget constraint (4.12) is satisfied for the home household and a similar ex-post budget constraint is satisfied for the foreign household. By the market-clearing conditions in (4.22) and (4.23), it must be that $\omega_1^1(s)+\omega_1^2(s)=0$, and $\omega_2^1(s)+\omega_2^2(s)=0$.

4.3 The Tariff Game with Financial Markets

A competitive equilibrium with financial markets and endogenous tariff setting is described as follows. Conditional upon the deliveries of commodities arising from financial contracts, households maximize ex-post utility, markets clear, and each government sets an optimal tariff to maximize home utility, taking the tariff of the other government as given. This equilibrium must then have the following property. The state contingent deliveries of goods $\omega_1^1(s)$ and $\omega_2^1(s)$ must be such that, in the ex-post competitive equilibrium where households maximize utility state by state, governments will choose tariffs so that the consumption allocations $c_{11}(s)$, $c_{12}(s)$, $c_{21}(s)$, and $c_{22}(s)$ are realised. Thus, governments choose tariffs so that, in equilibrium, the constrained optimal risk sharing implied by (4.24)-(4.27) is sustained.

The structure of the ex-post competitive equilibrium with financial markets, for any state s, is identical to that without financial markets, except for the presence of the deliveries of commodities from the financial contracts. The equilibrium relative price of good 2 is:

$$p(s)=\frac{[2+\tau_{21}(s)]\tilde{y}_{11}(s)+[1+\tau_{21}(s)][2+\tau_{12}(s)]\tilde{y}_{21}(s)}{[1+\tau_{12}(s)][2+\tau_{21}(s)]\tilde{y}_{12}(s)+[2+\tau_{12}(s)]\tilde{y}_{22}(s)}, \tag{4.28}$$

where $\tilde{y}_{1j}(s)=y_{1j}(s)+\omega_j^1(s)$, $\tilde{y}_{2j}(s)=y_{2j}(s)-\omega_j^1(s)$[7], for $j=1,2$.

[7]Note that market clearing in the financial markets imply: $\omega_j^2(s)=-\omega_j^1(s)$, for $j=1,2$.

The tariff game played between governments is the same as that described above. Given total endowments of each good, which now include state contingent deliveries of goods, the governments of each country choose tariffs to maximize home welfare, given the tariff of the other government. In a Nash equilibrium of the tariff game, with financial markets, the tariff rates will be[8]:

$$\tau_{12}^I(s) = \sqrt{\left(\frac{\tilde{y}_{22}(s)}{y_{22}(s)+y_{12}(s)}\right)\left(\frac{y_{11}(s)+y_{21}(s)}{\tilde{y}_{21}(s)}\right)} - 1, \tag{4.29}$$

$$\tau_{21}^I(s) = \sqrt{\left(\frac{\tilde{y}_{11}(s)}{y_{11}(s)+y_{21}(s)}\right)\left(\frac{y_{12}(s)+y_{22}(s)}{\tilde{y}_{12}(s)}\right)} - 1. \tag{4.30}$$

We can now establish the following proposition.

Proposition 4 *There is an equilibrium of the tariff-setting game with financial markets in which ex-post tariffs are zero and full international consumption risk sharing is realized.*

There is an equilibrium with financial markets where tariffs are zero and optimal risk sharing is achieved. In this equilibrium, the optimal contingent claims holdings for the home household are:

$$\omega_1^1(s) = \frac{1}{2}[y_{21}(s) - y_{11}(s)], \tag{4.31}$$

$$\omega_2^1(s) = \frac{1}{2}[y_{22}(s) - y_{12}(s)]. \tag{4.32}$$

In the economy with complete financial markets and full diversification, in the sense of (4.31) and (4.32), welfare is independent of the terms of trade. Thus, the terms-of-trade effect is zero and there is no welfare gain to any one government from imposing tariffs. Rather, the only welfare effect of tariffs is negative, since they drive a wedge between the world price and the marginal rate of substitution in consumption between exportables and importables. This latter point has been made before by Stockman and Dellas (1986).

[8]The Nash equilibrium tariffs with financial markets are derived using the same method as that for financial autarky by replacing y_{ij} with $\tilde{y}_{ij}$, for $i,j = 1,2$.

In a clear sense, then, financial markets have two effects in this model: they first achieve optimal constrained risk sharing given a stochastic distribution of tariffs, and secondly, they also affect the motivation for tariff setting itself. Given the holdings of financial contracts in (4.31) and (4.32), financial markets actually eliminate the ex-post gain from tariffs, leading governments to endogenously choose a free trade policy. It is in this sense that financial markets have a "trade dividend" by setting up a binding contract that causes the government to choose free trade as the optimal trade policy. In the next section, we attempt to quantify the magnitude of this secondary effect of financial market integration, both for this model and for a more general infinite horizon model.

Table 4.1 reports some examples of the gains to financial markets when tariffs are exogenous and compares these gains to the situation with endogenous tariffs. This table takes a simple two-state $\{l, h\}$ distribution in which:

$$y_{11}(1) = y_{22}(2) = x_l,$$

$$y_{11}(2) = y_{22}(1) = x_h,$$

$$y_{12}(1) = y_{21}(2) = m_l,$$

$$y_{12}(2) = y_{21}(1) = m_h,$$

where both states are equally likely.

Thus, there are four parameters to the distribution and world output of good 1 (2) fluctuates between $x_l + m_h$ $(x_h + m_l)$ in state 1 to $x_h + m_l$ $(x_l + m_h)$ in state 2. In the benchmark case in Table 4.1, the parameters are chosen so that the standard deviation of consumption is 2%. The second and third columns in Table 4.1 report the percentage of average consumption that a household in either country would be willing to give to achieve full risk sharing, starting with financial autarky. In the case of exogenous trade policy, average tariffs are set at zero under both regimes, while in the case of endogenous trade policy, tariffs adjust as in the model above. The gains from trade reported in the table represents the "trade dividend" from financial markets.

The relative welfare gains from financial markets under exogenous and endogenous trade policy critically depend on the degree of asymmetry in endowments. When countries have identical endowments, there is no reason for commodity trade and the gains are identical under both financial market structures. As the ratio of average endowments of importables to exportables falls, the gains from financial markets under exogenous trade policy falls, since, as pointed out by Cole and Obstfeld (1991), in this case, there is greater product specialisation, and the terms of trade can achieve some risk sharing. But, as the ratio falls with endogenous trade policy, the gains from financial market integration increase and become increasingly larger and larger as the country becomes more and more specialised. This is because, as illustrated in the right-hand column, the endogenous tariff rates become very large as each country becomes more specialised. Thus, our model predicts that the gains to international financial market integration is greater, the more specialised are countries in their production structure.

To quantitatively assess the benefits to financial market integration under endogenous trade policy, however, we must extend the model. This is done in the next section.

4.4 A More General Infinite Horizon Model

To adequately compare the quantitative impact of financial market integration in this economy with other literature, we must extend the model to an infinite horizon and allow for more general preferences. Preferences are now given by:

$$E\left[\sum_{0}^{\infty}\beta^t\frac{\left(c_{11t}^{1-\frac{1}{\rho}}+c_{12t}^{1-\frac{1}{\rho}}\right)^{\frac{1-\sigma}{1-\frac{1}{\rho}}}}{(1-\sigma)}\right], \tag{4.33}$$

where ρ represents the elasticity of substitution between commodities and σ represents the relative risk aversion parameter.

In the absence of financial markets, the world equilibrium price is determined as in Section 4.2.1 in every period, with tariffs being determined by a Nash equilibrium of the tariff game between governments.[9] For any period, in state s, the consumption decision is determined as:

$$c_{11t}(s) = \frac{[1+\tau_{12t}(s)]^{\rho} p_t(s)^{\rho-1}[p_t(s)y_{11t}(s)+y_{12t}(s)]}{1+p_t(s)^{\rho-1}[1+\tau_{12t}(s)]^{\rho}}, \tag{4.34}$$

$$c_{12t}(s) = \frac{p_t^{-\rho}[p_t(s)y_{11t}(s)+y_{12t}(s)]}{p_t(s)^{1-\rho}+[1+\tau_{12t}(s)]^{\rho}}, \tag{4.35}$$

$$c_{21t}(s) = \frac{p_t(s)^{\rho-1}[p_t(s)y_{21t}(s)+y_{22t}(s)]}{p_t(s)^{\rho-1}+[1+\tau_{21t}(s)]^{\rho}}, \tag{4.36}$$

$$c_{22t}(s) = \frac{[1+\tau_{21t}(s)]^{\rho}[p_t(s)y_{21t}(s)+y_{22t}(s)]}{p_t(s)^{\rho}+p_t(s)[1+\tau_{21t}(s)]^{\rho}}. \tag{4.37}$$

The relative price of good 2, $p_t(s)$, is implicitly determined by the equation:

$$y_{11t}(s)+y_{11t}(s) = \frac{[1+\tau_{12t}(s)]^{\rho} p_t(s)^{\rho-1}}{1+p_t(s)^{\rho-1}[1+\tau_{12t}(s)]^{\rho}}[p_t(s)y_{11t}(s)+y_{12t}(s)]$$
$$+\frac{p_t(s)^{\rho-1}}{p_t(s)^{\rho-1}+[1+\tau_{21t}(s)]^{\rho}}[p_t(s)y_{21t}(s)+y_{22t}(s)]. \tag{4.38}$$

Finally, Appendix B shows that the Nash equilibrium values of $\tau_{12t}(s)$ and $\tau_{21t}(s)$ are implicitly determined by:

$$\tau^{A}_{12t}(s) = \frac{1}{\gamma_2(p_t(s),\tau_{12t}(s),\tau_{21t}(s))}, \tag{4.39}$$

$$\tau^{A}_{21t}(s) = \frac{1}{\gamma_1(p_t(s),\tau_{12t}(s),\tau_{21t}(s))}. \tag{4.40}$$

where $\gamma_i(p_t(s),\tau_{12t}(s),\tau_{21t}(s)) = \frac{d\Gamma_i(p_t(s);\tau_{12t}(s),\tau_{21t}(s))}{dp_t(s)}\frac{p_t(s)}{\Gamma}$, and $\Gamma_i(p_t(s),\tau^{I}_{12t}(s),\tau^{I}_{21t}(s))$ is the "offer curve" of country i. Thus, (4.39) and (4.40) represent the classic optimal tariff

[9] If limited financial markets were allowed, such as a market for risk-free bonds, the tariff game would become more complicated, as governments would have to consider the current account implications of their tariff actions.

formula, indicating that the tariff should equal the inverse of the elasticity of the other country's offer curve. The Appendix gives the exact expression for $\Gamma_i(p_t(s), \tau_{12t}(s), \tau_{21t}(s))$.

For each period t and state s, equations (4.34)-(4.40) determine the equilibrium consumption rates, terms of trade, and tariff levels that constitute an equilibrium in financial market autarky.

With complete financial market diversification, when agents in each country are ex-ante identical, a perfect pooling equilibrium will be reached in the first period. In the absence of tariffs, this will be maintained forever. But it follows immediately from the arguments of the previous section that optimal tariffs in a perfect pooling equilibrium will be zero, since, in this equilibrium, the terms of trade have no direct effect on welfare. Thus, even for this extended model, the equilibrium with complete financial markets and perfect pooling entails zero tariffs and each country consuming half of world output of each good in every state.

We now use this extended model to compute the welfare gains from financial market integration, again with and without endogenous trade policy. In order to motivate comparison, we calibrate the model in a way similar to Cole and Obstfeld (1991). The output processes in the home and foreign countries have growth rates that are determined by a two-state Markov chain. Thus, let endowment of good i, for $i = 1, 2$, in each sector in the home country be:

$$y_{ijt+1}(s) = y_{ijt}[1 + \mu_{it}(s)].$$

The joint distribution of the home and foreign growth rates μ_{1t} and μ_{2t} are assumed to be completely symmetric and are calibrated to the average growth of US GDP per capita from 1960 to 1992 at 1.7%, with a standard deviation of the growth rate equal to 2.6%. In addition, we set the correlation coefficient between μ_{1t} and μ_{2t} equal to that between US and Japanese growth over the same interval at 0.29. The ratio of the average endowment of importables to exportables is set to match the average export-GDP ratio for the US economy over the 1960-92 interval, which is 8.2%. Each household is assumed to have a time preference factor β of 0.98 in our computation of welfare gains.

This gives the following parameters of the distribution:

$$State\ 1 \qquad 1+\mu_{1t}=1.043, \qquad 1+\mu_{2t}=1.043;$$

$$State\ 2 \qquad 1+\mu_{1t}=1.043, \qquad 1+\mu_{2t}=0.991;$$

$$State\ 3 \qquad 1+\mu_{1t}=0.991, \qquad 1+\mu_{2t}=1.043;$$

$$State\ 4 \qquad 1+\mu_{1t}=0.991, \qquad 1+\mu_{2t}=0.991;$$

with the probability vector $\{0.3225, 0.1775, 0.1775, 0.3225\}$.

Table 4.2 gives the welfare gains to financial market integration with and without endogenous trade policy based on this calibration. In each case, the welfare gains correspond to the percentage of permanent consumption that an agent (in either country) would be willing to give to move to a regime of full risk sharing from a regime of financial market autarky. Utilities are estimated from 1000 replications of 50 periods. The ratio of importables to exportables is set so that, on average, the export to GDP ratio is 8.2%. Again, as in Section 3, welfare gains are reported both with exogenous trade policy and with endogenous trade policy. The estimates are reported for a range of values of σ and ρ.

As expected, the welfare gains are increasing in σ, the degree of relative risk aversion. For the case of exogenous tariffs, welfare gains are increasing in the elasticity of substitution between goods. This result is familiar from Cole and Obstfeld (1991). Since the greater is ρ, the less the terms of trade can respond to national endowment shocks and the less potential there is for movement in the terms of trade to achieve effective risk sharing. Note, however, that under endogenous trade policy, welfare gains are falling in the elasticity of substitution between goods. This is because, as ρ rises, the equilibrium average tariff rates endogenously fall.

In relative terms, the gains from international financial markets in the presence of endogenous trade policy dramatically exceed those under exogenous trade policy. The magnitude of the "trade dividend" (reported as gain from trade Table 4.2) is sensitive to the particular parameters. For values of relative risk aversion less than 4, the gains from financial markets under endogenous trade policy are never less than 6 times the gains under exogenous trade policy and may be up to 50 times as great.

Table 4.2 also reports the average tariff rates for the endogenous trade policy case under each parameterization. With elasticity of substitution between goods equal to 1.5, average tariffs are 26%. While tariff rates among OECD economies are only about 4% (Laird and Yeats (1989)), it is more relevant to interpret the trade policy in this model as capturing a wider measure of governmental barriers to trade including regulatory controls and non-tariff barriers. Laird and Yeats report an increase of 5% to 51% in non-tariff barriers in manufactured products. Wei (1996) reports a tariff-equivalent measure of barriers to trade for OECD economies of 10%. Using this number and taking a coefficient of relative risk aversion of 2, our model suggests that the gains from financial markets contains a "trade dividend" somewhere around half of a percent of permanent consumption, which, although relatively small, is far greater than the direct gains from risk sharing.

4.5 Multiple Equilibria

In previous sections, we identified one equilibrium of the tariff game with financial markets. We have not, however, established the uniqueness of the equilibrium. In fact, the financial contracts given in (4.31) and (4.32) are not unique. There is a continuum of equilibria values of $\tau_{12}(s)$, $\tau_{21}(s)$, $\omega_1(s)$, $\omega_2(s)$, and $p(s)$ which satisfy the system (4.29), (4.30), (B.16), (B.17), and (B.18), where the last three equations are described in Appendix B. Intuitively, this is because, for a given distribution of tariff levels, the way in which agents divide up their optimal portfolio diversification plan between purchasing ex-ante financial contracts and engaging in ex-post commodity trade is indeterminate. Trade in financial markets is a substitute for trade in commodities, given that part of the risk sharing may be borne by terms of trade fluctuations. One policy is to follow (4.31) and (4.32), but there are many other ways in which agents can achieve full risk sharing for a given stochastic distribution of tariff rates.[10,11] From our analysis above, we know that the optimal tariff levels depend on the actual financial contracts chosen by households in each country. Because households take the distribution of tariff levels as exogenous in their ex-ante choice of contracts, this gives rise to multiple equilibria indexed by the degree to which risk sharing is achieved by ex-post commodity trade relative to ex-ante trade in securities. If households choose to purchase a set of securities so that they need to engage in a lot of ex-post trade, for a given distribution of tariffs, governments will set positive tariffs to exploit the terms of trade in ex-post commodity trade. This will then give rise to an equilibrium with a limited degree of international risk sharing and high average tariff rates. But we know that there is another equilibrium

[10] In the absence of tariffs, trade in commodities is a perfect substitute for trade in securities whenever countries are completely specialised, as noted by Cole and Obstfeld (1991).

[11] In the previous chapter, the issue of multiple equilibria does not exist because the government chooses the ex-ante tariff conditioned upon the households hedging against terms of trade fluctuations in the financial markets.

(with full international risk sharing and free trade) which Pareto dominates this.

The possibility of multiple equilibria is illustrated in the Edgeworth box in Figure 4.1. Suppose there are two states of nature and world output of goods 1 and 2 is symmetric and non-stochastic. Let $e(1)$ and $e(2)$ represent the endowment bundle of the two goods in states 1 and 2, respectively. In both states of the world, the home country is endowed with more of good 1 and less of good 2 relative to the foreign country. The households can trade in state-contingent claims to smooth their allocation of each good across the two states. Under the symmetry assumption, the 45 degree line Y_1Y_2 represents the set of all possible ex-post allocations. At Y_1, the home household owns the world's endowment of good 1 and none of good 2. At the other extreme, Y_2, the home household owns the world's endowment of good 2 and none of good 1. The household in each country owns half of the world's endowment in each good at the mid-point, $\tilde{e}^I$. In the other allocations between Y_j and $\tilde{e}^I$, for $j = 1, 2$, the home household owns a bigger share of the world's endowment of good j and a smaller share of the world's endowment of the other good relative to the foreign household. Given any one of these ex-post allocations, the households trade in the commodity market to allocate their consumption between goods 1 and 2 optimally. In the absence of tariffs, any point along the Y_1Y_2 line is equivalent in the sense that it can support the same allocation. Households can attain the optimal allocation, $\tilde{e}^I$, starting from anywhere on this line.

