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Asset markets, stochastic policy and international trade

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Asset markets, stochastic policy and international trade

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Asset markets, stochastic policy and

international trade

by

Mahua Barari

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To Saibal

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I. INTRODUCTION AND REVIEW OF LITERATURE

A. Introduction

The essential elements of the modern theory of international trade were originally formulated by the Swedish economist Eli Hecksher and further developed by his student Bertil Ohlin. Since its appearance in the early thirties, Hecksher Ohlin theory has received close scrutiny from many economists who have refined and extended the basic premise. However, for many years, no systematic analysis was made of the impact of uncertainty on trade and specialization. The pioneering research in this area was initiated by Brainard and Cooper (1968). In a descriptive paper they explained why uncertainty (about trading prices) plays an important role in influencing economic behavior and how the pure theory of trade can be modified to take this uncertainty into account. Since then the literature on trade under uncertainty has become a growth industry and it is still an active field of research.

In spite of the fact that uncertainty calls for financial markets that explicitly provide risk sharing opportunities, and such markets are indeed established in reality, none of the earlier models considered either local or international financial markets.[1] It was Helpman and Razin

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[1]The only exception is Kemp & Liviatan who considered domestic Arrow Debreu contingent commodity markets.

(1978) who first felt the need to seriously integrate the theory of financial markets into the theory of international trade. In an economy with stock markets, they investigated the interaction between ex post trading in goods and ex ante trading in firm ownership shares and their implications for resource allocation. Since then, several economists have pursued this approach and slowly trade theory under uncertainty has become intertwined with finance theory. The positive and normative implications of Hecksher Ohlin trade theory have been reexamined in an uncertain world with international financial markets.

The earlier models considered several sources of uncertainty. For instance, uncertainty in preferences or technology leading to uncertain terms of trade or uncertainty in terms of trade without reference to more basic causes were all examined. It was not until recently that it was recognized that one of the fundamental sources of uncertainty may be the government policy itself. Policy may or may not change and there are probability distributions attached to it. The current trend in research is explicitly modelling this uncertainty as opposed to older models which ignored it. More important, the new breed of models is considering the impact of rapidly growing financial markets on the effects of uncertain government policy.

It turns out that these recent models can address policy issues more effectively. In a deterministic setting, to investigate the effects of exogenous change in government policy, the economist contrasts two alternative economies with different policies, the implicit assumption

being that it is _possible_ to change policies. Such possibility, when

recognized by the economic agents, creates a risk that may be termed as

"policy risk." When the risk-averse individuals know that there is a

possibility that a policy change will occur, they have incentives to insure

the risks they face. The availability of financial markets explicitly

provides risk sharing opportunities by permitting individuals to transfer

resources over time as well as across states of nature. Consequently,

opportunities to trade in these markets alter the responses of the economy

to changes in government policies, if such a change occurs. In view of

this, the earlier models that ignore policy risks and/or the role of

financial markets[2] in mitigating these risks may give rise to

inappropriate comparative static results.

Pioneering research in this area has been undertaken by Alan

Stockman (1986,1987,1988a,1988b,1988c). The primary focus of his research

has been to investigate interesting policy issues in the area of

international finance in the presence of financial markets. Only in one of

the studies, Stockman and Dellas (1986) provide example of a random tariff

policy. Based on my literature review, it is the Stockman and Dellas (S-D

from now on) paper which first addressed the role of financial markets for

trade policy under conditions of uncertainty.

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[2]It is important to emphasize here that the absence of financial
markets (or their limited availability) does not eliminate the ability of
economic agents to deal with risk completely. They switch over to
alternative, imperfect ways of reallocating risk across states of nature.
This is reflected in the composition of production, level of consumption
and savings, level of labor supply than would have occurred in models that
ignore policy uncertainty altogether.

In their model, it is the exogenous "political risk" which creates uncertainty about tariffs. Political risk, in turn, is thought to arise from uncertainty that results from the political process. Using a simplified two good, two country stochastic general equilibrium model where the agents trade in contingent commodity claims, S-D show that the relationship between consumption and import tariffs in their model differs radically from the relations predicted by standard trade models without political risk or asset markets. Instead of consuming more with a domestic import tariff that improves the terms of trade, a country consumes less in states of the world in which it imposes a tariff, and consumes more in states in which the other country imposes an import tariff. They attribute these counter intuitive results to the ability of households to insure against random government policy via asset markets.

B. Objective of The Present Study

The study of stochastic trade policy in conjunction with finance theory is an exciting and relatively new area of research. The neglect of financial markets in earlier trade models may have been justified on the ground that these markets were at their initial stages of development. However, due to the improved technology of communications and fewer government restrictions, financial markets have developed rapidly in the past decade, both in sophistication and scope. In view of the growing integration of international financial markets, we feel that it has become

essential to incorporate risk sharing opportunities explicitly as provided by these markets when analyzing effects of random government policy.