However, this equivalence fails when tariffs are endogenous. If households achieve the allocation $\tilde{e}^I$ directly with ex-ante state-contingent claims, the governments have no incentives to levy tariffs and the optimal tariffs are zero. This is the equilibrium identified in the previous sections. However, at every other point along the Y_1Y_2 line, equilibrium tariffs will be positive. If the ex-post allocation is at $\tilde{e}^1$, then the home country exports good 1 and imports good 2 and the foreign country will carry out the opposite trades.

In this case, both governments levy tariffs and the consumption allocation will be above and to the left of $\tilde{e}^I$.

The ex-post allocations and optimal tariffs can be categorised into four sets. The categorisation depends on the relative magnitudes of the ratios $\frac{\tilde{y}_{11}(s)}{\tilde{y}_{12}(s)} = \frac{y_{11}(s)+\omega_1^1(s)}{y_{12}(s)+\omega_2^1(s)}$ and $\frac{y_{11}(s)}{y_{12}(s)}$ for the home country, as well as the relative magnitudes of the ratios $\frac{\tilde{y}_{22}(s)}{\tilde{y}_{21}(s)} = \frac{y_{22}(s)-\omega_2^1(s)}{y_{21}(s)-\omega_1^1(s)}$ and $\frac{y_{22}(s)}{y_{21}(s)}$ for the foreign country. For the rest of this section, we shall refer to the two ratios as the home and foreign ex-post allocation ratios, respectively. Let $\tau_{12}(s)^A$ and $\tau_{12}(s)^I$ denote the home tariff choice under financial autarky and complete financial markets, respectively. From equations (4.9) and (4.10) as well as (4.29) and (4.30), we can identify four sets of relations.

Set 1 $\tau_{12}^{I}(s) = \tau_{21}^{I}(s) = 0$

if $\frac{\tilde{y}_{22}(s)}{\tilde{y}_{21}(s)} \leq 1$ and $\frac{\tilde{y}_{11}(s)}{\tilde{y}_{12}(s)} \leq 1$, $\forall s \in S$.

Set 2 $\tau_{12}^{I}(s) < \tau_{12}^{A}(s)$ and $\tau_{21}^{I}(s) < \tau_{21}^{A}(s)$

if $\frac{\tilde{y}_{22}(s)}{\tilde{y}_{21}(s)} < \frac{y_{22}(s)}{y_{21}(s)}$ and $\frac{\tilde{y}_{11}(s)}{\tilde{y}_{12}(s)} < \frac{y_{11}(s)}{y_{12}(s)}$, $\forall s \in S$.

Set 3 $\tau_{12}^{I}(s) \gtrless \tau_{12}^{A}(s)$ and $\tau_{21}^{I}(s) \gtrless \tau_{21}^{A}(s)$

For the home country:

$\tau_{12}^{I}(s_1) > \tau_{12}^{A}(s_1)$

if $\frac{\tilde{y}_{22}(s_1)}{\tilde{y}_{21}(s_1)} > \frac{y_{22}(s_1)}{y_{21}(s_1)}$,

$\tau_{12}^{I}(s_2) < \tau_{12}^{A}(s_2)$

if $\frac{\tilde{y}_{22}(s_2)}{\tilde{y}_{21}(s_2)} < \frac{y_{22}(s_2)}{y_{21}(s_2)}$, $\forall s_1, s_2 \in S$.

For the foreign country:

$\tau_{21}^{I}(s_1) > \tau_{21}^{A}(s_1)$

if $\frac{\tilde{y}_{11}(s_1)}{\tilde{y}_{12}(s_1)} > \frac{y_{11}(s_1)}{y_{12}(s_1)}$,

$\tau_{21}^{I}(s_2) < \tau_{21}^{A}(s_2)$

if $\frac{\tilde{y}_{11}(s_2)}{\tilde{y}_{12}(s_2)} < \frac{y_{11}(s_2)}{y_{12}(s_2)}$, $\forall s_1, s_2 \in S$

Set 4 $\tau_{12}^{I}(s) > \tau_{12}^{A}(s)$ and $\tau_{21}^{I}(s) > \tau_{21}^{A}(s)$

if $\frac{\tilde{y}_{22}(s)}{\tilde{y}_{21}(s)} > \frac{y_{22}(s)}{y_{21}(s)}$, and $\frac{\tilde{y}_{11}(s)}{\tilde{y}_{12}(s)} > \frac{y_{11}(s)}{y_{12}(s)}$, for $\forall s \in S$.

In Figure 4.1, the ex-post allocations along $Y_2\tilde{e}^I$ belong to Set 1, where the home and foreign ex-post allocation ratios are less than 1. The home country exports good 2 and imports good 1, while the foreign country engages in the opposite trades ex-post. Therefore, there will be no tariffs on good 1 or 2, since both goods will not be imported ex-post by the foreign and home country, respectively. The allocations along $\tilde{e}^I\tilde{e}^1$ belong to Set 2, where the optimal tariffs are lower in complete financial markets than under financial autarky in both states. Set 3 is depicted by the allocations along $\tilde{e}^1\tilde{e}^2$, where the optimal tariff in complete financial markets is higher than the optimal tariff under financial autarky for one country in one state and the reverse relationship is true in the other state. In the example illustrated in the figure, $\tau^I_{12}(1) > \tau^A_{12}(1)$ and $\tau^I_{12}(2) < \tau^A_{12}(2)$ for the home country; $\tau^I_{21}(1) < \tau^A_{21}(1)$ and $\tau^I_{21}(2) > \tau^A_{21}(2)$ for the foreign country. Set 4 is represented by $\tilde{e}^2Y_1$ in the figure, where the optimal tariffs in complete financial markets are higher relative to that under financial autarky in both states. Therefore, the presence of complete financial markets makes households strictly better off only if their ex-post allocations are in Sets 1 and 2, depicted by $\tilde{e}^1Y_2$, and strictly worse off if their ex-post allocations are in Set 4, represented by $\tilde{e}^2Y_2$. Moreover, any ex-post allocation Pareto dominates all other allocations that are to the north-west of $\tilde{e}^I$.

These multiple equilibria exist due to the failure of households to internalize all the gains of complete financial markets when they share the endowment risk of each good separately. If they expect the possibility of positive tariffs in the future and hedge against the movements in terms of trade in the ex-ante financial markets, they will achieve the ex-post Pareto optimal consumption allocation at $\tilde{e}^I$.

The key reason for multiple equilibrium then, is twofold. First, tariffs will depend upon the breakdown of risk sharing between trade in goods and trade in financial markets. Secondly, households take the distribution of tariffs as given in their portfolio decisions. When households rely more on trade in goods ex-post rather than portfolio diversification ex-ante, the terms of trade motivation for tariff setting is more important and, in the game between national governments, tariffs will be positive. The strategic situation is like that in Calvo (1988), where the decisions of private agents in asset markets will critically affect the actions of governments. But, since private agents do not take account of this link, there are multiple equilibria, indexed by the degree of international portfolio diversification and the level of tariffs.

Thus, in the equilibrium with financial market integration and endogenous trade policy, there are multiple expectational equilibria and it is, in fact, possible that financial market integration *reduces* welfare. To fully exploit the gains from international financial markets, we would need some coordinating device to ensure that people follow the strategy of choosing the security markets contract structure given by (4.31) and (4.32). But there is no market mechanism endogenous in our model that will cause the coordination to come about.

4.6 Conclusion

The main finding in this chapter is that welfare gains from international financial markets are higher in an economy with endogenous trade policy. The presence of international financial markets allow the households to enter financial contracts with each other that will bind the government to choose free trade as the optimal policy. The assets in place (chosen by the households in a competitive equilibrium) under complete financial markets disables the government's ability to use the terms of trade fluctuations to extract monopoly rent from the other country and removes the incentive for trade protection. We find that the direct gains from free trade is relatively higher (approximately 15 times for a reasonable set of parameters) than the gains from risk sharing. Our result indicates one possible externality associated with international financial markets that will cause the evaluation of welfare gains purely from a risk sharing perspective to be too conservative.

Unfortunately, this externality from financial markets might not be realised by the households due to the lack of coordination in financial trade. In our model, there exists other equilibria with limited risk sharing and state-dependent tariffs. The lack of coordination between the households when they trade in the financial markets could be one of the many reasons why we do not see more fully integrated financial markets. Private households might not hold a fully diversified portfolio because they are not aware of the full potential gains of a diversified portfolio. If they do not hold a fully diversified portfolio, they would not be able to attain full risk sharing ex-post in the goods market through commodity trading due to the presence of trade barriers.

Average Importable to Exportable Ratio	Exogenous Free Trade Policy	Endogenous Trade Policy	Gain from Trade	Tariff (in %)
1	0.0050	0.0050	0	0
0.9	0.0050	0.0397	0.0347	5
0.8	0.0049	0.1606	0.1557	12
0.7	0.0047	0.4027	0.3980	20
0.6	0.0044	0.8214	0.8170	29
0.5	0.0040	1.5098	1.5054	41
0.4	0.0033	2.6396	2.6363	58
0.3	0.0025	4.5683	4.5658	83
0.2	0.0015	8.2080	8.2065	124
0.1	0.0005	17.0337	17.0332	216

Table 4.1: **Welfare gains from risk sharing (in %) in the 1-period model with logarithmic preferences.** The standard deviation of consumption is calibrated to be 2%. Under the exogenous trade policy, the tariffs are set to zero. The tariff level reported in the fourth column is obtained from (4.29) and (4.30) in our model. The welfare gain from trade reported in the third column is obtained by taking the difference in welfare under endogenous trade policy (column 2) and that under exogenous free trade (column 1).

	$\rho = 1.5$	$\rho = 3$	$\rho = 4.5$	$\rho = 6$
$\sigma = 0.5$				
	(Tariff=26%)	(Tariff=12%)	(Tariff=8%)	(Tariff=6%)
Exogenous Tariffs	0.0178	0.0188	0.0191	0.0192
Endogenous Free Trade	1.0028	0.5020	0.3394	0.2587
Gain from Trade	0.9850	0.4832	0.3203	0.2395
$\sigma = 2$				
Exogenous Tariffs	0.0325	0.0346	0.0354	0.0357
Endogenous Free Trade	1.0194	0.5189	0.3563	0.2757
Gain from Trade	0.9869	0.4843	0.3209	0.2400
$\sigma = 4$				
Exogenous Tariffs	0.0530	0.0557	0.0570	0.0576
Endogenous Free Trade	1.0415	0.5413	0.3788	0.2983
Gain from Trade	0.9885	0.4856	0.3218	0.2407
$\sigma = 8$				
Exogenous Tariffs	0.0904	0.0973	0.0996	0.1008
Endogenous Free Trade	1.0850	0.5855	0.4232	0.3428
Gain from Trade	0.9946	0.4882	0.3236	0.2420
$\sigma = 20$				
Exogenous Tariffs	0.1952	0.2107	0.2160	0.2187
Endogenous Free Trade	1.2038	0.7061	0.5444	0.4643
Gain from Trade	1.0086	0.4954	0.3284	0.2456

Table 4.2: **Welfare gains from risk sharing (in %) in a multi-period model with CES utility.** Numbers in the cells are computed by 1000 replications of 50 periods for each case, given the distribution of output reported in the text. For these computations, the mean GDP growth is set at 1.7%, the standard deviation is 2.6%, and the cross country correlation of GDP is 0.29. The export-GDP ratio is set at 8.2% and the time preference factor, $\beta = 0.98$. Under the exogenous trade policy, the tariffs are set to zero. The tariff level reported in the second row is obtained from (4.39) and (4.40) in our model. The welfare gain from trade is obtained by taking the difference in welfare under endogenous trade policy and that under exogenous free trade.

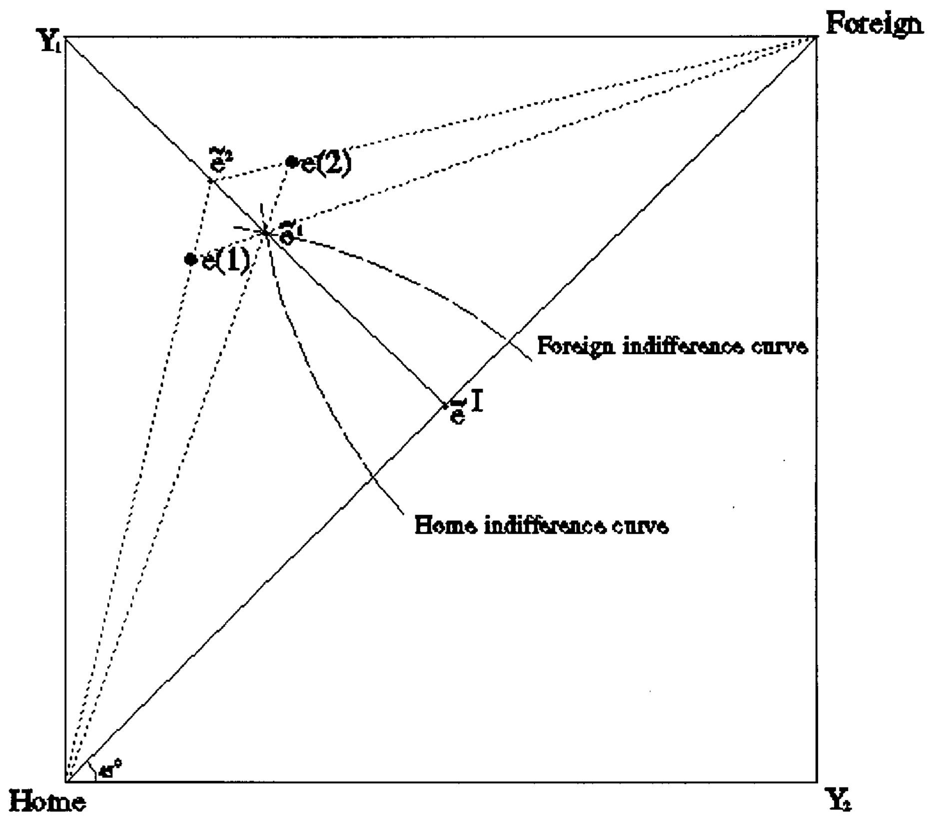

Figure 4.1: **Edgeworth box representation of the tariff game.** In the representation, there are two states of nature. World output of goods 1 and 2 is symmetric and non-stochastic.

Chapter 5

Choice of Financial Market Structure

5.1 Introduction

In the previous two chapters, we have considered the optimal tariff level and welfare implications under different, exogenously given, financial market structures. In this chapter, the real decision we consider is not trade policy but we model the investment decision in the goods market. The objective of this chapter is to provide some understanding of the financial market integration process by allowing it to be a policy choice. Specifically, we examine the choice of financial market structures; in particular, if a country could choose the degree of openness of financial markets, under what conditions would it prefer to have less than perfectly integrated financial markets.

We will analyse the choice of financial market structure in a two-country world economy, where each country can differ in its initial capital endowment, productivity levels, factor share of input in production, time preference and relative risk aversion. The model we develop is a generalisation of the production economy in Sellin and Werner (1993).

In our model, financial markets will have three roles: risk-sharing, intertemporal consumption smoothing, as well as efficient capital allocation. The risk-free rate in our model is determined by the households' intertemporal consumption decisions, which in turn, depend on the financial market structure in the economy. It is worthwhile to mention that some form of intertemporal consumption smoothing can also be achieved via investment in the production of the next period's consumption. Since the investment decision depends on the risk-free rate, it will also be influenced by the financial market structure.

Our model differs from that in Sellin and Werner in two important ways. First, we consider more general preferences and production technologies, which allows for heterogeneity between the two countries. Second, we model the household's decision of portfolio holdings and the firm's production decision separately. The focus of our analysis also differs from that in Sellin and Werner: we examine the government's policy choice regarding financial market structure, while they study the hedging motives and risk-free rates under different, exogenously determined, financial market structures.

Our contribution to the literature on international financial market segmentation is to endogenize the choice of financial market integration. The work in the literature (described in Chapter 2) takes the financial market structure as given in studying how financial market integration affects financial and real decisions, as well as the welfare of the economy. Given the endogeneity of the financial market structure in our model, our findings will have policy implications.

The welfare analysis of market segmentation has been studied by Basak (1996) in a two-period intertemporal endowment model. By modelling production in our economy, we are able to examine the welfare effects in a more general setting than Basak. Also, the governments in Basak's model do not choose the financial market structure. By allowing both governments to be strategic in choosing the degree of financial market integration, we can determine the equilibrium financial market structure in the economy. However, the generalization in our model comes at a cost: we are not able to obtain analytical results for our model so we have to rely on numerical analysis.

Our main result is that complete financial market integration is the Nash outcome of a financial policy game between two governments when the capital share in the production technology is less than unity (or decreasing returns to scale). In the special case where the capital share is unity (or constant returns to scale), the country that is a net borrower is better off when it restricts foreign portfolio investment in its capital markets. The Nash equilibrium in this setting is one where the net borrowing country restricts foreign ownership of its own stock in the capital markets. Basak's finding is consistent with this asymmetric financial market segmentation equilibrium. The empirical evidence, however, appears to support that the capital share in the production technology is relatively less than unity. Stockman and Tesar (1990) estimated the average capital share in the production technology for the G7 countries during 1960-1985 to range from 0.35 to 0.5. Hence, our model (which does not restrict capital share in the production technology to be unity) could be a reasonable representation of the real world.

Another result we obtain is that the risk-free rate increases with financial market integration. This finding is also obtained by Sellin and Werner, Basak, as well as Devereux and Saito (1997). The explanation provided by these papers for this result is that the reduction of volatility associated with the risky assets with financial market integration drives up the risk-free rate. The implication of this relationship is that a country that was a borrower could be made worse off with complete financial market integration[1] because of the higher interest repayment in the second period. In this case, financial market integration is jointly welfare improving for both countries, but it might not improve the welfare of each individual country. Thus, if the government of each country were to choose the financial market structure to maximize its household's utility, it is not clear that the optimal choice is financial market integration.

[1]Complete financial integration here means that there is international lending and borrowing and that the stock markets of both countries are open to foreign investors.

The rest of the chapter is organised as follows. The next section describes the model we develop, and Section 3 presents the equilibrium of our model. Section 4 reports and analyzes the welfare results of the model, and Section 5 concludes. The comparison between our model and that of Sellin and Werner is provided in Appendix C.1 and a description of the method adopted for the numerical analysis is given in Appendix C.2.

5.2 The Model

In this section we describe a two-date ($t = 0, 1$), one-good production economy. We assume there are two countries in our world economy, home and foreign ($i = 1$ and 2, respectively) with a representative household in each country. The representative household is assumed to have constant relative risk aversion (CRRA) preferences. Each country is endowed with an initial capital stock, $K_i(0)$, a constant labour force, L_i, and a Cobb-Douglas constant returns to scale production technology. We assume that the home (foreign) firm is owned by the home (foreign) household in the initial period. We interpret a country's share of initial world capital stock to be the size of the country. The output, $y_i(s)$, in each country is produced by a representative competitive "local" firm using the endowed production technology. Hence, $y_i(s) = \theta_i(s)K_i(1)^{\alpha_i}L_i^{1-\alpha_i}$, where $\theta_i(s)$ is a random technology shock, α_i is the factor share of capital in the production function, and $(1 - \alpha_i)$ is the factor share of labour in the production function. For the numerical analysis, we assume $\theta_i(s)$ to follow a binomial distribution with mean μ_i and variance σ_i^2. A deterministic variable (u) at time-0 and time-1 is denoted by $u(0)$ and $u(1)$, respectively. A stochastic variable (v) in state s at time-1 is denoted by $v(s)$.

Each country also starts with a given financial market structure, which is determined by its government. Under complete financial market integration, each household can buy or sell the claims to each firm's output and, borrow or lend from each other. With financial market segmentation, however, there will be restrictions on the type of financial assets that can be traded by each household.

We now describe the optimization problem of the representative household, the firm and the government. We start with the household's problem. At time-0, each household chooses its consumption, $c_i(s)$, its asset-claim to firm j's output, s_{ij}, for $j = \{1,2\}$, and the amount to borrow or lend, b_i, to maximize its expected utility, given its budget constraint in each period and the firm's production decision which will be described later. The notation is as follows. The parameters for relative risk aversion and time preference factor for household i are represented by η_i and β_i, respectively. For firm j, its dividend payment is denoted by d_j and its rate of capital depreciation by δ_j. For most cases, the rate of depreciation is assumed to be 100%. The price of a claim to firm j is represented by S_j and r is the risk-free rate of return between the two periods. The home household's problem is then described as:

$$\max_{c_1(0),c_1(s),s_{1j},b_1} \frac{c_1(0)}{1-\eta_1}^{1-\eta_1} + \beta_1 E_0 \left[\frac{c_1(s)}{1-\eta_1}^{1-\eta_1} \right], \tag{5.1}$$

subject to the time-0 and time-1 budget constraints, respectively,

$$\begin{aligned} c_1(0) + \sum_{j=1}^{2} s_{1j} S_j + b_1 &= d_1(0) + S_1, & (5.2)\\ c_1(s) &= \sum_{j=1}^{2} s_{1j} d_j(s) + b_1(1+r), & (5.3) \end{aligned}$$

where,

$$\begin{aligned} d_j(0) &= y_j(0) - I_j, & (5.4)\\ d_j(s) &= y_j(s) + (1-\delta_j)K_j(1), & (5.5)\\ K_j(1) &= I_j + (1-\delta_j)K_j(0), \qquad j = \{1,2\}. & (5.6) \end{aligned}$$

The maximization problem for the foreign household can be obtained by changing the subscripts from 1 to 2.

The budget constraints (5.2) and (5.3) indicate that the financial markets of both countries are perfectly integrated such that the household can borrow from or lend to each other, as well as trade in the claims of both firms. Segmentation in the financial markets can be modelled by imposing restrictions on the stock holdings and/or borrowing or lending by households. For example, if the home stock market is not accessible to the foreign household, the home household is restricted to hold the entire claim to its own firm in both periods, i.e., $s_{11} = 1$ and $s_{21} = 0$.

Second, we describe the firm's maximization problem. At time-0, each firm chooses the allocation of the initial capital stock between time-0 dividend payment (for immediate consumption by its time-0 shareholder) and re-investment (for time-1 production) to maximize its present value. Each firm uses its original shareholder's marginal rate of substitution of consumption between time-0 and time-1 to determine its value.[2] The maximization problem of the home firm is given by:

$$\max_{I_1(s)} d_1(0) + E_0[\phi_1(s) d_1(s)], \tag{5.7}$$

where,

$$\phi_1(s) = \beta_1 \left(\frac{c_1(s)}{c_1(0)} \right)^{-\eta_1}. \tag{5.8}$$

It is important that the household's portfolio choice and the firm's investment decision are made simultaneously so that there are no discrepancies in the choice of dividend payment and investment level between the firm and its shareholders. This point will

[2]When the firm is traded, the investment decision is the same whether the original or new shareholder's marginal rate of substitution is used in the valuation of the firm's profits. This will be demonstrated later. When the firm is not traded, it is logical to use the firm's only shareholder's marginal rates of substitution to value the firm's profits.

be elaborated on in the next section. At time-1, after the state is realised, the firm's dividends are distributed to its shareholders.

Finally, we describe the government's optimization problem. The solution to the household's and firm's maximization problems is a competitive equilibrium. Given this competitive equilibrium, the government chooses the financial market structure to maximize the indirect expected utility of its household in a Nash game. The home government's problem becomes:

$$\max_{a_1} V_1(a_1, a_2^N) \equiv \frac{c_1^e(0)}{1-\eta_1}^{1-\eta_1} + \beta_1 E_0 \left[\frac{c_1^e(s)}{1-\eta_1}^{1-\eta_1} \right] \tag{5.9}$$

where the superscripts "e" and "N" denote the competitive equilibrium solution and the Nash action of the foreign government, respectively. The financial market structure is determined by a combination of actions, a_i, that can be undertaken by government i. The action set consists of four possible strategies in the financial market:

- $a_i(0)$: No restriction in financial trade;
- $a_i(1)$: Prohibit foreign household to own any claim to the domestic firm;
- $a_i(2)$: Prohibit domestic household to own any claim to the foreign firm;
- $a_i(3)$: Prohibit domestic household from international lending and borrowing;

where "domestic" is made with refers to country i.

Each government can choose a combination of the above four actions. Each restriction in the action set can be interpreted as an extreme form of a legal barrier to a particular financial market. However, our results do not change qualitatively in the case of less than 100% restriction on asset ownership. It should also be noted that since there are only two countries in our economy, and the restriction on financial markets does not require bilateral agreement, a prohibition of home (foreign) portfolio in foreign (home) stock implies that the $s_{12} = 0$ ($s_{21} = 0$) and $s_{22} = 1$ ($s_{11} = 1$) even if the foreign (home) country's stock market remains accessible to home household. Therefore, the financial market structure associated with each individual home government's action: $a_1(1)$, $a_1(2)$, and $a_1(3)$ is equivalent to the market structure associated with the corresponding individual foreign government's action: $a_2(2)$, $a_2(1)$, and $a_2(3)$, respectively. If one government chooses to undertake all three restrictions simultaneously, financial autarky is imposed in the economy. If both governments choose $a(0)$, this will result in complete financial market integration.

Before we present the equilibrium of our model in the next section, we briefly discuss how the different financial market structure affects the households' ability to share risk. Under financial autarky, households cannot trade in any financial asset and they smooth their intertemporal consumption through the firms' investment decisions. Under this financial market structure, there is no risk sharing between the two households. Basak notes that under financial autarky households must be made better off in the presence of some financial trade because they can always choose not to trade in financial assets under any financial market structure. This characteristic is observed in our model as well, since there are neither imperfections nor externalities in the goods market. In the presence of partial or complete international financial market integration, the households can use the available financial assets to achieve both intratemporal risk sharing and intertemporal consumption smoothing. With partial completeness of financial markets, it is not clear whether both households will be made better off by expanding the menu of financial assets, since introducing financial assets will alter the investment decision of the households, as well as the cost of risk sharing and intertemporal consumption smoothing.

5.3 Equilibrium of the Model

The equilibrium solution to our model consists of the competitive equilibrium of the household's and the firm's maximization problems and the Nash equilibrium to the government's financial policy game. We will describe the equilibrium conditions of each problem individually.

5.3.1 Competitive Equilibrium

The first-order conditions for the home household's maximization problem give the following price conditions for the assets traded in the financial markets:

$$E_0[\phi_1(s)(1+r)] = 1, \tag{5.10}$$

$$E_0[\phi_1(s)d_j(s)] = S_j, \quad j = \{1,2\} \tag{5.11}$$

The pricing kernel of the traded assets for household i is given by $\phi_i(s)$, which is described in equation (5.8). The market-clearing price of the traded asset will equate the risk-adjusted expected value of a firm's future dividends for both the home and the foreign households.

The first-order condition for the home firm's maximization problem is:

$$E_0[\phi_1(s)\{(\alpha_1\theta_1(s)K_1(1)^{\alpha_1-1}L_1^{1-\alpha_1} + (1-\delta_1)\}] = 1 \tag{5.12}$$

The investment decision is chosen so that the home household's risk-adjusted expected marginal product of capital at time-1 equals the marginal cost of investment at time-0. The cost of investment is the dividend foregone at time-0. Hence, the firm trades off lower dividend (due to higher investment) in the initial period with higher dividend (due to higher production from higher investment) in the next period. When the foreign (instead of the home) household's marginal rate of substitution is used to value the profits of the home firm, the first-order condition for the investment decision becomes:

$$E_0[\phi_2(s)\{(\alpha_1\theta_1(s)K_1(1)^{\alpha_1-1}L_1^{1-\alpha_1}+(1-\delta_1)\}]=1 \tag{5.13}$$

In order to show that the firm's optimal investment decision is same whether the firm is valued using the home or foreign household's marginal rate of substitution, we need to show that equations (5.12) and (5.13) are consistent with each other. We observe that the left-hand side of equations (5.12) is equal to the derivative of the home household's risk-adjusted expectation of firm 1's dividend payment with respect to the firm's investment decision. Similarly, the left-hand side of (5.13) is equal the derivative of the foreign household's risk-adjusted expectation of firm 1's dividends with respect to the firm's investment decision. These derivatives are obtained by partially differentiating the first-order conditions for the home and the foreign household's portfolio choice of the claim to firm 1 with respect to the firm's investment decision:

$$\frac{\partial E_0[\phi_1(s)d_1(s)]}{\partial I_1} = \frac{\partial S_1}{\partial I_1}, \tag{5.14}$$

$$\frac{\partial E_0[\phi_2(s)d_1(s)]}{\partial I_1} = \frac{\partial S_1}{\partial I_1}. \tag{5.15}$$

The presence of a price in equilibrium for the claim to firm 1, S_1, equates the right-hand side of both equations (5.15) and (5.15). This implies that:

$$\frac{\partial E_0[\phi_1(s)d_1(s)]}{\partial I_1} = \frac{\partial E_0[\phi_2(s)d_1(s)]}{\partial I_1}, \tag{5.16}$$

$$E_0\left[\phi_1(s)\frac{\partial d_1(s)}{\partial I_1}\right] = E_0\left[\phi_2(s)\frac{\partial d_1(s)}{\partial I_1}\right]. \tag{5.17}$$

The left-hand side of equation (5.17) equals the left-hand side of equation (5.12), where the home household's marginal rate of substitution is used to value the firm's profits. The right-hand side of equation (5.17) equals the left-hand side of equation (5.13), where the foreign household's marginal rate of substitution is used to value the firm's profits. The equality in equation (5.17) implies that it does not matter whose marginal rate of substitution is used to value the firm's profits. In this case, the investment decision will be the same. The equilibrium condition on the market-clearing price of the traded claim to a particular firm causes the firm's optimal investment decision to be the same for both households (who are both shareholders of the firm).

Therefore, in our model, both shareholders (home and foreign) will agree on the investment level in equilibrium for a particular firm as long as they trade the claim to the firm. The is true even in the presence of incomplete markets.[3] The intuition behind this result is that the trading of the claim to future dividends of the firm forces the household to reach an agreement on the risk-adjusted (by their marginal rates of substitution) expected value of these dividends. This process lines up their investment decisions in determining these future dividends.[4] In the case when the claim to the firm is not traded between the two households, the firm will use the marginal rates of substitution of its domestic household (now the only shareholder) to value its profits.

The market-clearing conditions in the financial markets are:

$$s_{11} + s_{21} = 1, \tag{5.18}$$

$$s_{12} + s_{22} = 1, \tag{5.19}$$

$$b_1 + b_2 = 0. \tag{5.20}$$

[3]This point is shown also in Obstfeld and Rogoff (1996, p.309). The conditions under which the statement holds are given by Ekern and Wilson (1974). The relevant condition for our model is that the investment decision does not change the set of return distributions available to the entire economy. This condition is satisfied in our model because the shocks to production are independent of the firm's investment decision.

[4]It is important that the portfolio decisions, which equate the risk-adjusted expected value of the dividends between the two households in equilibrium, are made simultaneously with the firm's investment decisions.

The competitive equilibrium is obtained by solving the first-order conditions (5.10), (5.11), and the budget constraints (5.2) and (5.3) for each household, the first-order condition (5.12) for each firm, and the financial market-clearing conditions (5.18), (5.19) and (5.20). The number of equations to solve depends on the financial market structure imposed by the government.

5.3.2 Nash Equilibrium

The government in each country takes as given the competitive equilibrium described in the previous subsection when it chooses its actions in setting financial market restrictions. The competitive equilibrium consumption is substituted into the household's utility function to obtain the indirect utility, which is evaluated by the government. The objective of the government is to maximize its household's indirect utility. The Nash equilibrium is computed by finding the best response of each government in a normal-form game presented in Table 5.1. We only consider pure-strategy Nash equilibrium in our model. In all our numerical analyses, we find that at least one pure-strategy Nash equilibrium exists in our model. In the next section, we present the numerical results and arguments that lead to the Nash equilibrium financial market structure in our model.

5.4 Results of Financial Market Structure Choice

In this section, we solve our model numerically for a set of values for the relative risk aversion parameter, η_i, the time preference factor, β_i, the initial capital endowment, $K_i(0)$, the average productivity growth, μ_i, the volatility of productivity shock, σ_i, and the capital share in the production technology, α_i. The numerical solution method is described in Appendix C.2. A Nash equilibrium is obtained for each set of parameter values. We then investigate how the various parameter values affect the Nash outcome of the government's financial policy game.[5] We will provide a summary of our findings and discuss the intuition behind the results we obtain. This section is structured as follows. We first present our main result and describe how it differs from the existing results in the literature. Then, we discuss the intuition for our result. Finally, we will show that the results in the literature are a special case of our general model.

5.4.1 Main Result

In this subsection, we first investigate how the capital share in the production technology affects the financial market structure choice. We assume symmetry[6] between the two countries so that the numerical results are not confounded by wealth effects that arise from the countries' initial endowment position. The productivity shocks in both countries are assumed to have a mean of 10% and a variance of 5%. Both countries are assumed to have a relative risk aversion of 2.

The Nash equilibrium in our model is the best response of each government in the financial policy game. Each government's best response in turn depends on the relative magnitudes of its household's indirect utility under different financial market structures. Therefore, we focus our analysis on the magnitudes of indirect utility which are reported in the last column of Tables 5.2, 5.3 and 5.4. The main result is that: as the capital share in the production technology α_i, decreases from unity, each individual country (whether it is a net borrower or lender) is made better off with complete financial market integration.

[5] As the households are always made better off with any type of asset trade relative to financial autarky, the autarkic solutions do not provide any useful information in our analysis and hence, are not reported in our results.

[6] The symmetry assumption is not necessary. We find that varying the other parameters to allow for heterogeneity does not alter the qualitative results in this subsection.

The numerical results for the analysis in this subsection are presented in Tables 5.2, 5.3 and 5.4. The share of capital in the production technology decreases as we move down the panels in these Tables. The results show that the risk-free rate increases with integration regardless of the capital share in the production technology. The results also show a substitution of capital investment towards the production of the firm that is traded on the financial markets in the presence of asymmetric financial market segmentation. In addition, the price of the traded asset increases as the financial market moves from complete integration to partial segmentation. The findings in the literature are consistent with these observations.

Before we present the detailed results regarding the Nash equilibrium, we will first explain how the financial market structure in the economy affects the welfare of both the home and the foreign households. Whether a household will be made better off with greater degrees of financial market integration depends on whether the household is a net borrower or lender with financial market segmentation and also, on how the capital allocation, the risk-free rate and asset prices change with financial market integration. When the home government prohibits foreign ownership in the claim to the home firm ($a_1(1)$), the home household has to own its entire stock and it has to borrow from the foreign household to purchase the foreign stock. We observe in Tables 5.2, 5.3 and 5.4 that the home household is a borrower ($b_1 < 0$) while the foreign household is a lender ($b_2 > 0$) when the home stock is not accessible to the foreign household. On the other hand, when the home government prohibits the home household to own any foreign stock ($a_1(2)$), the home household is a lender while the foreign household is a borrower.

The inverse relationship between the risk-free rate and degree of financial market segmentation implies that the household that borrows under financial market segmentation can do so at a lower rate (than under financial market integration) to invest in the foreign stock with a higher rate of return (than the risk-free rate). The restriction of foreign portfolio investment in the domestic stock causes the world capital to substitute towards the foreign production, which raises the next period's dividend payment of the foreign stock. As well, the portfolio investment is substituted towards the foreign asset. Both the substitution of capital, as well as portfolio investment towards the foreign firm, will drive up the asset price of the foreign stock under financial market segmentation. On the other hand, the substitution of capital allocation towards foreign production implies that the total investment in the domestic production is reduced and, hence, the dividend payment of the domestic stock will fall.

We can break down the costs of financial market segmentation for the borrower to consist of the higher foreign stock price at which it has to purchase, the lower next period's dividend payment from its domestic stock and the loss in risk sharing. The benefits consist of the lower borrowing rate and the higher next period's dividend payment from its partial holding of the foreign stock. Whether the borrower will be better off under financial market segmentation relative to complete financial market integration depends on the magnitude of these costs and benefits. On the other hand, the costs of financial market segmentation for the lender are: lower lending rates and the loss in risk sharing. The benefit is the higher price for the stock that it owns initially. The relative magnitudes of these costs and benefits will determine the optimal financial structure for the lender. It is not clear which magnitude will dominate for either the lender or the borrower. The aim of our numerical analysis is to examine the conditions under which the costs might outweigh the benefits for the borrower and the lender.