The attempt made by S-D in this regard deserves considerable praise. We find the main theme of their paper interesting and thought provoking. However, the S-D type of framework raises more questions than it answers. We have made an attempt in the present study to pursue some of these issues with the help of our own theoretical framework.

The first question that comes to mind concerns the role of tariff structure in a stochastic world with asset markets. How sensitive are S-D conclusions to the choice of export versus import tariffs? In the standard deterministic framework, such a distinction is irrelevant since both the export and import tariffs affect the domestic relative commodity prices in the same direction and by the same magnitude. This was first pointed out by Lerner (1936) and is commonly referred to as the <u>Lerner symmetry theorem</u> in the trade literature. We show in this study that Lerner's notion of equivalence between export and import tariffs does not necessarily extend to a stochastic framework with asset markets.

Since Lerner's symmetry theorem is at the heart of many important results in trade theory, the non-equivalence of export and import tariffs in a stochastic framework is likely to give rise to important positive and normative implications. We examine some of these implications in the present study and find that S-D results are sensitive to the <u>composition of tariffs</u>. For example, S-D conclusions are completely reversed if an equal export tariff is used instead of an import tariff in their model, i.e., the

standard policy implications are retained in this case. Further, the optimal composition calls for <u>both</u> export and import tariffs, given some arbitrarily chosen effective protection (of any composition of export and import tariffs) sought by the domestic government and the foreign tariff vector.

Since the welfare ranking of alternative policies has played a key role in furthering our understanding of commercial policy, it also seems appropriate to investigate the nature of optimal policy in a stochastic framework with asset markets. This, in turn, requires an extension of S-D type of framework to endogenize tariff policy by postulating the fundamental sources of uncertainty in government policy. We make endowments random and assume that tariffs are chosen optimally. We argue that the first best policy in such a setup calls for both export and import tariffs. Further, with the help of simulation results, we also demonstrate that the introduction of asset markets need not always be welfare improving, although there exists potential gains from trading in these markets.

In our setup where private decisions are made in two stages due to the presence of spot markets (for instance, first financial decision and then consumption decision), the government may have an incentive to alter tariff level ex post once financial decisions are in place. Hence, <u>time consistency</u> issues are germane to our framework. We find that the financial structure plays an important role in determining the time consistent policy ex post. We also compare the time consistent tariff

policy with the precommitment tariff policy under alternative tariff structure in this study and present some preliminary results.

The plan of this study is as follows. Since Arrow (1964) first laid out clearly the principles of optimality under uncertainty, we begin Chapter I by reviewing the Arrow-Debreu contingent commodity claims or financial claims markets. The related concept of completeness versus incompleteness of financial markets is also discussed. This is followed by a brief review of literature on trade models under conditions of uncertainty with asset markets. In chapter II, Stockman and Dellas framework is formally introduced, since our study builds upon and extends such a framework. In Chapter III, we present our own theoretical framework and formally derive the condition under which Lerner's symmetry theorem will hold. The positive and normative implications of non-equivalence (of export and import tariffs) are also worked out. We relax the assumption of exogenous tariffs in Chapter IV and discuss the nature of optimal policy under alternative tariff structure and with or without asset markets. In Chapter V, the potential time consistency issues inherent in such a framework are addressed. We also compare precommitment and time-consistent tariff policies and present simulation results in support of our claims. In Chapter VI, we provide concluding remarks and suggest possible ways of extending the current research.

C. Arrow-Debreu Contingent Claims Markets

In his pathbreaking article, Arrow (1964) addressed the issue of optimal allocation of resources under uncertainty. His discussion was confined to a pure exchange economy though he admitted that adding a production side would not be difficult. His approach was elaborated later by Debreu who also considered production decisions explicitly.

The novelty of Arrow's approach lay in introducing an ingenious device whereby commodities are distinguished not only by their physical characteristics, location and dates of their availability, but also by the state of nature in which they are consumed.[3] In the literature such goods are referred to as <u>state contingent commodities</u> or simply contingent commodities. By virtue of this characterization, the list of commodities is greatly expanded compared to the corresponding case of certainty. What Arrow showed is that under certain conditions, this new definition of commodities allows one to obtain a theory of uncertainty free from any probability concept and formally identical with the theory of certainty. This is illustrated below with the help of an Arrow type pure exchange economy.