In Table 5.2, where $\alpha_i = 1$ and 0.995, each household is weakly better off when its government restricts foreign ownership of its own stock ($a_i(1)$, $i = \{1,2\}$) so that it can borrow at a lower risk-free rate and invest at a higher return risky stock. The reduction in welfare for a borrowing country in moving from financial market segmentation towards complete financial market integration suggests that its government will impose restrictions on the foreign ownership of its own stock. However, this does not necessarily mean that both countries will simultaneously pursue this action $a_i(1)$ for $i = 1, 2$.

In order to determine the Nash equilibrium of the financial policy game, we have to examine the action of each government in the strategic or normal form game. Table 5.1 shows the normal form of the game. From the same table, note that financial autarky and bond regime[7] are two possible Nash equilibria in the model. For the sake of arguments, we will focus on the Nash equilibria with the least possible restrictions on the financial markets in the rest of the analysis. The ranking of the indirect utility given the numerical results in Table 5.2 is:

$$V_1^B < V_1^{S2} < V_1^I < V_1^{S1}, \tag{5.21}$$

$$V_2^B < V_2^{S1} < V_2^I < V_2^{S2}, \tag{5.22}$$

where V_i denotes the indirect utility of household i, the superscript "B" denotes the presence of international lending and borrowing only, "$S1$" denotes the presence of trading in the foreign stock in addition to international lending and borrowing, "$S2$" denotes the presence of trading in the home stock in addition to international lending and borrowing, and "I" denotes complete financial market integration. In words, the ranking in (5.21) and (5.22) implies that the welfare of a household is the greatest when the household is a net borrower under the financial market structure where foreign ownership of the domestic stock is denied. The welfare of the same household is lower as the financial market structure moves toward complete financial market integration, and is even lower when

[7]Here bond regime refers to the financial market structure where households can only borrow from or lend to each other.

the household becomes a net lender under the financial market structure where domestic ownership of the foreign stock is denied. Finally, the welfare of the same household is the lowest when it can only borrow or lend in the international capital markets.

In order to pin down the Nash equilibrium, we consider the best response of each government given the action of the other government. The foreign government's best response to each of the home government's action: $a_1(0)$, $a_1(1)$, and $a_1(2)$ are $a_2(1)$, $a_2(0)$, and $a_2(0)$, respectively.[8] The home government's best response to each of the foreign government's action: $a_2(0)$, $a_2(1)$, and $a_2(2)$ are $a_1(1)$, $a_1(0)$, and $a_1(0)$, respectively. Therefore, there are two possible Nash equilibria in the game we consider in this subsection. They are: $[a_1(0), a_2(1)]$ and $[a_1(1), a_2(0)]$. Therefore, the financial market structure that result from each Nash equilibrium is an asymmetric financial market segmentation, where either the home or the foreign government will restrict foreign ownership of its own stock. The asymmetry in the financial market structure arises because the unilateral financial policy decision of each government will impose the equilibrium financial market structure in the economy and in this case, each government will deny foreign ownership of its domestic stock when the other government does not choose any restrictive action.

Now we examine how the Nash equilibrium financial market structure changes when the capital share in the production technology declines from 0.99 to 0.35. From the numerical results reported in Table 5.3, where $\alpha_i = 0.99$ and 0.98, and Table 5.4, where $\alpha_i = 0.5$ and 0.35, we obtain the following ranking in the households' indirect utility:

$$V_1^B < V_1^{S2} < V_1^{S1} < V_1^I, \tag{5.23}$$

$$V_2^B < V_2^{S1} < V_2^{S2} < V_2^I. \tag{5.24}$$

With this ranking, we observe that each household will be made better off full with

[8]We assume that when the government is indifferent between two strategies, $a_i(j)$ and $a_i(0)$, for $j = \{1, 2, 3\}$, it will always choose $a_i(0)$.

financial market integration than all other financial market structures. In this case, the dominant strategy for each government is $a_i(0)$, for $i = 1, 2$, and the Nash equilibrium financial market structure will be complete financial market integration. Therefore, the main result from our numerical analysis is that complete financial market integration is the Nash equilibrium financial structure in an economy where the capital share in the production technology is relatively less than unity.

We vary the risk aversion parameters, the endowment share of the initial capital stock between the two countries, as well as the mean and volatility of the productivity shocks in our subsequent numerical analyses of the model, and find that the above result described in this subsection is insensitive to the changes.

Our main result differs from the welfare ranking obtained by Basak in which the net borrowing country is better off with asymmetric financial market segmentation than with complete financial market integration. Our result suggests that when the capital share in the production technology is relatively less than unity, complete financial market integration is the Nash equilibrium of a financial policy game between two governments whose countries could differ in size and productivity. Therefore, share of capital in the production technology of a country is important in determining whether the country will be made better off or worse off with financial market integration.

The intuition behind our main result can be explained as follows. When foreign ownership of the claim to the home firm is prohibited, the home household has to absorb the risk of its entire output shock by itself. It can reduce its exposure to the shock by reducing the investment in the production, as the shock enters the production in a multiplicative way. When the capital share in the production is unity, the percentage of exposure to the production shock is reduced one-for-one by a percentage decrease in investment.[9] However, with a lower capital share in the production technology, the percentage reduction in the production shock exposure is less than the percentage decrease in investment. Consequently, the effectiveness of using investment to partially reduce the production risk decreases. A more effective way for the home household to share its production risk would be to borrow from the foreign household to purchase the foreign stock. This increase in demand for the foreign stock suggests that its price will be higher when the capital share in the production technology is lower. Moreover, the higher stock price would require the home household to borrow more for a given purchased amount of the foreign stock. Although the home household can borrow at a lower rate, its increased borrowing and the rise in the foreign stock price (as a result of lower capital share in the production) would raise the costs of financial market segmentation. This could explain why no financial market restriction is the dominant strategy when the capital share in the production technology is relatively less than unity.

5.4.2 A Special Case

We consider a special case of our model in the numerical analysis in this subsection in order to compare our results to the previous work in the literature, namely Sellin and Werner, and Basak. The results presented here are generated with parameters that match the assumptions made in Sellin and Werner.[10] The standard deviation of productivity is

[9] This is because the elasticity of production i with respect to investment i equals α_i, which is 1 with unit capital share.

[10] As mentioned in Section 5.2, the prohibitive measures on financial trade available to the governments in the action set of our model are the extreme cases of the two types of financial market segmentation examined by Sellin and Werner. In our experiments, we also allow each government to engage in less restrictive actions so that it can impose a binding percentage (for example, $x\%$) on the foreign ownership of domestic stocks or on the domestic ownership of foreign stocks. We find that the government always prefers 100% over $x\%$ restriction if it prefers the latter over no restriction. In other words, the indirect utility of the households either increases or decreases monotonically with financial market restriction and we always obtain a corner solution. For the rest of the section, we will report our results based on the extreme restrictions described by the action set in Section 5.2.

assumed to be 2.5% and $\frac{2}{3} \times 2.5\%$ for the home and the foreign production, respectively. The relative risk aversion parameter and the capital share in the production technology are assumed to be unity. The two assumptions give us logarithmic preferences and constant returns to scale in production, respectively. The mean productivity is assumed to be 10% for both productions. By making these parameter assumptions, we have implicitly assumed $n = 1$ and $m = 1.5$ in the context of Sellin and Werner's model. Table 5.5 reports the results of our model using these parameters.

In this special economy, the productivity levels in both countries are the same on average, but the home production is riskier than the foreign production. When the financial markets are completely integrated, the total investment in the foreign production will be higher than that in the home production. Given the same endowment in initial capital stock, both households will hold half of each stock. In Table 5.5, we observe that the risk-free rate falls with increasing restriction in financial trade. The inverse relationship between the risk-free rate and the degree of financial market segmentation in our model is consistent with the finding in Sellin and Werner as well as Basak.

The welfare result in the last column of Table 5.5 suggests that the borrowing country under financial market segmentation is made worse off with financial market integration. This welfare ordering obtained in the specials case of our model is consistent with Basak's finding. However, the condition that the borrowing country needs to have a lower initial endowment and higher productivity in Basak's model is not required in our model. In the special economy we have assumed, both countries are endowed with the same initial capital stock and average productivity in their production technology.

As in the previous subsection, we determine the Nash equilibrium of the financial policy game by examining the best response of each government. The ranking of the indirect utility given the numerical results in Table 5.5 is:

$$V_1^B < V_1^{S2} < V_1^I < V_1^{S1}, \tag{5.25}$$

$$V_2^B < V_2^{S1} < V_2^I < V_2^{S2}. \tag{5.26}$$

The foreign government's best response to each of the home government's action: $a_1(0)$, $a_1(1)$, and $a_2(1)$ are $a_2(1)$, $a_2(0)$, and $a_2(0)$, respectively. The home government's best response to each of the foreign government's action: $a_2(0)$, $a_2(1)$, and $a_2(2)$ are $a_1(1)$, $a_1(0)$, and $a_1(0)$, respectively. Therefore, the Nash equilibria in the game are $[a_1(0), a_2(1)]$ and $[a_1(1), a_2(0)]$. Similar to the result obtained in the previous subsection under constant returns to scale of production in capital, the Nash equilibrium is an asymmetric financial market segmentation, where either the home or the foreign government will restrict foreign ownership of its own stock.

As in the previous subsection, we find that the Nash equilibrium financial market structure is not sensitive to the changes in the other parameters of the model. The results in this subsection show that the findings in Sellin and Werner as well as Basak can be obtained as the special case of our model. However, their results do not extend to the more general setting of our model where capital share in the production technology is less than unity.

5.5 Conclusion

The main result obtained in this chapter is that the Nash equilibrium financial structure of a financial policy game between two governments depends on the capital share in the production technology of the countries. When the production exhibits constant returns to scale in capital (or the capital share in the production technology is unity), the Nash equilibrium is an asymmetric financial market segmentation in which one of the stock markets is accessible only to one household and not to the other. This equilibrium result is consistent with Basak's finding. When the production exhibits decreasing returns to scale in capital (or the capital share in the production technology is less than unity), the Nash equilibrium is complete financial market integration. Hence, the share of capital in the production technology is important in determining whether it is welfare-improving for both households to move from an asymmetric financial market segmentation towards financial market integration. In the previous work, constant returns to scale is either explicitly (as in Sellin and Werner) or implicitly (as in Basak) assumed. With constant returns to scale, the borrower would be better off with asymmetric financial market segmentation because it can borrow at a lower rate to invest in a risky asset with a higher rate of return. The government will then impose a restriction on foreign ownership of its domestic stock that will "regulate" its household to be a borrower.

When the constant returns to scale assumption is relaxed, it is no longer clear that the borrower will always be better off with financial market segmentation although it can borrow at a lower risk-free rate under financial market segmentation. The price of the traded risky asset tends to increase when the share of capital in the production technology decreases. However, in order to partially share its output risk, the borrower needs to purchase the risky asset and be subjected to the higher (relative to that with constant returns to scale production) cost. Since the empirical literature seems to suggest that the share of capital in the production function is much less than one, our model suggests that the Nash equilibrium will be complete financial market integration.

The result in this chapter also shows the importance of modelling explicitly the investment decision in analysing the welfare of households under different financial market structures. In our model, the real investment decision affects asset prices, which determine the financial decisions of the households. Since the households' decisions in the goods and financial markets are interdependent, it is important for policy-makers to consider the interaction between the two markets in their decision choice.

	$a_1(i)$ i=1,2,3	$a_1(1), a_1(2)$	$a_1(2)$	$a_1(1)$	$a_1(0)$
$a_2(i)$ i=1,2,3	V_1^A, V_2^A	V_1^A, V_2^A	V_1^A, V_2^A	V_1^A, V_2^A	V_1^A, V_2^A
$a_2(1), a_2(2)$	V_1^A, V_2^A	V_1^B, V_2^B	V_1^B, V_2^B	V_1^B, V_2^B	V_1^B, V_2^B
$a_2(1)$	V_1^A, V_2^A	V_1^B, V_2^B	V_1^{S2}, V_2^{S2}	V_1^B, V_2^B	V_1^{S2}, V_2^{S2}
$a_2(2)$	V_1^A, V_2^A	V_1^B, V_2^B	V_1^B, V_2^B	V_1^{S1}, V_2^{S1}	V_1^{S1}, V_2^{S1}
$a_2(0)$	V_1^A, V_2^A	V_1^B, V_2^B	V_1^{S2}, V_2^{S2}	V_1^{S1}, V_2^{S1}	V_1^I, V_2^I

Table 5.1: **Normal form of financial policy game.** The actions of the home and foreign governments are given by the columns and rows of the payout table respectively. Since there are only two countries in our economy, the restriction of financial trade in a particular asset by one country has the same restriction implication for the other country.

Financial structure	**Invest-ment**	**Asset price**	**Risk-free rate**	**Portfolio weights**	**Indirect utility** $\times 10^{-1}$
$\alpha_1 = \alpha_2 = 1$					
$a_1(0)$	I_1=2.44	S_1=2.44	4.79%	s_{11}=s_{12}=0.50, $b_1 = 0$	$V_1^I = -7.6435$
$a_2(0)$	I_2=2.44	S_2=2.44		$s_{21} = s_{22} = 0.50$, $b_2 = 0$	$V_2^I = -7.6435$
$a_1(1)$	I_1=1.48		3.61%	$s_{11} = 1, s_{12} = 0.43$, $b_1 = -0.52$	$V_1^{S1} = -7.6390$
$a_2(2)$	I_2=3.41	S_2=3.41		$s_{21} = 0, s_{22} = 0.57$, $b_2 = 0.52$	$V_2^{S1} = -7.6957$
$a_1(2)$	I_1=3.41	S_1=3.41	3.61%	$s_{11} = 0.57, s_{12} = 0$, $b_1 = 0.52$	$V_1^{S2} = -7.6957$
$a_2(1)$	I_2=1.48			$s_{21} = 0.43, s_{22} = 1$, $b_2 = -0.52$	$V_2^{S2} = -7.6390$
$a_1(1), a_1(2)$	I_1=2.45		2.10%	$s_{11} = 1, s_{12} = 0$, $b_1 = 0$	$V_1^B = -7.7012$
$a_2(1), a_2(2)$	I_2=2.45			$s_{21} = 0, s_{22} = 1$, $b_2 = 0$	$V_2^B = -7.7012$
$\alpha_1 = \alpha_2 = .995$					
$a_1(0)$	I_1=2.44	S_1=2.45	4.81%	s_{11}=s_{12}=0.50, $b_1 = 0$	$V_1^I = -7.6110$
$a_2(0)$	I_2=2.44	S_2=2.45		$s_{21} = s_{22} = 0.50$, $b_2 = 0$	$V_2^I = -7.6110$
$a_1(1)$	I_1=1.58		3.58%	$s_{11} = 1, s_{12} = 0.43$, $b_1 = -0.56$	$V_1^{S1} = -7.6109$
$a_2(2)$	I_2=3.31	S_2=3.33		$s_{21} = 0, s_{22} = 0.57$, $b_2 = 0.56$	$V_2^{S1} = -7.6613$
$a_1(2)$	I_1=3.31	S_1=3.33	3.67%	$s_{11} = 0.57, s_{12} = 0$, $b_1 = 0.56$	$V_1^{S2} = -7.6613$
$a_2(1)$	I_2=1.58			$s_{21} = 0.43, s_{22} = 1$, $b_2 = -0.56$	$V_2^{S2} = -7.6109$
$a_1(1), a_1(2)$	I_1=2.45		3.33%	$s_{11} = 1, s_{12} = 0$, $b_1 = 0$	$V_1^B = -7.6685$
$a_2(1), a_2(2)$	I_2=2.45			$s_{21} = 0, s_{22} = 1$, $b_2 = 0$	$V_2^B = -7.6685$

Table 5.2: **Comparison across different financial structures with α_i=1 and 0.995.** The first (second) row after each horizontal line refers to the variables of the home (foreign) country. The mean and variance of the productivity shock are assumed to be 10% and 5%, respectively, for both productions. Assumptions on other parameters are: $\eta_i = 2$, $\beta_i = .98$, $\delta_i = 1$, and $K_i(0) = 5$ for $i = 1, 2$. The labour endowments are assumed to be the same for both countries, but are chosen so that the risk-free rates under financial market integration with different α_i's are almost the same.

Financial structure	**Invest-ment**	**Asset price**	**Risk-free rate**	**Portfolio weights**	**Indirect utility $\times 10^{-1}$**
$\alpha_1 = \alpha_2 = 0.99$					
$a_1(0)$	I_1=2.44	S_1=2.46	4.84%	s_{11}=s_{12}=0.50, $b_1 = 0$	$V_1^I = -7.5787$
$a_2(0)$	I_2=2.44	S_2=2.46		$s_{21} = s_{22} = 0.50$, $b_2 = 0$	$V_2^I = -7.5787$
$a_1(1)$	I_1=1.66		3.56%	$s_{11} = 1, s_{12} = 0.42$, $b_1 = -0.60$	$V_1^{S1} = -7.5822$
$a_2(2)$	I_2=3.23	S_2=3.26		$s_{21} = 0, s_{22} = 0.58$, $b_2 = 0.60$	$V_2^{S1} = -7.6274$
$a_1(2)$	I_1=3.23	S_1=3.26	3.56%	$s_{11} = 0.58, s_{12} = 0$, $b_1 = 0.60$	$V_1^{S2} = -7.6274$
$a_2(1)$	I_2=1.66			$s_{21} = 0.42, s_{22} = 1$, $b_2 = -0.60$	$V_2^{S2} = -7.5822$
$a_1(1), a_1(2)$	I_1=2.45		2.28%	$s_{11} = 1, s_{12} = 0$, $b_1 = 0$	$V_1^B = -7.6360$
$a_2(1), a_2(2)$	I_2=2.45			$s_{21} = 0, s_{22} = 1$, $b_2 = 0$	$V_2^B = -7.6360$
$\alpha_1 = \alpha_2 = .98$					
$a_1(0)$	I_1=2.43	S_1=2.48	4.83%	s_{11}=s_{12}=0.50, $b_1 = 0$	$V_1^I = -7.5202$
$a_2(0)$	I_2=2.43	S_2=2.48		$s_{21} = s_{22} = 0.50$, $b_2 = 0$	$V_2^I = -7.5202$
$a_1(1)$	I_1=1.77		3.16%	$s_{11} = 1, s_{12} = 0.42$, $b_1 = -0.65$	$V_1^{S1} = -7.5289$
$a_2(2)$	I_2=3.32	S_2=3.39		$s_{21} = 0, s_{22} = 0.58$, $b_2 = 0.65$	$V_2^{S1} = -7.5666$
$a_1(2)$	I_1=3.32	S_1=3.39	3.16%	$s_{11} = 0.58, s_{12} = 0$, $b_1 = 0.65$	$V_1^{S2} = -7.5666$
$a_2(1)$	I_2=1.77			$s_{21} = 0.42, s_{22} = 1$, $b_2 = -0.65$	$V_2^{S2} = -7.5289$
$a_1(1), a_1(2)$	I_1=2.44		2.27%	$s_{11} = 1, s_{12} = 0$, $b_1 = 0$	$V_1^B = -7.5770$
$a_2(1), a_2(2)$	I_2=2.44			$s_{21} = 0, s_{22} = 1$, $b_2 = 0$	$V_2^B = -7.5770$

Table 5.3: **Comparison across different financial structures with α_i=0.99 and 0.98.** The first (second) row after each horizontal line refers to the variables of the home (foreign) country. The mean and variance of the productivity shock are assumed to be 10% and 5%, respectively, for both productions. Assumptions on other parameters are: $\eta_i = 2$, $\beta_i = .98$, $\delta_i = 1$, and $K_i(0) = 5$ for $i = 1, 2$. The labour endowments are assumed to be the same for both countries, but are chosen so that the risk-free rates under financial market integration with different α_i's are almost the same.

Financial structure	Invest-ment	Asset price	Risk-free rate	Portfolio weights	Indirect utility $\times 10^{-1}$
$\alpha_1 = \alpha_2 = 0.5$					
$a_1(0)$	I_1=2.09	S_1=4.18	4.90%	s_{11}=s_{12}=0.50, $b_1 = 0$	$V_1^I = -4.4588$
$a_2(0)$	I_2=2.09	S_2=4.18		$s_{21} = s_{22} = 0.50$, $b_2 = 0$	$V_2^I = -4.4588$
$a_1(1)$	I_1=2.03		2.94%	$s_{11} = 1, s_{12} = 0.37$, $b_1 = -1.52$	$V_1^{S1} = -4.4767$
$a_2(2)$	I_2=2.17	S_2=4.33		$s_{21} = 0, s_{22} = 0.63$, $b_2 = 1.52$	$V_2^{S1} = -4.4827$
$a_1(2)$	I_1=2.17	S_1=4.33	2.94%	$s_{11} = 0.63, s_{12} = 0$, $b_1 = 1.52$	$V_1^{S2} = -4.4827$
$a_2(1)$	I_2=2.03			$s_{21} = 0.37, s_{22} = 1$, $b_2 = -1.52$	$V_2^{S2} = -4.4767$
$a_1(1), a_1(2)$	I_1=2.10		2.02%	$s_{11} = 1, s_{12} = 0$, $b_1 = 0$	$V_1^B = -4.4925$
$a_2(1), a_2(2)$	I_2=2.10			$s_{21} = 0, s_{22} = 1$, $b_2 = 0$	$V_2^B = -4.4925$
$\alpha_1 = \alpha_2 = .35$					
$a_1(0)$	I_1=1.93	S_1=5.50	4.90%	s_{11}=s_{12}=0.50, $b_1 = 0$	$V_1^I = -3.3890$
$a_2(0)$	I_2=1.93	S_2=5.50		$s_{21} = s_{22} = 0.50$, $b_2 = 0$	$V_2^I = -3.3890$
$a_1(1)$	I_1=1.89		2.80%	$s_{11} = 1, s_{12} = 0.37$, $b_1 = -2.02$	$V_1^{S1} = -3.4029$
$a_2(2)$	I_2=1.98	S_2=5.67		$s_{21} = 0, s_{22} = 0.63$, $b_2 = 2.02$	$V_2^{S1} = -3.4072$
$a_1(2)$	I_1=1.98	S_1=5.67	2.80%	$s_{11} = 0.63, s_{12} = 0$, $b_1 = 2.02$	$V_1^{S2} = -3.4072$
$a_2(1)$	I_2=1.89			$s_{21} = 0.37, s_{22} = 1$, $b_2 = -2.02$	$V_2^{S2} = -3.4029$
$a_1(1), a_1(2)$	I_1=1.94		1.83%	$s_{11} = 1, s_{12} = 0$, $b_1 = 0$	$V_1^B = -3.4147$
$a_2(1), a_2(2)$	I_2=1.94			$s_{21} = 0, s_{22} = 1$, $b_2 = 0$	$V_2^B = -3.4147$

Table 5.4: **Comparison across different financial structures with α_i=0.5 and 0.35.** The first (second) row after each horizontal line refers to the variables of the home (foreign) country. The mean and variance of the productivity shock are assumed to be 10% and 5%, respectively, for both productions. Assumptions on other parameters are: $\eta_i = 2$, $\beta_i = .98$, $\delta_i = 1$, and $K_i(0) = 5$ for $i = 1, 2$. The labour endowments are assumed to be the same for both countries, but are chosen so that the risk-free rates under financial market integration with different α_i's are almost the same.

Financial structure	**Investment**	**Risk-free rate**	**Portfolio weights**	**Indirect utility**
$a_1(0)$	I_1=2.000	9.977%	s_{11}=s_{12}=0.500, $b_1 = 0.$	$V_1^I = 1.92778$
$a_2(0)$	I_2=3.000		$s_{21} = s_{22} = 0.500,$ $b_2 = 0.$	$V_2^I = 1.92778$
$a_1(1)$	I_1=1.242	9.971%	$s_{11} = 1, s_{12} = 0.496,$ $b_1 = -0.605.$	$V_1^{S1} = 1.92779$
$a_2(2)$	I_2=3.758		$s_{21} = 0, s_{22} = 0.504,$ $b_2 = 0.605.$	$V_2^{S1} = 1.92773$
$a_1(2)$	I_1=2.871	9.967%	$s_{11} = 0.506, s_{12} = 0,$ $b_1 = 1.048.$	$V_1^{S2} = 1.92768$
$a_2(1)$	I_2=2.129		$s_{21} = 0.494, s_{22} = 1,$ $b_2 = -1.048.$	$V_2^{S2} = 1.92781$
$a_1(1), a_1(2)$	I_1=2.005	9.955%	$s_{11} = 1, s_{12} = 0,$ $b_1 = 0.495$	$V_1^B = 1.92765$
$a_2(1), a_2(2)$	I_2=2.995		$s_{21} = 0, s_{22} = 1,$ $b_2 = -0.495$	$V_2^B = 1.92773$
$a_1(i), i = 1,2,3$	I_1=2.500	9.944%	$s_{11} = 1, s_{12} = 0,$ $b_1 = 0$	$V_1^A = 1.92764$
$a_1(i), i = 1,2,3$	I_2=2.500	9.962%	$s_{21} = 0, s_{22} = 1,$ $b_2 = 0$	$V_2^A = 1.92772$

Table 5.5: **Comparison across different financial structures with logarithmic preferences and constant returns to scale** The first (second) row after each horizontal line refers to the variables of the home (foreign) country. The volatility of productivity are assumed to be 2.5% and $\sqrt{\frac{2}{3}} \times 2.5\%$ for the home and the foreign production, respectively. The mean productivity is assumed to be 10% for both productions. Assumptions on other parameters are: $\eta_i = 1$, $\beta_i = 1$, $\alpha_i = 1$, $\delta_i = 1$, and $K_i(0)$, for $i = 1, 2$.

Chapter 6

Conclusions

We conclude this thesis by stating the main results of our analyses and discussing the implications of our findings. We also describe important assumptions we make in our model, and discuss how the relaxation of these assumptions might affect our results.

In this thesis our objective was to understand the relation between decisions in financial markets and those in commodity markets. Our analysis shows that the interaction between financial and real decisions in an international economy is important in the outcome of either a trade policy game or a financial policy game between two governments. The analysis in Chapter 3 shows that the structure of financial markets influences the pattern of commodity trade, which influences the terms-of-trade effect of a tariff levy. Consequently, the governments' incentives to levy tariffs are also affected. The main finding is that the tariff level chosen by a government in a Nash tariff game decreases as the degree of financial market integration increases. Chapter 4 examines the welfare improvement from financial market integration, given the influence of financial markets on the endogenously determined trade policy. The key finding is that the welfare gain from the secondary effects of financial market integration (as a result of free trade in the commodities markets) is much greater than the direct welfare gain (from risk sharing). Chapter 5 investigates the choice of financial openness in a production economy. The main conclusion of the analysis is that, except for the special case of constant returns to scale of production in capital, each country's government will choose to open its financial markets completely. In the special case where production exhibits constant returns to scale in capital, a country may choose to deny foreigners access to the domestic stock market.

There are at least two empirical implications of the theoretical work contained in this thesis. First, we could test the inverse relationship between tariff levels and the degree of financial integration that is suggested by the finding in Chapter 3 by using a cross-sectional regression across different countries. To do this, we would need to compute a proxy for financial market integration and also obtain estimates of the effective tariff levels between the countries. Second, we could test the finding in Chapter 5 which suggests that countries with a lower capital share in their production technologies are more likely to have integrated financial markets. In this case, in addition to computing the financial integration proxy, we would need to estimate the capital share in a Cobb-Douglas production function for each country.

We now discuss the implications of the key assumptions used in this thesis. In Chapter 3, trade policy is modelled as a tariff levy on imports. An alternative form of rent extraction trade policy that could be used by the government is the imposition of import quotas. This form of trade restriction is equivalent to the tariff levy in our endowment model where the domestic "production" (or rather, endowment) of the import good does not respond to the price increase in the good. Therefore, the influence of the financial market structure on the quotas would be qualitatively the same as its effect on tariff policy, so that the magnitude of the quota decreases with increasing financial integration. If we modelled production, the quota policy would generate greater monopolistic power than a tariff that restricts import by the same amount. This is because a quota policy removes any threat of imports beyond a quota amount and the domestic firm has the remaining market share to itself. Therefore, a quota policy that restricts the same amount of imports as a tariff policy would reduce welfare more than the equivalent tariff level. In this sense, the measure of welfare improvement from financial integration in Chapter 4 would be greater in magnitude if a quota policy were to be used.[1]

The financial segmentation in this thesis is represented by making the trading of some assets inaccessible to some investors. An alternative way to segment financial markets is a tax on capital flows. If a tax is imposed on the dividend payment of foreign assets (which is equivalent to a tax on the capital outflow), the portfolio choice of the domestic household would substitute away from the foreign assets toward domestic assets. The extreme case is a tax high enough that the domestic household does not purchase any foreign stock. Such a prohibitive tax has the same consequence as the closure of the foreign asset market to domestic households (which is the form of financial market segmentation examined in this thesis).

On the other hand, if the capital tax is non-dissipative and the tax revenue is redistributed to the households as a lump-sum transfer, it has the same wealth extraction role as the tariff policy in the goods market. In this case, the Nash equilibrium tariff could be zero with the capital tax in place because its role of wealth extraction is replaced by the capital tax. At the point where all wealth extraction is achieved via the capital tax, a tariff levy becomes welfare reducing for the domestic household. The advantage of using a tariff over a capital tax as the wealth extraction tool is that it is possible to target the tariff to only the import good, while a capital tax targets the dividend payments of all foreign assets, which can pay out the import or the export good. If the sole purpose of a capital tax or tariff levy is to transfer wealth from the foreign country, it would not be optimal to impose a dividend tax on the foreign stock that pays out the export

[1]This conjecture assumes that the quota is not applied to the ex-post delivery of the dividends of the financial claims in terms of goods, just as the tariff is not applied to the dividends of the financial claims in our model.

good because this has less flexibility. As the approach adopted by the recent literature that studies investment barriers in an international economy is to model financial market segmentation in the form of asset market accessibility, we choose the same approach in this thesis so that our results are comparable to the existing literature.

For most of the thesis, a two-period model is assumed. The results pertaining to complete financial markets and financial autarky will not be affected by extending the model to a multi-period setting because the household's problem is static under these extreme financial structures. The Nash equilibrium tariff is both ex-ante and ex-post optimal in this case. However, with incomplete financial markets (partial segmentation), the Nash equilibrium tariff level is not ex-post optimal. The extension of the investment model in Chapter 5 to a multi-period setting will make the household problem more complicated. In a multi-period setting, the portfolio and investment choice in each period will depend on the portfolio and investment decisions, as well as the production shock, in the previous period.

We have also assumed that the objective of the government in our model is to maximize the local household's utility. This assumption excludes other political considerations that the government might have. Since the main objective of this thesis is to examine the interaction between real and financial decisions in an international macroeconomy and not the game theoretic issues in politics, we picked a simple and parsimonious objective for the government which is to maximize its household's welfare. We have also adopted the representative agent approach in our analyses. This approach is appropriate given our interest in how the financial market structure affects the economy as a homogenous entity. We do not address the effect of financial market structure on the income distribution within a country or other individual-specific characteristics of the households that would require the modelling of heterogeneity across households of the same country.

To conclude, we explain how the analyses in this thesis address the issue of the interaction between real and financial decisions in an international economy. Chapter 3 and Chapter 4 bring out the interaction between the portfolio choice in the financial market and the consumption choice in the goods markets, while Chapter 5 points to the interaction between the investment decision in the goods market and the portfolio decision in the financial market. In each case, we show how the link between the real goods market and the financial market affects either the trade or financial policy decision in a government's Nash policy game. From this, we conclude that the interaction between real and financial decisions in an international economy is important in evaluating policy effects. Therefore, it is important for policy-makers to consider this interaction in their decision-making process. Moreover, it is our hope that a better understanding of this interaction will help governments make better policy decisions.

Appendix A

Appendix to Chapter 3

A.1 Proof for All Results

Derivation of Competitive Equilibrium with Complete Financial Markets

Under the assumption of symmetric initial expected value of all endowments in both countries, the presence of complete financial markets gives the following relationship: $\lambda_1(0) = \lambda_2(0)$. This equality, and the existence of a unique set of state contingent prices, $q_{ij}(s)$, implies that the left-hand side of the first-order condition (3.10) is the same for both countries. Hence, we can derive that all Lagrange multipliers between the two households are equal, that is, $\lambda_1(s) = \lambda_2(s)$. Then, using the first-order condition in equation (3.9) and the pricing relations (3.6) and (3.7), the ratio of consumption of the same good between the home and foreign households is derived for good i:

$$\frac{c_{11}(s)}{c_{21}(s)} = 1 + \tau_{21}, \tag{A.1}$$

$$\frac{c_{22}(s)}{c_{12}(s)} = 1 + \tau_{12}. \tag{A.2}$$

Substituting $c_{21}(s) = \frac{c_{11}(s)}{1+\tau_{21}}$ and $c_{22}(s) = (1+\tau_{12})c_{12}(s)$ into the market-clearing conditions gives the consumption rules defined in (3.13) and (3.14). The consumption rules for the foreign household are derived by substituting (3.13) and (3.14) into (A.1) and (A.2), respectively, resulting in the following:

$$c^I_{21}(s) = \frac{1}{2 + \tau_{21}}[y_{11}(s) + y_{21}(s)], \tag{A.3}$$

$$c^I_{22}(s) = \frac{1+\tau_{12}}{2+\tau_{12}}[y_{12}(s)+y_{22}(s)]. \tag{A.4}$$

The amount of the import good consumed by household i equals the amount of the good it is endowed with, plus the amount of the good it imports; that is:

$$c_{ij}(s) = y_{ij}(s) + m_{ij}(s), \tag{A.5}$$

for $i \neq j$ and $i, j = 1, 2$. Substituting (A.3) and (3.14) into (A.5) gives the optimal import of goods 1 and 2, respectively:

$$m^I_{21}(s) = \frac{1}{2+\tau_{21}}[y_{11}(s) - (1+\tau_{21})y_{21}(s)], \tag{A.6}$$

$$m^I_{12}(s) = \frac{1}{2+\tau_{12}}[y_{22}(s) - (1+\tau_{12})y_{12}(s)]. \tag{A.7}$$

The holdings of state-contingent claims are derived by substituting the equilibrium consumption rules into the budget constraint. The holdings are given by:

$$\omega^1_{11}(s) = -\frac{1}{2+\tau_{21}}y_{11}(s), \tag{A.8}$$

$$\omega^1_{12}(s) = -\frac{1}{2+\tau_{12}}y_{12}(s), \tag{A.9}$$

$$\omega^1_{21}(s) = \frac{1}{2+\tau_{21}}y_{21}(s), \tag{A.10}$$

$$\omega^1_{22}(s) = \frac{1}{2+\tau_{12}}y_{22}(s). \tag{A.11}$$

Thus, the value of state-contingent holdings, $w^I_1(s)$, in terms of the numeraire good is:

$$w^I_1(s) = -\frac{y_{11}(s)}{2+\tau_{21}} - \frac{p_{12}(s)}{p_{11}(s)}\frac{y_{12}(s)}{2+\tau_{12}} + \frac{p_{21}(s)}{p_{11}(s)}\frac{y_{21}(s)}{2+\tau_{21}} + \frac{p_{22}(s)}{p_{11}(s)}\frac{y_{22}(s)}{2+\tau_{12}}. \tag{A.12}$$

Proof of Proposition 3.1

First, we prove the proposition under the assumption of logarithmic preferences. Then we prove the proposition for a more general CRRA utility function.

Under the assumption of logarithmic preferences, the partial derivative in (3.16) is computed to be the following:

$$\begin{aligned}
\frac{\partial V_1^I}{\partial \tau_{12}} &= E_0\left[\frac{1}{c_{12}(s)}\left(-\frac{y_{12}(s)+y_{22}(s)}{(2+\tau_{12})^2}\right)\right] \\
&= E_0\left[\left(\frac{2+\tau_{12}}{y_{12}(s)+y_{22}(s)}\right)\left(-\frac{y_{12}(s)+y_{22}(s)}{(2+\tau_{12})^2}\right)\right] \\
&= -\frac{1}{2+\tau_{12}} < 0. \qquad \text{(A.13)}
\end{aligned}$$

The inequality (A.13) shows that the domestic indirect utility is decreasing in the domestic tariff. Hence, the optimal choice for the government is to choose $\tau_{12} = 0$, given our non-negativity constraint on tariffs.