Let us consider an economy which consists of H individuals. Let

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[3]We abstain from the discussion of the location at which delivery takes place and the date when delivery takes place so as to highlight the significance of state of nature.

there be N commodities and S states of nature. Suppose $e_i{}^h(\alpha)$ denotes individual h's endowment of good i in state α. Also let $c_i{}^h(\alpha)$ be her consumption of good i in state α, i.e., the amount of commodity i claimed by individual h if state α occurs. Then $c^h(\alpha)$ represents her consumption vector such that

$$c^h(\alpha) = [c_1^h(\alpha) \ldots \ldots c_N^h(\alpha)]$$

Let individual h's tastes be represented by a utility function $u^h[c^h(\alpha)]$. $u^h(.)$ is assumed to be a concave function exhibiting risk aversion. $\pi^h(\alpha)$ is individual h's subjective probability assessment of state α. Then expected utility of individual h is written as

$$W^h[c^h(1) \ldots \ldots c^h(S)] = \sum_\alpha \pi^h(\alpha) u^h[c^h(\alpha)]$$

Efficiency in consumption entails solving the following optimization problem:

$$\underset{c^h(1) \ldots \ldots c^h(S)}{\overset{Max}{}} \quad W^1[c^1(1) \ldots \ldots c^1(S)]$$

subject to

$$W^h[c^h(1) \ldots \ldots c^h(S)] = \overline{W}^h; \quad \forall h = 2 \ldots \ldots H$$

and

$$\sum_h c_i^h(\alpha) = \sum_h e_i^h(\alpha) \quad \forall i = 1 \ldots N; \quad \alpha = 1 \ldots S$$

Solving this system, one gets $c_i{}^{h*}(\alpha) = c_i{}^h[\overline{W}^h, \Sigma_h e_i{}^h(\alpha)]$. This is analogous to the certainty case. However the number of goods in this case

is SN instead of N in the certainty model. Moreover, the optimal allocation of resources reflects an ex ante Pareto optimum, since in this modified set up it is impossible to make someone better off in expected utility sense without making someone else worse off again in expected utility sense.

What Arrow showed is that if there exists markets for claims on all contingent commodities (i.e., SN number of markets in this example) and the same general caveats hold as under certainty; (i.e., no externality or no market power) then this optimal allocation of risk bearing can be achieved by a system of perfectly competitive markets in claims on commodities. This is illustrated below using the model described above.

Let $g_i(\alpha)$ be the unit price of a claim to good i to be delivered in state α. Then individual h's decision making problem is as follows:

$$\underset{c^h(1)\dots c^h(S)}{Max} \quad W^h[c^h(1)\dots\dots c^h(S)]$$

subject to

$$\sum_\alpha \sum_i g_i(\alpha) c_i^h(\alpha) \le \sum_\alpha \sum_i g_i(\alpha) e_i^h(\alpha)$$

Similar optimization problems faced by other individuals give rise to their respective consumption vectors. Finally, the goods market clearing condition is given by

$$\sum_h c_i^h(\alpha) = \sum_h e_i^h(\alpha); \quad \forall i=1\dots N; \quad \alpha=1\dots S$$

which in turn determines $g_i(\alpha)$. Such a competitive system as postulated by

Arrow leads to a Pareto optimal allocation of resources.

However, it is unlikely in the real world that the individuals will precommit their endowments to consumption before uncertainty is resolved. Instead, the allocation of risk bearing is more often accomplished by trading in financial contracts and the real asset income is measured in units of the numeraire good. In Arrow's terminology, an "elementary" security of α th type is a claim paying one unit of the numeraire good if state α occurs and nothing otherwise. There exists precisely as many securities as number of states of nature. Then any security may be regarded as a linear combination of the elementary types.

The trade in financial contracts[4] takes place before uncertainty is resolved. Once a particular state of nature occurs, trade in commodities takes place. In such a framework, Arrow showed that the same optimal allocation of resources (as obtained under contingent commodity claims markets) can also be achieved via perfect competition on both the financial contracts and commodities markets.

In contrast to the earlier case, individual h now faces a two stage decision making process. In line with dynamic programming, the second stage of the decision making process is usually considered first. Once state α is realized, individual h solves the following optimization problem:

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[4]In order to be consistent with the terminology used in the subsequent chapters, the term "financial contracts" is used instead of "securities" from now on.

$$\underset{c_1^h(\alpha)\ldots\ldots c_N^h(\alpha)}{Max} \quad U^h[c^h(\alpha)]$$

subject to

$$\sum_I p_I(\alpha) c_I^h(\alpha) \le \left[\sum_I p_I(\alpha) e_I^h(\alpha) + A^h(\alpha)\right]$$

where $A^h(\alpha)$ is the real asset income that accrues to individuals on trading financial contracts and $p_i(\alpha)$ is the spot price of commodity i in state α. The solution yields the indirect utility function as $V^h(\alpha)$.

Proceeding backwards, the individual h takes her financial decision in the first stage as follows.

$$\underset{A^h(1)\ldots.A^h(S)}{Max} \quad \sum_\alpha \pi^h(\alpha) V^h[p(\alpha); A^h(\alpha) + p(\alpha) e^h(\alpha)]$$

subject to

$$\sum_\alpha q(\alpha) A^h(\alpha) \le 0$$

where $q(\alpha)$ denotes the price of an elementary financial contract α. As before, the equilibrium prices of commodities and financial contracts are then determined using the respective market clearing conditions.