Suppose we have a general CRRA utility function defined as:

$$U_i[c_{i1}(s), c_{i2}(s)] \equiv \frac{1}{1-\eta}[c_{i1}(s)^{\frac{1}{2}} c_{i2}(s)^{\frac{1}{2}}]^{1-\eta}, \qquad \eta > 0. \qquad \text{(A.14)}$$

The budget shares of the import good and export good are assumed to be equal so that the problem is symmetric. The optimal consumption rule for the home household is:

$$\begin{aligned}
c_{11}^I(s) &= \frac{\kappa_1}{1+\kappa_1}[y_{11}(s)+y_{21}(s)], \qquad \text{(A.15)} \\
c_{12}^I(s) &= \frac{1}{1+\kappa_2}[y_{12}(s)+y_{22}(s)], \qquad \text{(A.16)}
\end{aligned}$$

where,

$$\begin{aligned}
\kappa_1 &= [(1+\tau_{12})^{1-\frac{1}{\eta}}(1+\tau_{21})^{1+\frac{1}{\eta}}]^{\frac{1}{2}}, \qquad \text{(A.17)} \\
\kappa_2 &= [(1+\tau_{12})^{1+\frac{1}{\eta}}(1+\tau_{21})^{1-\frac{1}{\eta}}]^{\frac{1}{2}}. \qquad \text{(A.18)}
\end{aligned}$$

The objective function of the home government is obtained by substituting the optimal consumptions in (A.15) and (A.16) into the utility function (A.14). The Kuhn-Tucker condition for the home government's maximization problem is:

$$\tau_{12} E_0\left[\left(\frac{1}{c_{11}^I(s)}\right)\left(\frac{\partial c_{11}^I(s)}{\partial \tau_{12}}\right) + \left(\frac{1}{c_{12}^I(s)}\right)\left(\frac{\partial c_{12}^I(s)}{\partial \tau_{12}}\right)\right] = 0. \qquad \text{(A.19)}$$

Similarly, the optimization problem of the foreign government gives:

$$\tau_{21} E_0 \left[\left(\frac{1}{c_{21}^I(s)} \right) \left(\frac{\partial c_{21}^I(s)}{\partial \tau_{21}} \right) + \left(\frac{1}{c_{22}^I(s)} \right) \left(\frac{\partial c_{22}^I(s)}{\partial \tau_{21}} \right) \right] = 0. \tag{A.20}$$

Suppose there exists a strictly positive optimal tariff for each country. This implies that both expectation terms in (A.19) and (A.20) equals zero. After some manipulation, setting the two expectation terms to zero gives the condition that either $\eta = 0$ or $\tau_{12} = \tau_{21}$. Since $\eta > 0$, this means that $\tau_{12} = \tau_{21}$. Substituting the equality of tariffs into either (A.19) or (A.20) to solve for the optimal tariff gives the solution that $\tau_{12} = \tau_{21} \leq 0$, which violates the Kuhn-Tucker condition. Hence, the optimal tariff for both countries is zero. At $\tau_{12}^I = \tau_{21}^I = 0$, the expectation terms in (A.19) and (A.20) is negative, which is consistent with the Kuhn-Tucker conditions.

We now show that a negative tariff will not be welfare improving if we relax our non-negativity constraint. For simplicity, we present the case of logarithmic preferences. The argument is the same for a more general CRRA utility function. If a negative tariff exists in the economy to increase the consumption of the import good, it must be financed by a tax that will reduce consumption of the export good; that is, there exists some inter-sectoral transfer from the export good sector to the import good sector. We show by contradiction that no such inter-sectoral transfer is optimal. We begin the argument by supposing that a negative tariff is optimal. Then, there exists a function of τ_{12}, $\varepsilon(\tau_{12}) > 0$ such that:

$$E_0 \left[\ln[(1-\varepsilon) c_{11}^I(s)_{|\tau_{12}=0}] + \ln[(1+\varepsilon) c_{12}^I(s)_{|\tau_{12}=0}] \right] > E_0 \left[\ln[c_{11}^I(s)_{|\tau_{12}=0}] + \ln[c_{12}^I(s)_{|\tau_{12}=0}] \right]. \tag{A.21}$$

For the inequality in (A.21) to hold, $(1-\varepsilon^2) > 1$ must be true. This is possible if and only if $\varepsilon < 0$. However, this contradicts the original statement that there exists $\varepsilon > 0$. Hence, a negative tariff will not be optimal in this economy given that it has to be financed by resources from the export good sector.

The Derivation of the Competitive Equilibrium under Financial Autarky

From the first-order condition in (3.31), the ratio of consumption of good 1 to good 2 in country 1 is derived as:

$$\frac{c_{11}^A(s)}{c_{12}^A(s)} = (1+\tau_{12})\frac{p_{22}(s)}{p_{11}(s)}. \tag{A.22}$$

By substituting the above relation into the budget constraint, the expressions for the consumption of goods 1 and 2 are given by:

$$c_{11}^A(s) = \frac{y_1(s)}{p_{11}(s)}, \tag{A.23}$$

$$c_{12}^A(s) = \frac{y_1(s)}{(1+\tau_{12})p_{22}(s)}, \tag{A.24}$$

where

$$y_1(s) \equiv p_{11}(s)y_{11}(s) + (1+\tau_{12})p_{22}(s)y_{12}(s) + \tau_{12}p_{22}(s)m_{12}(s). \tag{A.25}$$

These solutions are the usual Cobb-Douglas consumption shares, where $y_1(s)$ is the wealth of the home household, which includes the lump-sum transfer of tariff revenue from its government. A similar pair of solutions is derived for the foreign household.

$$c_{21}^A(s) = \frac{y_2(s)}{(1+\tau_{21})p_{11}(s)}, \tag{A.26}$$

$$c_{22}^A(s) = \frac{y_2(s)}{p_{22}(s)}, \tag{A.27}$$

where

$$y_2(s) \equiv (1+\tau_{12})p_{11}(s)y_{21}(s) + p_{22}(s)y_{22}(s) + \tau_{21}p_{11}m_{21}(s). \tag{A.28}$$

The amount of the import good consumed by household i equals the amount of the good it is endowed with, plus the amount of the good it imports; that is, $c_{ij}(s) = y_{ij}(s) + m_{ij}(s)$ for $i \neq j$ and $i, j = 1, 2$. Under the market-clearing conditions in commodity markets, the amount of good exported by a country must equal the amount of the good imported by the other country, hence, $m_{ij}(s) = x_{jj}$ for $i \neq j$ and $i, j = 1, 2$. Substitution of (A.24) into the market-clearing condition for the domestic good, $c_{12}(s) = y_{12}(s)+x_{22}(s)$ and (A.26) into $c_{21}(s) = y_{21}(s) + x_{11}(s)$ will give an expression for the optimal export rules in terms of price ratios. These export rules are:

$$x_{11}^A(s) = \frac{1}{2+\tau_{12}}\left[\frac{p_{11}(s)}{p_{22}(s)}y_{11}(s) - (1+\tau_{12})y_{12}(s)\right], \tag{A.29}$$

$$x_{22}^A(s) = \frac{1}{2+\tau_{21}}\left[\frac{p_{11}(s)}{p_{22}(s)}y_{22}(s) - (1+\tau_{21})y_{21}(s)\right]. \tag{A.30}$$

The export rules in (A.29) and (A.30) are then substituted back into the the consumption rules in (A.23)-(A.27). The result is a set of consumption rules described by:

$$c_{11}^A(s) = \frac{1+\tau_{12}}{2+\tau_{12}}\left[y_{11}(s) + \frac{p_{22}(s)}{p_{11}(s)}y_{12}(s)\right], \tag{A.31}$$

$$c_{12}^A(s) = \frac{1}{2+\tau_{12}}\left[\frac{p_{11}(s)}{p_{22}(s)}y_{11}(s) + y_{12}(s)\right]. \tag{A.32}$$

A similar set of consumption rules are also obtained for the foreign household. To solve for the price ratio analytically, the consumption rules in (A.31) and (A.32) are substituted into the world goods market-clearing conditions in (3.11) and (3.12). The substitution gives two linearly dependent equations in the price ratio $\frac{p_{22}(s)}{p_{11}(s)}$. The price ratio is solved analytically and is given by (3.37) in the text. To derive the expression for optimal consumption, we need to obtain the optimal exports in terms of the fundamental parameters. To do this, the price ratio in (3.37) is substituted into the expression for the optimal exports described in (A.29) and (A.30). The substitution gives:

$$x_{11}^A(s) = \frac{y_{11}(s)y_{22}(s) - (1+\tau_{12})(1+\tau_{21})y_{12}(s)y_{21}(s)}{(2+\tau_{12})y_{22}(s) + (1+\tau_{12})(2+\tau_{21})y_{12}(s)}, \tag{A.33}$$

$$x_{22}^A(s) = \frac{y_{11}(s)y_{22}(s) - (1+\tau_{12})(1+\tau_{21})y_{12}(s)y_{21}(s)}{(2+\tau_{21})y_{11}(s) + (1+\tau_{21})(2+\tau_{12})y_{21}(s)}. \tag{A.34}$$

The optimal consumption rules in (3.32) and (3.33) are obtained by substituting the optimal exports in (A.33) and (A.34) into $c_{11}(s) = y_{11}(s) - x_{11}(s)$ and $c_{12}(s) = y_{12}(s) + x_{22}(s)$, respectively.

Proof of Proposition 3.2

To prove that the tariff chosen by the government in an economy under financial autarky is strictly positive, we show that the domestic expected utility is increasing when evaluated at $\tau_{12} = 0$ for any given τ_{21}; that is $\frac{\partial V_1^A}{\partial \tau_{12}(t)}_{|\tau_{12}=0, \tau_{21} \geq 0} > 0$. The inequality implies that the home household can be made better off by a positive tariff at home, given a foreign tariff, $\tau_{21} \geq 0$. The partial derivative of domestic expected utility with respect to the domestic tariff is given by (3.36).

First, we evaluate the first term on the right-hand side of (3.36) at $\tau_{12} = 0$. This is done by taking the derivative of $c_{11}^A(s)$ described in (3.32) with respect to τ_{12} and then setting $\tau_{12} = 0$. Similarly, $c_{11}^A(s)$ is evaluated at $\tau_{12} = 0$. The product of the two variables gives:

$$\left[\frac{1}{c_{11}^A(s)}\left(\frac{\partial c_{11}^A(s)}{\partial \tau_{12}}\right)\right]_{|\tau_{12}=0, \tau_{21} \geq 0} = \frac{y_{22}(s)}{2y_{22}(s) + (2 + \tau_{21})y_{12}(s)}. \tag{A.35}$$

As the derivative in (A.35) is positive at $\tau_{12} = 0$, increasing τ_{12} to a positive number will increase the consumption of the export good.

Now, we evaluate the second term on the right-hand side of (3.36) at $\tau_{12} = 0$. This is done by taking the derivative of $c_{12}^A(s)$ described in (3.33) with respect to τ_{12}, and then setting $\tau_{12} = 0$. Similarly, $c_{12}^A(s)$ is evaluated at $\tau_{12} = 0$. The product of the two variables gives:

$$\left[\frac{1}{c_{12}^A(s)}\left(\frac{\partial c_{12}^A(s)}{\partial \tau_{12}}\right)\right]_{|\tau_{12}=0, \tau_{21} \geq 0} = -\frac{(1 + \tau_{21})y_{21}(s)}{(2 + \tau_{21})y_{11}(s) + 2(1 + \tau_{21})y_{21}(s)}. \tag{A.36}$$

As the derivative in (A.36) is negative at $\tau_{12} = 0$, increasing τ_{12} to a positive number will reduce the consumption of the import good. For the chosen tariff to be positive, the marginal gain in utility from the increased consumption of the export good must exceed the marginal loss in utility from the decreased consumption of the import good, valued at $\tau_{12} = 0$.

The sum of the two marginal effects of the domestic tariff is computed to be:

$$\begin{aligned}
\frac{\partial V_1^A}{\partial \tau_{12}}_{|\tau_{12}=0,\tau_{21}\geq 0} &= E_0\left[\frac{(2+\tau_{21})[y_{11}(s)y_{22}(s)-(1+\tau_{21})y_{12}(s)y_{21}(s)]}{[2y_{22}(s)+(2+\tau_{21})y_{12}(s)][(2+\tau_{21})y_{11}(s)+2(1+\tau_{21})y_{21}(s)]}\right] \\
&= E_0\left[\frac{(2+\tau_{21})}{[(2+\tau_{21})y_{11}(s)+2(1+\tau_{21})y_{21}(s)]}x_{22\ |\tau_{12}=0,\tau_{21}\geq 0}^A\right] > 0. \quad \text{(A.37)}
\end{aligned}$$

This means that the marginal gain exceeds the marginal loss from a tariff levy at the point where the domestic tariff equals zero, given any positive foreign tariff. Hence, the home household can be made better off by a positive tariff. The same argument applies to the foreign household. This implies that each government will choose a strictly positive import tariff.

Under financial autarky, the assumption of a more general CRRA utility function in (A.14) will not affect any of the analytical results described above. As each household does not have any ability to share endowment risk in the financial markets ex-ante, the equilibrium consumption depends only on the budget shares of the import good and export good. Since symmetry is assumed in this economy, the budget share for both goods is half under the assumption of logarithmic utility and also with the general CRRA utility function in (A.14). This means that the equilibrium consumption is the same for both utility functions.

Proof of Proposition 3.3

In Section 3.3, we have assumed the presence of state-contingent claims in deriving our equilibrium. Now we show that the equilibrium in Section 3.3 is identical to that in an economy with no financial market restrictions. In the absence of financial market restrictions, the economy is described by type $\mathbf{T}(0)$ segmentation. Household i maximizes its expected utility subject to the budget constraints in (3.43) and (3.44). The first-order conditions with respect to consumption is the same as that in equation (3.9). The first-order condition with respect to stock and bond holdings are:

$$S_{ij}(0) = \sum_{s\in S} \frac{\lambda_i(s)}{\lambda_i(0)}[p_{ij}(s)y_{ij}(s)], \tag{A.38}$$

$$B_{ij}(0) = \sum_{s\in S} \frac{\lambda_i(s)}{\lambda_i(0)}p_{ij}(s), \tag{A.39}$$

where $i, j = 1, 2$. The price equation above provides a relation between the Lagrange multipliers in countries 1 and 2:

$$\sum_{s\in S} \frac{\lambda_1(s)}{\lambda_1(0)}[p_{ij}(s)y_{ij}(s)] = \sum_{s\in S} \frac{\lambda_2(s)}{\lambda_2(0)}[p_{ij}(s)y_{ij}(s)], \tag{A.40}$$

$$\sum_{s\in S} \frac{\lambda_1(s)}{\lambda_1(0)}p_{ij}(s) = \sum_{s\in S} \frac{\lambda_2(s)}{\lambda_2(0)}p_{ij}(s). \tag{A.41}$$

One possible solution to the above relation is:

$$\frac{\lambda_1(s)}{\lambda_1(0)} = \frac{\lambda_2(s)}{\lambda_2(0)}. \tag{A.42}$$

Given the assumption of identical initial endowments and future endowments across the two countries, $\lambda_1(0) = \lambda_2(0)$. This implies that $\lambda_1(s) = \lambda_2(s)$, from equation (A.42) above. This same equality is obtained in the economy with state-contingent claims. Since the first-order condition with respect to consumption is the same in the two economies, and the same equality relation (A.42) holds, this implies that the optimal consumption policies in these economies are identical.

Substituting the optimal consumption solutions into the budget constraint (3.44) and equating the coefficients of $p_{ij}(s)y_{ij}(s)$ gives the following solution for the asset holdings of the two households:

$$\delta_{11}^1(s) = \frac{1+\tau_{21}}{2+\tau_{21}}, \qquad \delta_{11}^2(s) = \frac{1}{2+\tau_{21}}, \tag{A.43}$$

$$\delta^1_{12}(s) = \frac{1+\tau_{12}}{2+\tau_{12}}, \qquad \delta^2_{12}(s) = \frac{1}{2+\tau_{12}}, \tag{A.44}$$

$$\delta^1_{21}(s) = \frac{1}{2+\tau_{21}}, \qquad \delta^2_{21}(s) = \frac{1+\tau_{21}}{2+\tau_{21}}, \tag{A.45}$$

$$\delta^1_{22}(s) = \frac{1}{2+\tau_{12}}, \qquad \delta^2_{22}(s) = \frac{1+\tau_{12}}{2+\tau_{12}}, \tag{A.46}$$

$$\gamma^1_{ij}(s) = 0, \qquad \gamma^2_{ij}(s) = 0. \tag{A.47}$$

To hedge the changes in relative prices due to tariffs, each household will hold a bigger portion of its domestic stock than it otherwise would in an economy with no tariffs. As well, the household in each country does not hold any bond in equilibrium. This implies that the Nash equilibrium tariff in **E**(3) with **T**(1) financial market segmentation is zero, the same as the optimal tariff in **E**(1) described in Section 3.

The description of the numerical method to solve the optimal tariff level in **E**(3) with **T**(2)-**T**(5) segmentation is provided in Appendix A.2.

A.2 Description of the Numerical Method Used to Obtain the Optimal Tariff Level

In the economy we consider, there are four stochastic endowment processes. Using He's (1990) technique, we generate a (4+1)-nomial process using symmetric initial endowment; that is, $y_{11}(0) = y_{22}(0)$ and $y_{12}(0) = y_{21}(0)$. This technique generates 5 states in the economy at time 1. The quantity of an endowment good j in country i at state s, for $s \in [1,5]$, is represented by $y_{ij}(s)$. The mean and volatility parameters for each endowment process are 0.02 and 0.025, respectively. These parameters are chosen to represent the drift and volatility of real output growth in the US (based on the estimates in Summers and Heston (1991)). The time preference parameter is chosen to be $\beta = 0.98$. We find that the optimal tariff in **E**(1) to **E**(3) is not sensitive to the drift and volatility parameters chosen. The figures in Chapter 3 are generated with the initial endowment of $y_{11}(0) = y_{22}(0) = 3$ and $y_{12}(0) = y_{21}(0) = 1$.