The crucial link between the contingent commodity claims models vis-a-vis the financial contracts models is provided by the following relation:

$$q(\alpha) p_I(\alpha) = g_I(\alpha)$$

An individual, confronted with these prices, has the same range of alternatives available in either case. In the contingent commodity claims markets, she can effectively acquire a unit of commodity i in state α by

paying $g_i(\alpha)$. In the markets for financial contracts, she can effectively acquire a "claim" to a unit of commodity i in state α by paying $q(\alpha)p_i(\alpha)$. The social significance of the latter lies in the fact that it permits economizing on markets. Now there are only (N+S) markets instead of NS number of contingent markets earlier.

A close examination reveals that the only way the two systems will enable individuals to consume the same bundle of contingent commodities is if their price expectations are correct under financial contracts; i.e., individuals can correctly foresee the structure of future spot prices of commodities. There is no obvious mechanism in Arrow's model which would guarantee so. So trading in financial contracts may not be sufficient in practice for Pareto optimality in the presence of uncertainty. This point was first raised by Radner (1970).

Complete Versus Incomplete Financial Markets

At this point it would be appropriate to introduce the concepts of complete versus incomplete financial markets. The market structure as envisaged by Arrow is said to be complete. In other words, if there exists markets for claims on all contingent commodities or there exists as many financial contracts as states of nature (and agents price expectations are correct), the resulting financial market structure is termed "complete." It is true that one may have a complete market system even if there are no Arrow type elementary contracts. What is important is to have sufficiently diverse contracts in adequate numbers so that by an appropriate combination

of them an investor is able to assure herself of a unit return in a particular state of nature and zero return in all other states of nature. As it turns out, this is possible if there exists as many contracts as states of nature with linearly independent payoff structure. From the above discussion it is apparent that an uncertain world with complete market structure is essentially analogous to an appropriate deterministic competitive world with redefined goods. Hence such an uncertain world is easy to model and the complete market structure is usually used as a useful benchmark case in many studies which explicitly incorporate risk sharing opportunities.

Unfortunately, Arrow's world is an idealized environment. Despite the rapid growth of financial markets in recent years, such wide varieties of contracts as required for a complete financial structure rarely exist in reality. Due to informational difficulties related to "moral hazard" or "adverse selection" and/or various government restrictions prevailing in financial markets, some insurance market or other is usually missing. In view of this, optimality under uncertainty which presupposes a complete financial structure is intuitively less plausible. And when the financial structure is incomplete, the existing markets no longer reveal an objective price for every good in every state which can be conveniently used by all market participants to evaluate their consumption or production plans. Instead the risk prices become subjective and vary from one investor to another. In such a set up, the optimality principles of the standard deterministic world can no longer be retained.

To sum up, the complete market assumption is invoked for its analytical simplicity. But an incomplete market assumption describes the real world better. In the present study, we have used Arrow-Debreu type complete markets to model the financial structure. We feel that although such an assumption is unrealistic, even more so is the common assumption that there are no markets for contingent claims.

D. Review of Literature

Helpman and Razin (1978), for the first time, felt that it is only natural to consider trade theory under uncertainty in the presence of financial markets because of the risk sharing arrangements that they explicitly provide. In their book, they laid the groundwork by extending the standard trade models to a world of uncertainty where international risk-sharing is allowed to take place.

In the Helpman and Razin model, uncertainty is generated by random production technology and reflected in random world prices. The random elements produce an incentive to develop financial markets. The only way the investors can spread risk in their model is by holding securities issued by the firms. Hence Helpman and Razin essentially had an "incomplete" financial market in their mind. Firms, which act in the interest of their shareholders, choose input levels by maximizing their net value on the stock market. The consumers face a two stage decision making process. In the first stage, before the resolution of uncertainty, they

choose their optimal portfolio by trading in the stock market. In the second stage, after uncertainty resolves, individuals use the proceeds from portfolios to purchase commodities.

In this backdrop, Helpman and Razin reassessed the positive and normative implications of standard trade models once again. The main theme that emerges from their analysis is this: most of the propositions of standard deterministic trade theory do carry over to uncertain environments if international trade in securities is allowed. Their conclusions directly contradicted the predictions of earlier trade models (for example, see Batra, 1975) under uncertainty which did not take asset markets into account explicitly. As Helpman and Razin aptly pointed out, this could be due to the fact that these earlier models were "closed" from a very important aspect. Each country's production decisions were tied to its consumption decisions in the absence of financial markets. This is in direct contrast to standard trade theory under certainty, where given commodity prices, a country's production decisions are independent of its consumption decisions.