To find the solution in $\mathbf{E}(3)$, we impose the appropriate restrictions on $\delta_{ij}^{A}(0)$ and $\gamma_{ij}^{A}(0)$ for the different types of financial segmentation, $\mathbf{T}(2)$ to $\mathbf{T}(5)$, described in Section 5. Then we solve numerically the system of first-order conditions (given by (3.9), (A.38) and (A.39)), goods market-clearing conditions (given by (3.11)-(3.12)), financial market-clearing conditions ($\delta_{ij}^{1}(0) + \delta_{ij}^{2}(0) = 1$ and $\gamma_{ij}^{1}(0) + \gamma_{ij}^{2}(0) = 0$) and budget constraints (given by (3.43) and (3.44)) numerically. To obtain the optimal tariff in $\mathbf{E}(3)$, we solve the system of equations for a grid of tariff levels between 0 and 1, and substitute the numerical solutions for consumption into the household's utility to search for the tariff level in the grid that maximizes its expected utility.

Appendix B

Appendix to Chapter 4

Derivation of Optimal Tariffs (Logarithmic Utility)

The maximization problem of the home government gives the following first-order condition:

$$\frac{1}{c_{11}(s)}\frac{\partial c_{11}(s)}{\partial \tau_{12}(s)} + \frac{1}{c_{12}(s)}\frac{\partial c_{12}(s)}{\partial \tau_{12}(s)} = 0. \tag{B.1}$$

From equations (4.3) and (4.4), we can derive the consumption of good 2 in the home country as:

$$c_{12}(s) = \frac{1}{2+\tau_{12}(s)}\left(\frac{y_{11}(s)}{p(s)} + y_{12}(s)\right). \tag{B.2}$$

Taking the derivative of $c_{11}(s)$ and $c_{12}(s)$ with respect to $\tau_{12}(s)$ gives:

$$\frac{\partial c_{11}(s)}{\partial \tau_{12}(s)} = \frac{1}{[2+\tau_{12}(s)]^2}[y_{11}(s) + p(s)y_{12}(s)] + y_{12}(s)\left(\frac{1+\tau_{12}(s)}{2+\tau_{12}(s)}\right)\frac{\partial p(s)}{\partial \tau_{12}(s)}, \tag{B.3}$$

$$\frac{\partial c_{12}(s)}{\partial \tau_{12}(s)} = -\frac{1}{[2+\tau_{12}(s)]^2}\left(\frac{y_{11}(s)}{p(s)} + y_{12}(s)\right) - \frac{y_{11}(s)}{p(s)^2}\left(\frac{1}{2+\tau_{12}(s)}\right)\frac{\partial p(s)}{\partial \tau_{12}(s)}. \tag{B.4}$$

From the household's maximization problem, we know that the marginal rate of substitution between goods 1 and 2 is:

$$\frac{c_{12}(s)}{c_{11}(s)} = \frac{1}{p(s)[1+\tau_{12}(s)]}. \tag{B.5}$$

Substituting the partial derivatives in (B.3) and (B.4) and the marginal condition, (B.5), into (B.1), gives the following equation after some manipulation:

$$\frac{1}{2+\tau_{12}(s)}\left(1 - \frac{1}{1+\tau_{12}(s)}\right)[y_{11}(s) + p(s)y_{12}(s)] = \left(y_{12}(s) - \frac{y_{11}(s)}{p(s)}\right)\frac{\partial p(s)}{\partial \tau_{12}(s)}. \tag{B.6}$$

Similarly for the foreign country, the first-order condition from the maximization problem can be expressed as:

$$\frac{1}{2+\tau_{21}(s)}\left(1-\frac{1}{1+\tau_{21}(s)}\right)[y_{21}(s)+p(s)y_{22}(s)] = \left(y_{22}(s)-\frac{y_{21}(s)}{p(s)}\right)\frac{\partial p(s)}{\partial \tau_{21}(s)}, \quad \text{(B.7)}$$

where $p(s)$ is given by equation (4.7) in the text. The partial derivatives of $p(s)$ are given by:

$$\frac{\partial p(s)}{\partial \tau_{12}(s)} = -[2+\tau_{21}(s)]\frac{[1+\tau_{21}(s)]y_{12}(s)y_{21}(s)+[2+\tau_{21}(s)]y_{11}(s)y_{12}(s)+y_{11}(s)y_{22}(s)}{\{[1+\tau_{12}(s)][2+\tau_{21}(s)]y_{12}(s)+[2+\tau_{12}(s)]y_{22}(s)\}^2}, \quad \text{(B.8)}$$

$$\frac{\partial p(s)}{\partial \tau_{21}(s)} = [2+\tau_{12}(s)]\frac{[1+\tau_{12}(s)]y_{12}(s)y_{21}(s)+[2+\tau_{12}(s)]y_{21}(s)y_{22}(s)+y_{11}(s)y_{22}(s)}{\{[1+\tau_{12}(s)]\{[2+\tau_{21}(s)]y_{12}(s)+[2+\tau_{12}(s)]y_{22}(s)\}^2}. \quad \text{(B.9)}$$

Substituting (B.8), (B.9) and (4.7) into (B.6) and (B.7) and after some algebraic manipulation, the following two simultaneous equations are obtained:

$$\begin{aligned}[1+\tau_{21}(s)]y_{21}(s)\{[1+\tau_{12}(s)]^2[2+\tau_{21}(s)]y_{12}(s)+\tau_{12}(s)[2+\tau_{12}(s)]y_{22}(s)\}& \\ = [2+\tau_{21}(s)]y_{11}(s)y_{22}(s),& \quad \text{(B.10)}\\ [1+\tau_{12}(s)]y_{12}(s)\{[1+\tau_{21}(s)]^2[2+\tau_{12}(s)]y_{21}(s)+\tau_{21}(s)[2+\tau_{21}(s)]y_{11}(s)\}& \\ = [2+\tau_{12}(s)]y_{11}(s)y_{22}(s).& \quad \text{(B.11)}\end{aligned}$$

Solving equations (B.10) and (B.11) gives six solutions to the tariff problem. However, only one solution yields 2 positive roots for both home and foreign tariffs. This solution is reported in equations (4.29) and (4.30) in the text.

Derivation of Combined Budget Constraint in (4.14)

The first-order condition for the home household's maximization problem with respect to its choice of state-contingent claims, $\omega_1(s)$ and $\omega_2(s)$, respectively, is given by:

$$\lambda_1(0)q_1(s) = \lambda_1(s), \quad \text{(B.12)}$$

$$\lambda_1(0)q_2(s) \quad = \quad \lambda_1(s)p(s). \tag{B.13}$$

where $\lambda_1(0)$ and $\lambda_1(s)$ are the Lagrangian multipliers of the time-0 and time-1 state-s budget constraints, respectively. Combining the two first order conditions (B.12) and (B.13), gives the ratio of state prices to be $\frac{q_2(s)}{q_1(s)} = p(s)$. Substituting $q_1(s)$ in terms of $q_2(s)$ into the self-financing constraint at time-0, gives:

$$\sum_s \frac{q_2(s)}{p(s)}\omega_1^1(s) + \sum_s q_2(s)\omega_2^1(s) = 0. \tag{B.14}$$

Multiply the time-1 state s budget constraint by $q_2(s)$, add the resulting equation over all states, to obtain:

$$\begin{aligned}\sum_s q_2(s)c_{11}(s) + \sum_s q_2(s)[1+\tau_{12}(s)]p(s)c_{12}(s) &= \sum_s q_2(s)[1+\tau_{12}(s)]p(s)y_{12}(s) \\ +\sum_s q_2(s)y_{11}(s) + \sum_s q_2(s)\tilde{z}_1(s) &+ \sum_s \frac{q_2(s)}{p(s)}\omega_1^1(s) + \sum_s q_2(s)\omega_2^1(s).\end{aligned} \tag{B.15}$$

From the constraint (B.14), the last two terms on the right-hand side of (B.15) equal zero, and (B.15) simplifies to the budget constraint (4.14) in the text.

Proof of Proposition 4.1

For any state s, we may describe an equilibrium with financial markets and endogenous tariff setting by combining equations (4.24)-(4.27) with the optimal ex-post consumption rules for the households. This gives

$$\frac{1+\tau_{21}(s)}{2+\tau_{21}(s)}[y_{11}(s)+y_{21}(s)] = \frac{1+\tau_{12}(s)}{2+\tau_{12}(s)}\{y_{11}(s)+\omega_1^1(s)+p(s)[y_{12}(s)+\omega_2^1(s)]\}, \tag{B.16}$$

$$\frac{y_{12}(s)+y_{22}(s)}{2+\tau_{12}(s)} = \frac{1}{2+\tau_{12}(s)}\left(\frac{y_{11}(s)+\omega_1^1(s)}{p(s)} + y_{12}(s) + \omega_2^1(s)\right), \tag{B.17}$$

where

$$p(s) = \frac{[2+\tau_{12}(s)][y_{11}(s)+\omega_1(s)] + [1+\tau_{21}(s)][2+\tau_{12}(s)][y_{21}(s)-\omega_1(s)]}{[1+\tau_{12}(s)][2+\tau_{21}(s)][y_{12}(s)+\omega_2(s)] + [2+\tau_{12}(s)][y_{22}(s)-\omega_2(s)]}. \tag{B.18}$$

Equation (B.16) says that for the home country, the constrained optimal consumption of good 1 must be equal to the optimal ex-post consumption, given tariffs, the terms of trade, and the state-contingent contract deliveries. Equation (B.17) has a similar interpretation. If (B.16) and (B.17) are satisfied for the home economy, then the analogous conditions must be satisfied for the foreign economy given Walras' law.

The system (4.29)-(B.18) contains five equations and may be solved for the five variables $\tau_{12}(s)$, $\tau_{21}(s)$, $\omega_1^1(s)$, $\omega_2^1(s)$, and $p(s)$. To prove the proposition, set:

$$\omega_1(s) = \frac{1}{2}[y_{21}(s) - y_{11}(s)], \tag{B.19}$$

$$\omega_2(s) = \frac{1}{2}[y_{22}(s) - y_{12}(s)]. \tag{B.20}$$

Substituting the optimal choice of contingent claims into (4.29) and (4.30), we get $\tau_{12}(s) = 0$ and $\tau_{21}(s) = 0$. This also satisfies (B.16)-(B.18) with $p(s) = 1$.

Derivation of Optimal Tariffs (General CES Utility)

After the state of nature is realized, the ex-post trade balance has to hold in each country. This implies the following relationship:

$$x_{11t}(s) = p_t(s)m_{12t}(s), \tag{B.21}$$

$$p_t(s)x_{22t}(s) = m_{21t}(s), \tag{B.22}$$

where $x_{11t}(s)$ and $m_{12t}(s)$ are the home country's export of good 1 and import of good 2, respectively, and $x_{22t}(s)$ and $m_{21t}(s)$ are the foreign country's export of good 2 and import of good 1, respectively. The maximization problem of the home government gives the following first-order condition:

$$\left[c_{11t}(s)^{1-\frac{1}{\rho}} + c_{12t}(s)^{1-\frac{1}{\rho}}\right]^{\frac{1-\rho}{1-\frac{1}{\rho}}-1} \left[c_{11t}(s)^{-\frac{1}{\rho}}\frac{\partial c_{11t}(s)}{\partial \tau_{12t}(s)} + c_{12t}(s)^{-\frac{1}{\rho}}\frac{\partial c_{12t}(s)}{\partial \tau_{12t}(s)}\right] = 0. \tag{B.23}$$

We can re-write the above equation as:

$$\left(\frac{c_{11t}(s)}{c_{12t}(s)}\right)^{-\frac{1}{\rho}} \frac{\partial x_{11t}(s)}{\partial p_t(s)}\frac{\partial p_t(s)}{\partial \tau_{12t}(s)} = \frac{\partial m_{12t}(s)}{\partial p_t(s)}\frac{\partial p_t(s)}{\partial \tau_{12t}(s)}. \tag{B.24}$$

From the household's maximization problem, we know that the marginal rate of substitution between goods 1 and 2 is:

$$\left(\frac{c_{11t}(s)}{c_{12t}(s)}\right)^{-\frac{1}{\rho}} = \frac{1}{p_t(s)[1+\tau_{12t}(s)]}. \tag{B.25}$$

Substituting the marginal condition (B.25) into (B.24) gives:

$$\frac{1}{p_t(s)[1+\tau_{12t}(s)]}\frac{\partial x_{11t}(s)}{\partial p_t(s)} = \frac{\partial m_{12t}(s)}{\partial p_t(s)}. \tag{B.26}$$

Differentiating the trade balance condition in (B.21) yields:

$$\frac{\partial x_{11t}(s)}{\partial p_t(s)} = p_t(s)\frac{\partial m_{12t}(s)}{\partial p_t(s)} + m_{12t}(s). \tag{B.27}$$

Substitute the above relation into (B.26) and apply the ex-post trade balance constraint (B.21) and market-clearing condition that $m_{12t}(s) = x_{22t}(s)$ to the resulting equation. This will give the expression for the Nash home tariff:

$$\tau^A_{12t}(s) = \left[\frac{\partial x_{22t}(s)}{\partial p_t(s)}\frac{p_t(s)}{x_{22t}(s)}\right]^{-1}. \tag{B.28}$$

The offer curve of the foreign country is the export function of good 2 at the Nash equilibrium. Therefore,

$$\Gamma_2(p_t(s), \tau_{12t}(s), \tau_{21t}(s)) \equiv x_{22t}(s) = \frac{p_t(s)^\rho y_{22t}(s) - [1+\tau_{21t}(s)]^\rho y_{21t}(s)}{p_t(s)^\rho + p_t(s)[1+\tau_{21t}(s)]^\rho}. \tag{B.29}$$

Similarly, the Nash foreign tariff can be derived:

$$\tau^A_{21t}(s) = -\left[\frac{\partial x_{11t}(s)}{\partial p_t(s)}\frac{p_t(s)}{x_{11t}(s)}\right]^{-1}, \tag{B.30}$$

and the offer curve of the home country is the export function of good 1 at the Nash equilibrium. Therefore,

$$\Gamma_1(p_t(s), \tau_{12t}(s), \tau_{21t}(s)) \equiv x_{11t}(s) = \frac{y_{11t}(s) - \{[1+\tau_{12t}(s)]p_t(s)\}^\rho y_{12t}(s)}{1 + p_t(s)^{\rho-1}[1+\tau_{12t}(s)]^\rho}. \tag{B.31}$$

Appendix C

Appendix to Chapter 5

C.1 Comparison of Analytical Results to Sellin and Werner (1993)

We compare some of our analytical results to that in Sellin and Werner to show how the their model is a special case of ours. To make our results comparable to Sellin and Werner's, we assume capital to be the only input to production with constant returns to scale, i.e., $\alpha_i = 1$, for $i = \{1, 2\}$. With this assumption, the Sellin and Werner production economy in which agents choose the investment amount in home and foreign production is equivalent to the Basak endowment economy in which agents make the portfolio choice in home and foreign stocks, which are claims written on the home and foreign endowment, respectively. In our portfolio model with production, constant returns to scale in capital leads to the total investment in home (foreign) production being equal to the price of the claim to the home (foreign) firm. This is because the investment in the initial period is the one-for-one cost of production for the next period's consumption, which can be re-interpreted as the price of the next period's production (if the claim to production is traded). Later in this Appendix, we derive the equivalence between Sellin and Werner's investment model and our portfolio model when production exhibits constant returns to scale in capital.

As in Sellin and Werner, we assume that each household i to have logarithmic preferences ($\eta_i = 1$), that the rate of return to investment in each firm j is driven by an independent Wiener process with a drift of μ_j and a volatility of σ_j, and that there is full depreciation ($\delta_i = 1$). For simplicity, we also assume $\beta_i = 1$. For agents with logarithmic preferences, this assumption means that they will allocate half of the world initial capital stock to the investment for the next period's production. If $\beta_i < 1$, the allocation of investment for the next period's production will be less than half.

Starting from complete financial integration, neither government engages in any of the three restrictive actions on financial markets and the consumption allocation for each household is a constant fraction of the total consumption in each state and period. Using this property of individual consumption and the equivalence of S_j and I_j explained in later in this Appendix, the first-order condition of the portfolio choice (5.11) can be simplified to the following:

$$E\left[\frac{\theta_1(s)I_1}{\theta_1(s)I_1+\theta_2(s)I_2}\right](K_1(0)+K_2(0)-I_1-I_2) = I_1, \tag{C.1}$$

$$E\left[\frac{\theta_2(s)I_2}{\theta_2(s)I_2+\theta_2(s)I_2}\right](K_1(0)+K_2(0)-I_1-I_2) = I_2, \tag{C.2}$$

where (C.1) and (C.2) are the first-order conditions for the portfolio choice in the claim to the home and foreign firm, respectively. The optimal investment ratio is:

$$\frac{I_1}{I_2} = \frac{(\mu_1-\mu_2)+\sigma_2^2}{(\mu_2-\mu_1)+\sigma_1^2} \tag{C.3}$$

In complete financial markets, the allocation of capital is efficient and it depends on the mean and variance of the productivity of each firm. The optimal ratio (C.3) says that more capital is allocated to the production with higher mean and lower variance. In Sellin and Werner, where $\mu_1 = \mu_2$, $\sigma_1^2 = \frac{\sigma^2}{n}$ and $\sigma_2^2 = \frac{\sigma^2}{m}$, the above ratio becomes $\frac{n}{m}$.

The investment decision can be solved in terms of the initial world capital endowment as:

$$I_1 = \frac{1}{1+\Gamma}\left\{\frac{(1+\Gamma)[\Gamma(\mu_1-\mu_2)+(1+\Gamma)]-\Gamma(\sigma_1^2-\Gamma\sigma_2^2)}{(1+\Gamma)[\Gamma(\mu_1-\mu_2)+2(1+\Gamma)]-\Gamma(\sigma_1^2-\Gamma\sigma_2^2)}\right\}K_w(0), \tag{C.4}$$

$$I_2 \quad = \quad \frac{\Gamma}{1+\Gamma}\left\{\frac{(1+\Gamma)[\Gamma(\mu_1-\mu_2)+(1+\Gamma)]-\Gamma(\sigma_1^2-\Gamma\sigma_2^2)}{(1+\Gamma)[\Gamma(\mu_1-\mu_2)+2(1+\Gamma)]-\Gamma(\sigma_1^2-\Gamma\sigma_2^2)}\right\}K_w(0), \qquad \text{(C.5)}$$

where $K_w(0) = K_1(0) + K_2(0)$, which is the world initial capital endowment and $\Gamma = \frac{(\mu_1-\mu_2)+\sigma_2^2}{(\mu_2-\mu_1)+\sigma_1^2}$. The investment decisions simplify to $I_1 = \frac{n}{n+m}\frac{K_w(0)}{2}$ and $I_2 = \frac{m}{n+m}\frac{K_w(0)}{2}$ in Sellin and Werner.