Dumas (1980) explained that the only reason Helpman and Razin could extend the basic trade theorems to an uncertain environment is because of the restrictive nature of the production function that they assumed. Uncertainty is introduced into the production function through a random multiplicative term, known in the literature as "scalar" uncertainty. When the technology is of this form, output of the same commodity in different states is always produced in constant proportions regardless of the input

combination. The price of this composite good is state independent and defined as the weighted sum of individual state prices, weighted by the random multiplicative terms. The trade theorems are then easily verified with composite price playing the role of "certain" output price. In an alternative analysis, Dumas extended the trade theorems for the case of "generalized uncertainty" where the production function was fully random. However, the financial structure was assumed complete. In this backdrop, he concluded that the basic propositions can be easily extended to generalized technological uncertainty.

In a recent paper, Grinols (1985a) has observed that just as "scalar uncertainty" is crucial to Helpman and Razin analysis (as aptly pointed out by Dumas), so is the assumption of complete financial markets to Dumas analysis. Both these assumptions are made for analytical simplifications. As it turns out, the models resulting from either assumption reduce to standard deterministic models of competitive equilibrium, with appropriate reinterpretation. In an alternative framework of incomplete market structure with generalized technological uncertainty, Grinols has reexamined the fate of the trade theorems once again. His analysis shows that whether the basic propositions of standard trade theory can be extended or not will depend on the extent of risk sharing opportunities available.

Grinols (1985b) also put the theory of commercial policy in perspective by incorporating the risk sharing opportunities explicitly. In his view, commercial policy no longer operates solely through its effect on

prices and incomes; but also through its effect on foreign ownership income or through the use of monopoly power in risk markets. A traditional optimal tariff which achieves gains for a nation at the expenses of its trading partner may no longer be appropriate if the assets of that trading partner are partly owned by the domestic investors. The gains in current terms of trade improvements must then be weighed against the gains (losses) in foreign assets and policies must be reevaluated. Moreover, a small country in commodity markets may still gain from an optimal tariff on equity trade if it is large relative to the world financial markets.

This last issue has been pursued by Varian (1988) where he has derived a general formula for an optimal tariff and then applied it to the optimal taxation of internationally traded financial assets. It turns out that the size of the tax is directly proportional to the riskiness of the foreign assets and the degree of risk aversion of the exporting country. The more risk averse a country is, the more anxious it is to shift its risk and therefore the more susceptible it is to exploitation by the other country. However, the gains from exploitation rapidly diminish as the number of participants increases.

In another very recent paper, Cole (1988) has studied the relationship between the structure of financial markets and the key macro variables in a simple general equilibrium model of trade. In particular, he has looked at the effects of changes in the degree of completeness of financial markets upon the variance and covariance of consumption, output and trade balance. The distinguishing feature of his model lies in using the utility

maximizing approach along with the representative agent paradigm. Uncertainty arises from a random technology and is of the multiplicative type. As financial markets become more complete, the agents are better able to diversify the risks associated with production shocks. Hence with an increasing degree of completeness, the variability of consumption decreases, the covariance between domestic and foreign consumption increases and the variability of output increases. As a result, the effect on the trade balance is ambiguous. In short, his results suggest that one way to obtain a measure of change in the completeness of international financial markets would be to examine how the variance - covariance structure of national output and consumption series were changing.

E. Summary

In short, we emphasize that the area of trade in conjunction with finance is appealing and thought provoking. Given the increasing openness of domestic financial markets and the expanding variety of financial assets being traded in recent years, trade modelling under uncertainty now explicitly requires modelling risk sharing using various structures of financial markets available. A decade ago Helpman & Razin felt that most of the positive and normative implications of standard trade theory would easily extend to a stochastic environment as long as international trade in securities is allowed. Later Grinols pointed out that the international trade in securities is not important per se other than that it equalizes

risk prices across countries. For that, what is needed is a complete financial market structure. The effect of varying degrees of completeness of international financial markets on key real variables has been analyzed in detail by Cole. In an attempt to explain the prevailing practice by many governments to discourage international portfolio diversification, Varian has invoked the optimal tariff formula and applied it to the taxation of foreign assets. Yet the impact of financial markets on trade theory and policy is a relatively unexplored area and there is scope for future research.

One common feature of all these studies mentioned above is that uncertainty is generated by the production side. In none of these studies is explicit reference made to policy uncertainty. Yet a random government policy is as much a fact of reality as random technology or preferences. Governments may or may not impose tariffs and there are probability distributions attached to those actions. Hence we focus on policy uncertainty in the present study. Based on my literature review, only Stockman & Dellas (1986) has analyzed the impact of random policy in the context of a general equilibrium trade model with "complete" financial markets. A detailed description of their framework is provided next.

II. STOCKMAN AND DELLAS FRAMEWORK

Since the present study builds upon and extends the Stockman-Dellas type of framework, we sketch out an outline of their model in this chapter.

A. Stockman-Dellas Model

S-D model has two distinguishing features. One, it recognizes that one of the fundamental sources of uncertainty lies in the government policy itself. Policy may or may not change and there are probability distributions attached to it. Second and more important, it considers the impact of rapidly growing financial markets on the effects of government policy. As it turns out, the explicit consideration of financial markets may reverse the policy implications of traditional models.

S-D examine the effects of changes in random but exogenous import tariffs on consumption levels ex post and hence realized utility levels. They perceive policy uncertainty to arise from the uncertain political process and hence term the risk associated with policy change as "political risk." The agents, in their model, trade in Arrow-Debreu contingent commodity claims to insure the policy risk they face. The main theme that emerges from their analysis is that in a world with asset markets, economists should not be surprised if the relationship between consumption and import tariffs differs from the predictions of standard trade theory

without asset markets. In their example with complete asset markets, a country consumes more in states in which it does not impose any import tariff and the foreign country does impose tariffs.[5]

Assumptions

To demonstrate their results, S-D use a two country (both large), two good general equilibrium model. They call these goods X and Y. Some simplifying assumptions are made at the outset. It is an exchange economy. $\bar{X}$ and $\bar{Y}$ denote the endowments of these goods in the home country. Similarly $\bar{X}^*$ and $\bar{Y}^*$ denote the foreign endowment levels. The endowment levels are assumed state independent and symmetric with respect to each other, i.e.,

$$\bar{X} = \bar{Y}^*; \quad \bar{Y} = \bar{X}^* \quad \rightarrow \quad X^w = Y^w$$

where X^w and Y^w represent the world endowment levels of good X and Y respectively. There is a representative consumer in each country and tastes are identical across countries. Hence trade occurs due to differing endowments. It is assumed that $\bar{X} > \bar{Y}$ implying that the home country is always an exporter of X and importer of Y.

The domestic country imposes an import tariff at the rate r, if at

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[5]In another section of their paper, S-D investigate the effects of changes in the probability that a tariff will be imposed. Their second conclusion (on which they do not put as much emphasis) is that a large country benefits, in expected utility sense, by a higher probability of domestic tariff and a lower probability of foreign tariff. This result emerges from their assumption that the probability is not itself viewed as a random variable by the agents.

all. Similarly, r^* is the foreign import tariff rate, when imposed. They assume $r = r^*$. To investigate the effects of possible changes in tariff policy, they consider four alternative outcomes of a one time change in the level of tariffs as indicated in the table below.

Table 2.1   Four-state world in Stockman-Dellas model

	States of Nature			
	0	1	2	3
Home	0	r	0	r
Foreign	0	0	r	r

The probability of occurrence of each of these states is given exogenously. π_i is the probability with which any state i occurs. It is assumed that $\pi_i = \pi \ \forall \ i$. Also the utility function is assumed such that $U(x,y) = U(y,x)$ where lowercase x and y reflect the consumption level of these two goods in the home country. All these assumptions taken together imply that the domestic and foreign country behave symmetrically with respect to each other in states 1 and 2 and identically in states 0 and 3.

In S-D model, the economic agents have access to complete financial markets where trading takes place in Arrow Debreu type contingent commodity claims. Payments for such claims are made only in state 0 in units of good X. The risk-averse, expected utility maximizing individuals participate in the financial markets to smooth income fluctuations across states of nature arising from a policy change, i.e., to "sell" increased income in good

states and to "buy" income in adverse states that offset losses in those

states. The optimal portfolio allocation is obtained on solving the

following optimization problem:

Exact Optimization Problem

The representative agent in the __home country__ chooses the optimal

consumption levels as follows:

$$\underset{x_i, y_i}{Max} \quad \sum_{i=0}^{3} \pi_i U(x_i, y_i)$$

subject to

$$\sum_{i=0}^{3} p_i(\overline{X} - x_i) + \sum_{i=0,2} q_i(\overline{Y} - y_i) + \sum_{i=1,3} q_i(1+\tau)(\overline{Y} - y_i) - \tau \sum_{i=1,3} q_i\overline{(Y - y_i)} = 0$$

where p_i is the relative price of X in state i in the offshore market in

terms of X in state 0; q_i is the relative price of Y in state i in terms of

X in state 0.

The representative agent in the __foreign country__ solves a similar

optimization problem:

$$\underset{x_i^*, y_i^*}{Max} \quad \sum_{i=0}^{3} \pi_i U(x_i^*, y_i^*)$$

subject to

$$\sum_{i=0}^{3} q_i(\overline{Y}^* - y_i^*) + \sum_{i=0,1} p_i(\overline{X}^* - x_i^*) + \sum_{i=2,3} p_i(1+\tau)(\overline{X}^* - x_i^*) - \tau \sum_{i=2,3} q_i\overline{(X^* - x_i^*)} = 0$$

The budget constraints need some explanation. The settlement of

contingent commodity claims takes place in an off-shore market. When the

agents <u>sell</u> contingent claims and <u>make</u> delivery if a certain state occurs, they find it cheaper to deliver in terms of their <u>export</u> good. Similarly, when they <u>buy</u> contingent claims and <u>receive</u> delivery, they prefer bringing it in terms of their <u>import</u> good. Hence the first term on each budget constraint represents the state dependent payments that accrue to the typical agent in each country on selling contingent claims. The second and third term, on the other hand, denote the payments she makes by purchasing the claims. Furthermore, the final term in each budget equation indicates the tariff revenue which is rebated back to the people in each country in a lump-sum fashion. The bar indicates that the representative consumer takes this refund as given while choosing her portfolio.