The risk-free rate in this economy is obtained by solving the first-order condition for bond holdings (5.10):

$$\frac{1}{1+r} = (K_w(0) - I_1 - I_2)E\left[\frac{1}{\theta_1(s)I_1 + \theta_2(s)I_2}\right]. \qquad \text{(C.6)}$$

To compare the risk-free rate in our discrete-time model to the instantaneous risk-free rate in Sellin and Werner's continuous-time model, we express the risk-free rate as a continuously compounded rate in this section. The compounded rate can be derived as:

$$r_c = \frac{1}{2}\frac{I_1}{K_w(0)}\left[(\mu_1 + \Gamma\mu_2) - (1+\Gamma) - \frac{\sigma_1^2 + \Gamma^2\sigma_2^2}{(1+\Gamma)}\right]. \qquad \text{(C.7)}$$

where I_1 is given by (C.4). It can be shown that the above equation simplifies to $1 + r_c = \mu - \frac{\sigma^2}{n+m}$ in Sellin and Werner.

The competitive equilibrium asset holdings to this economy are computed to be:

$$s_{11} = \quad s_{12} = \quad \gamma; \qquad \text{(C.8)}$$

$$s_{21} = \quad s_{22} = \quad 1-\gamma; \qquad \text{(C.9)}$$

$$b_1 = \quad b_2 = \quad 0 \qquad \text{(C.10)}$$

where $\gamma = \frac{K_1(0)}{K_w(0)}$. The equilibrium stock holdings chosen by each household is given by its share of the initial world capital, which is interpreted as the size of the country in our model. These results are the same as those presented in Sellin and Werner. Under the assumption that production exhibits constant returns to scale in capital, the price of the home (foreign) stock equals the total investment in the home (foreign) production.

The analytical results presented in this section show that our model is equivalent to Sellin and Werner's model when production exhibits constant returns to scale in capital. We use these results as a base case and also to verify our numerical work when we consider an economy where the production does not exhibit constant returns to scale in capital and the households' preferences utility are not logarithmic.

Equivalence of Investment Model and Portfolio Model

We assume the rate of capital depreciation to be 100% to simplify the presentation. However, the assumption is not necessary to show the equivalence. The budget constraints of the home household in an investment model (Werner and Sellin) are given by:

$$c_1(0) + \sum_{j=1}^{2} I_{1j} + b_1 = \theta_1(0)K_1(0)^{\alpha_1}L_1^{1-\alpha_1}, \tag{C.11}$$

$$c_1(s) = \sum_{j=1}^{2} \theta_1(s) I_{1j}^{\alpha_j} L_j^{1-\alpha_j} + b_1(1+r). \tag{C.12}$$

The budget constraints of the home household in a portfolio model with investment (presented in Section 5.2) are given by:

$$c_1(0) + \sum_{j=1}^{2} s_{1j}S_j + b_1 = [K_1(0)^{\alpha_1}L_1^{1-\alpha_1} - I_1] + S_1, \tag{C.13}$$

$$c_1(s) = \sum_{j=1}^{2} s_{1j}(\theta_j(s) I_j^{\alpha_j} L_1^{1-\alpha_j}) + b_1(1+r). \tag{C.14}$$

For both models to be equivalent, the payout from home (foreign) investment must equal the payout from the portfolio choice in home (foreign) stock for each household. This implies that:

$$\theta_1(s) I_{11}^{\alpha_1} L_1^{1-\alpha_1} = s_{11}(\theta_1(s) I_1^{\alpha_1} L_1^{1-\alpha_1}) \tag{C.15}$$

$$\theta_1(s) I_{21}^{\alpha_1} L_1^{1-\alpha_1} = s_{21}(\theta_1(s) I_1^{\alpha_1} L_1^{1-\alpha_1}). \tag{C.16}$$

Since in a two-country economy the investment of home and foreign households in the domestic production must aggregate to the total investment in the domestic production, the following equality must hold: $I_{11} + I_{21} = I_1$. Using this aggregation equation and the market-clearing condition that $s_{11} + s_{21} = 1$, the sum of (C.15) and (C.16) gives:

$$\theta_1(s)[(I_{11}^{\alpha_1} + I_{11}^{\alpha_1})L_1^{1-\alpha_1}] = \theta_1(s)(I_{11} + I_{21})^{\alpha_1} L_1^{1-\alpha_1}. \tag{C.17}$$

A sufficient condition for the right-hand side to equate to the left-hand side in (C.17) is to set $\alpha_1 = 1$, where the production exhibits constant returns to scale in capital. When $\alpha_1 = 1$, (C.15) and (C.16) imply that $I_{11} = s_{11}I_1$ and $I_{21} = s_{21}I_1$. Substituting these two relations into (C.11) and comparing the result to (C.13), we obtain $S_1 = I_1$.

Derivation of Equations (C.3), (C.4), (C.5), and (C.7)

We apply Ito's Lemma[1] to find the expectation terms in (C.1) and (C.2):

$$E\left[\frac{\theta_1(s)I_1}{\theta_1(s)I_1 + \theta_2(s)I_2}\right] = \frac{I_1I_2[(I_1+I_2)(\mu_1-\mu_2) - (I_1\sigma_1^2 - I_2\sigma_2^2)] + I_1(I_1+I_2)^2}{(I_1+I_2)^3} \tag{C.18}$$

$$E\left[\frac{\theta_2(s)I_2}{\theta_1(s)I_1 + \theta_2(s)I_2}\right] = \frac{I_1I_2[(I_1+I_2)(\mu_2-\mu_1) - (I_2\sigma_2^2 - I_1\sigma_1^2)] + I_2(I_1+I_2)^2}{(I_1+I_2)^3} \tag{C.19}$$

Dividing (C.1) by (C.2), and cross multiplying the terms in the resulting equation, gives:

$$I_1E\left[\frac{\theta_2(s)I_2}{\theta_2(s)I_2 + \theta_2(s)I_2}\right] = I_2E\left[\frac{\theta_1(s)I_1}{\theta_1(s)I_1 + \theta_2(s)I_2}\right] \tag{C.20}$$

$$\begin{aligned} &I_1\{I_1I_2[(I_1+I_2)(\mu_2-\mu_1) - (I_2\sigma_2^2 - I_1\sigma_1^2)] + I_2(I_1+I_2)^2\} = \\ &\quad I_2\{I_1I_2[(I_1+I_2)(\mu_1-\mu_2) - (I_1\sigma_1^2 - I_2\sigma_2^2)] + I_1(I_1+I_2)^2\} \end{aligned} \tag{C.21}$$

Simplifying the above equation gives (C.3).

To obtain (C.4) and (C.5), express I_2 in terms of I_1 using (C.3), substitute the result into either (C.1) or (C.2), and isolate I_1. I_2 can be similarly derived.

[1]To make our model comparable to Sellin and Werner's, we have assumed that the rate of return to investment in each firm j is driven by an independent Wiener process. Hence, we use Ito's Lemma to derive the expectation of the stochastic terms generated from the Wiener process.

We apply Ito's Lemma to find the expectation term in (C.7).

$$E\left[\frac{1}{\theta_1(s)I_1+\theta_2(s)I_2}\right]=\frac{1}{(1+\Gamma)^3 I_1}\{(1+\Gamma)[(1+\Gamma)-(\mu_1+\Gamma\mu_2)]+\sigma_1^2+\Gamma^2\sigma_2^2\}. \quad \text{(C.22)}$$

We can re-express the risk-free rate in (C.7) as a compound rate, r_c, such that:

$$\exp(-r_c)=\exp\left\{[K_1(0)+K_2(0)-I_1-I_2]E\left[\frac{1}{\theta_1(s)I_1+\theta_2(s)I_2}\right]\right\}. \quad \text{(C.23)}$$

Substituting (C.22) for the expectation term in (C.23), and simplifying the resulting expression, gives (C.7).

C.2 Description of the Numerical Method Used to Obtain the Optimal Financial Market Structure

In the economy we consider, there are two stochastic endowment processes. Using He's (1990) technique, we generate trinomial processes for the productivity shocks. This technique generates three states in the economy at time 1. The mean and volatility parameters for each productivity shock process are chosen for the purpose of comparing our numerical results with previous work. To find the competitive equilibrium in an economy with partial financial market segmentation, we impose the appropriate restrictions on s_{ij} for $i, j = 1, 2$. Then we numerically solve the system of first-order conditions (given by (5.10), (5.11), and (5.12)), budget constraints (given by (5.2) and (5.3)), and financial market-clearing conditions (given by (5.18), (5.19) and (5.20)). Finally, we substitute the competitive equilibrium consumption into the respective utility function to obtain the indirect utility of each household.

Bibliography

[1] Baldwin, R., 1969, "The case against infant-industry tariff protection," *Journal of Political Economy*, 77, 295-305.

[2] Barari, M. and H.E. Lapan, 1993, "Stochastic trade policy with asset markets: the role of tariff structure," *Journal of International Economics*, 35, 317-333.

[3] Basak, S., 1996, "An intertemporal model of international capital market segmentation," *Journal of Financial and Quantitative Analysis*, 31, 161-188.

[4] Bhagwati, J. and M.C. Kemp, 1969, "Ranking of tariffs under monopoly power in trade," *Quarterly Journal of Economics*, 83, 330-335.

[5] Brock, W. and S. Magee, 1978, "The economics of special-interest politics: the case of the tariff," *American Economic Review*, 68, 246-250.

[6] Calvo, A., 1988, "Servicing the public debt: the role of expectations," *American Economic Review*, 78, 647-661.

[7] Cole, H., 1988, "Financial structure and international trade," *International Economic Review*, 29, 237-259.

[8] Cole, H. and M. Obstfeld, 1991, "Commodity trade and international risk sharing," *Journal of Monetary Economics*, 28, 3-24.

[9] Devereux, M., 1995, "Growth, specializationand trade liberalization," forthcoming in *International Economic Review*.

[10] Devereux, M and M. Saito, 1997, "Growth and risk-sharing with incomplete international assets markets," *Journal of International Economics*, 42, 453-481.

[11] Devereux, M. and G. Smith, 1994, "International risk sharing and economic growth," *International Economic Review*, 35, 535-550.

[12] Diamond, P., 1967, "The role of the stock market in a general equilibrium model with technological uncertainty," *American Economic Review*, 57, 759-773.

[13] Dixit, A., 1987a, "Strategic aspects of trade policy," in Truman F. Bowley ed., *Advances in Economic Theory: Fifth World Congress*, Cambridge University Press, New York, 329-362.

[14] Dixit, A., 1987b, "Trade and insurance with moral hazard," *Journal of International Economics*, 23, 201-220.

[15] Dixit, A., 1989, "Trade and insurance with adverse selection," *Review of Economic Studies*, 56, 235-248.

[16] Dumas, B., 1980, "The theories of international trade under generalized uncertainty," *Journal of International Economics*, 10, 481-498.

[17] Eaton, J. and G. Grossman, 1985, "Tariffs as insurance: optimal commercial policy when domestic markets are incomplete," *Canadian Journal of Economics*, 18, 258-272.

[18] Ekern, S. and R. Wilson, 1974, "On the theroy of the firm in an economy with incomplete markets," *Bell Journal of Economics and Management Science*, 5, 171-184.

[19] Errunza, V. and E. Losq, 1985, "International asset pricing under mild segmentation: theory and test," *Journal of Finance*, 40, 105-124.

[20] Eun, C. and S. Janakiramanan, 1986, "A model of international asset pricing with a constraint on foreign equity ownership," *Journal of Finance*, 41, 1025-1037.

[21] Feeney, J., 1994, "Goods and asset market interdependence in a risky world," *International Economic Review*, 35, 551-563.

[22] Frenkel, J., A. Razin and E. Sadka, 1991, *International Taxation in an Integrated World*, MIT Press, Massachusetts.

[23] Gardner, W.G. and K.P. Kimbrough, 1992, "Tax regimes, tariff revenues and government spending," *Economica*, 59, 75-92.

[24] Gordon, R.H. and H.R. Varian, 1989, "Taxation of asset income in the presence of a world securities market," *Journal of International Economics*, 26, 205-226.

[25] Grossman, G. and H. Horn, 1988, "Infant-industry protection reconsidered: the case of informational barriers to entry," *Quarterly Journal of Economics*, 103, 767-787.

[26] Grossman, G. and A. Razin, 1985, "The pattern of trade in a Ricardian model with country-specific uncertainty," *International Economic Review*, 26, 193-202.

[27] Gultekin, M., B. Gultekin and A. Penati, 1989, "Capital controls and international captial market segmentation: the evidence from Japanese and American Stock Markets," *Journal of Finance*, 44, 849-869.

[28] Halliday, L., 1989, "The international stock exchange directory," *Institutional Investor*, March, 194-204.

[29] He, H., 1990, "Convergence from discrete to continuous-time contingent claims prices," *The Review of Financial Studies*, 3, 523-546.

[30] Helpman, E. and A. Razin, 1978a, *A Theory of International Trade under Uncertainty*, New York, Academic Press.

[31] —, 1978b, "Uncertainty and international trade in the presence of stock markets," *Review of Economic Studies*, 45, 239-250.

[32] —, 1978c, "Welfare aspects of international trade in goods and securities," *Quarterly Journal of Economics*, 92, 489-508.

[33] —, 1978d, "The protective effect of a tariff under uncertainty," *Journal of Political Economy*, 86, 1131-1141.

[34] Hillman, A., 1989, *The Political Economy of Protection*, Harwood Academic, New York.

[35] Johnson, H.G., 1953, "Optimum tariffs and retaliation, " *Review of Economic Studies*, 21, 142-153.

[36] Kennan, J. and R. Riezman, 1988, "Do big countries win tariff wars?" *International Economic Review*, 29, 81-85.

[37] Krueger, A. and B. Tuncer, 1982, "An empirical test of the infant industry argument", *American Economic Review*, 72, 1142-1152.

[38] Laird, S. and A. Yeats, 1989, "Nontariff barriers of developed countries, 1966-1986," *Finance and Development*, 26, 12-13.

[39] Lewis, K., 1996, "Consumption, stock returnsand the gains from international risk-sharing," NBER working paper 5410.

[40] Lucas, R., 1982, "Interest rates and currency prices in a two-country world," *Journal of Monetary Economics*, 10, 336-360.

[41] Magee, S.P., 1994, "The political economy of trade policy," in *Surveys in International Trade*, in D. Greenaway and L.A. Winters, eds., Blackwell, Oxford, 139-176.

[42] Magee, W., W. Brock and L. Young, 1989, *Blackhole tariffs and endogenous policy theory*, Cambridge University Press, New York.

[43] Mayer, W., 1981, "Theoretical considerations on negotiated tariff adjustments," *Oxford Economic Papers*, 33, 135-153.

[44] Mayer, W. and R. Riezman, 1987, "Tariff formations in political economy models," *Conference on Political Economy*, World Bank, Washington, D.C.

[45] McMillan, J., 1986, *Game Theory in International Economics*, Harwood Academic Publishers, London.

[46] Meade, J., 1955, *Trade and Welfare*, Oxford University Press, London.

[47] Mendoza, E., 1995, "The terms of trade, the real exchange rate and economic fluctuations," *International Economic Review*, 36, 115-121.

[48] Obstfeld, M., 1994, "Risk-taking, global diversification and growth," *American Economic Review*, 84, 1310-1329.

[49] Obstfeld, M. and K. Rogoff, 1996, *Foundations of international macroeconomics*, The MIT Press, Massachusetts.

[50] Riezman, R., 1991, "Dynamic tariffs with asymmetric information," *Journal of International Economics*, 30, 267-283.

[51] Riley, J.G., 1970, "Ranking of tariffs under monopoly power in trade: an extension," *Quarterly Journal of Economics*, 84, 710-712.

[52] Sellin, P. and I.M. Werner, 1993, "International investment barriers in general equilibrium," *Journal of International Economics*, 34, 137-151.

[53] Sercu, P. and R. Uppal, 1995, "Exchange rate volatility and trade: a general equilibrium analysis," NBER.

[54] Sercu, P., R. Uppal and C. Van Hulle, 1995, "The exchange rate in the presence of transaction costs: Implications for tests of Purchasing Power Parity," *Journal of Finance*, 50, 1309-1319.

[55] Staiger, R. and G. Tabellini, 1987, "Discretionary trade policy and excessive protection," *American Economic Review*, 77, 823-837.

[56] Stockman, A., 1987, "Some interactions between goods and asset markets in open economies," in S. Arndt and D. Richardson, eds., *Real-Financial Linkages among Open Economies*, Cambridge, MIT Press.

[57] —, 1988, "On the roles of international financial markets and their relevance for economic policy," *Journal of Money, Credit and Banking*, 20, 531-549.

[58] Stockman, A. and H. Dellas, 1986, "Asset markets, tariffs and political risk," *Journal of International Economics*, 21, 199-213.

[59] Stockman, A. and A.D. Hernandez, 1988, "Exchange controls, capital controls and international financial markets," *American Economic Review*, 78, 362-373.

[60] Stockman, A. and L. Tesar, 1990, "Tastes and technology in a two-country model of business cycle: explaining international co-movements," National Bureau of Economic Research (Cambridge, MA) Working paper no. 3566.

[61] Summers, R. and A. Heston, 1991, "The Penn World Table (Mark 5): An expanded set of international comparisons," 1950-1988, *Quarterly Journal of Economics*, 327-368.

[62] Tesar, L., 1995, "Evaluating the gains from international risk-sharing," *Carnegie Rochester Conference Series on Public Policy* 42, 95-143.

[63] Uppal, R., 1992, "Deviations from purchasing power parity and capital flows," *Journal of International Money and Finance*, 11, 126-144.

[64] Van Wincoop, E., 1996, "How big are potential welfare gains from international risk-sharing?" mimeo, Boston University.

[65] Vousden, N., 1990, *The Economics of Trade Protection*, Cambridge University Press, New York.

[66] Wei, S.J., 1996, "How reluctant are nations in global integration?" mimeo, Harvard University.

[67] Wildasin, D. and J. Wilson, 1991, "Theoretical issues in local public economics: an overview," *Regional Science and Urban Economics*, 21, 2317-331.