Finally, the spot relative prices are solved using the goods market equilibrium conditions as follows.

$$X^w = \bar{X} + \bar{X}^* = x_i + x_i^* \quad \forall i$$

$$Y^w = \bar{Y} + \bar{Y}^* = y_i + y_i^* \quad \forall i$$

The symmetry assumptions about endowments, tariff levels and probabilities simplify the solution procedure to a great extent. In particular, these symmetry assumptions imply

$$q_0 = p_0 = 1; \quad q_3 = p_3; \quad q_2 = p_1; \quad q_1 = p_2$$

$$x_0 = y_0 = x_0^* = y_0^*; \quad x_3 = y_3^*; \quad y_3 = x_3^*$$

$$x_1 = y_2^*; \quad y_1 = x_2^*; \quad x_2 = y_1^*; \quad y_2 = x_1^*$$

From these symmetry conditions, it follows that there are only three

independent relative prices to solve for, namely p_1, p_2 and p_3. On solving

the system of first order conditions, it turns out that the optimal

portfolio investment radically alters the covariation of consumption and

tariffs. A country consumes more in states of the world in which the other

country imposes a tariff than in states in which it does.

B. Stockman-Dellas Results

S-D illustrate their point with the example of a log utility function.
The preferences of the home country agent are given by

$$U(x, y) = \ln(x) + \ln(y)$$

On solving the optimization problems as outlined above, the optimal home
consumption levels ex post can be obtained as follows.

$$x_0 = x_1 = \frac{X^v}{2}; \quad x_2 = x_3 = X^v \frac{(1+\tau)}{(2+\tau)}$$

$$y_0 = y_2 = \frac{X^v}{2}; \quad y_1 = y_3 = \frac{X^v}{(2+\tau)}$$

Comparing these consumption levels across states of nature, it can be seen
that for this example,

$$(x_2, y_2) \succ (x_0, y_0) \succ (x_1, y_1)$$

where $\succ$ denotes strict preference.

From this result, S-D conclude that the domestic country is better off when

the foreign country imposes an import tariff than with free trade. Also

the domestic country is better off with free trade than if it imposes a tariff. The term "better off" refers to the realized utility level since the ex ante consumption and utility are identical across countries in their model.

The intuitive explanation of their results is simple. As explained in Chapter I, when the risk averse agents know that the government policy might change and they have the knowledge of the probability distribution function with which it will change, if at all, they alter their behavior to maximize utility subject to this uncertainty. Because the government policies frequently affect the domestic and foreign nationals differently, the possibility of a policy change creates risk that differs across countries. This, in turn, creates gains from trading on international financial markets. If these financial markets are complete, as they are in S-D model, then the income redistribution effect associated with a tariff policy change is eliminated. However, distortions introduced by tariffs cannot be eliminated. Substitution effect of a policy change continues to operate via changes in relative prices within and across states. For instance, in state 1 when only the home country imposes tariff, substitution effect entails a domestic consumption distortion since the domestic price of the import good is artificially raised in that state compared to other states. Hence domestic consumers are worse off in this state. In contrast, if only foreign country imposes import tariff, as in state 2, the foreign price of their import good rises in that state. This, in turn, creates a pure substitution effect for the domestic agents in a

general equilibrium framework since the price of the home consumption of exports falls in the offshore market through secondary substitution effect. Thus, the domestic agents are better off in state 2. In general, the main point is that whenever a policy has important redistributive effects, its implications may be substantially altered by the ability of agents to insure against policy risks by trading on financial markets.

Finally, S-D incorporate the production decision explicitly in the Appendix. Adding production in their model simply reinforces the results obtained earlier. This is because tariff now distorts production in addition to consumption in the country in which it is imposed while the income redistribution effect is eliminated as before.

We conclude this chapter by noting that S-D study is indeed novel and deserves considerable credit. However, fascinating as this study is, it can be extended to examine some deeper issues which have already been outlined in Chapter I. We present our own theoretical framework next and analyze these issues in details.

III. EXOGENOUS TARIFFS: THE ROLE OF LERNER'S SYMMETRY THEOREM

A. The Basic Model

Assumptions

A detailed description of our model is provided in this chapter. Some simplifying assumptions are made at the outset and listed below.

1. We consider a two country, two good stochastic general equilibrium model. Let us denote the countries by home country and foreign country and the goods by C and F.

2. It is an exchange economy. The production decisions are not explicitly taken into account.

3. Both countries are policy active and can improve welfare through trade restrictions. We assume that they impose a combination of export and import tariffs.

4. Each government's tariff policy is random and considered exogenous for the time being. This assumption will be relaxed later. In the absence of true uncertainty, the states of nature are synonymous with tariffs.

5. There is a representative agent in each country such that aggregate behavior can be analyzed by looking at the representative agent's maximizing behavior. This is possible if preferences are identical and homothetic within each country.

6. The preferences are also assumed identical across countries. Hence

trade can only occur due to differing endowments. We assume that endowments differ such that the home (foreign) country exports (imports) C and imports (exports) F in all the states.

Notations

Good C is chosen as the numeraire. Initially we assume S possible states of the world, each state corresponding to a different world tariff vector. π_i denotes the probability of occurrence of any state i.

Let r_s $(\bar{r}_s)$ and $\gamma_s(\bar{\gamma}_s)$[6] be the rates at which import and export tariffs are imposed respectively by the home (foreign) government in any state s. We assume all tariffs are ad valorem and paid in kind. An import tariff of r_s on F in the home country implies that for one unit of gross import of F, only $(1-r_s)$ units remain with the importer, while r_s units go to the government. Similarly, if the home country imposes export tariffs at rate γ_s on C, for each unit of gross exports, only $(1-\gamma_s)$ units leave the country while γ_s units are collected by the home government.

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[6]Barred terms pertain to the foreign country throughout.

Arbitrage Relations

Assuming positive trade flows, arbitrage implies,

$$P_s^F = \frac{\hat{P}_s^F}{(1-\tau_s)} = \frac{\overline{P}_s^F}{(1-\tau_s)(1-\overline{\gamma}_s)} \tag{3.1}$$

$$P_s^C = \hat{P}_s^C(1-\gamma_s) = \overline{P}_s^C(1-\gamma_s)(1-\overline{\tau}_s) \tag{3.2}$$

where $\hat{P}_s^i$ denotes the offshore (world) price of good i in state s.
Combining (1) and (2),

$$p_s = \frac{\hat{p}_s}{(1-\eta_s)} = \frac{\overline{p}_s}{(1-\eta_s)(1-\overline{\eta}_s)} \tag{3.3}$$

where $(p_s, \hat{p}_s, \overline{p}_s)$ denote the state s relative price of F and η_s denotes the effective protection, in state s, of the combination of import and export tariffs.[7]

The Economic Environment

We assume that spot markets exist. With the provision of spot trading, the representative agent in each country faces a two stage decision making process as explained in Chapter I. In the first stage, before uncertainty about government tariffs is resolved, she determines her optimal asset income by trading in financial contracts. At this stage, she is only interested in the asset income and not in its composition per se. Hence she is indifferent between trading in financial contracts on C, F or any combination of C and F as long as the net asset income (net of cost of

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[7]η_s and $\bar{\eta}_s$ are defined such that $(1-\eta_s) = (1-\tau_s)*(1-\gamma_s)$
and $(1-\bar{\eta}_s) = (1-\bar{\tau}_s)*(1-\bar{\gamma}_s)$ $\forall$s

acquiring these contracts) from any possible financial structure is the same.[8] In the second stage, after actual tariff levels are observed and spot market opens, she uses her asset income to purchase consumption goods without further risk bearing.[9]

We assume that the home and foreign agents trade in contracts on good C. The settlement of such contracts takes place in an offshore market, outside the tariff boundaries of the two countries. This is because if financial contracts are settled in a policy active country, the government of that country is likely to alter tariff policy ex post after contracting decisions are made so as to extract as much resources as possible from the residents of the other country. Those residents, being aware of such a possibility, will never enter into such a contract.

Each such contract entitles domestic individual h to a unit of C if and only if a certain state s occurs and it costs her θ_s units of good C in

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[8]It is implicitly assumed in this Chapter that government's tariff policy is irrevocably determined. As we will show in Chapter V, when a government has the discretionary power to alter tariff policy after financial decisions are made, the financial structure will play a critical role in determining tariff policy ex post.

[9]Based upon our discussion of Arrow-Debreu contingent markets in Chapter I, as long as the agents can correctly foresee the structure of future spot prices, the same optimal allocation of risk bearing as obtained with contingent commodity claims can also be attained with ex ante trading in financial contracts and spot trading in consumption goods. Since we assume for now that tariff policies which are announced are actually pursued, the two structures remain equivalent. Hence, there is no real difference between S-D model and our model so far. Spot trading is emphasized in the present model because it is a commonplace in the real world and it will play a key role in analyzing time consistency issues later.

the offshore market in all states.[10] Hence,

$$\sum_s \theta_s = 1 \qquad\qquad (3.4)$$

Let A^h_s denote the real asset income, measured in units of C, which accrues to domestic individual h in any state s on purchasing (or selling) financial contracts. The asset budget constraint faced by the domestic agent h requires

$$\sum_j \theta_j A^h_j = 0 \qquad\qquad (3.5)$$

i.e., asset income across states must add up to zero. The possibility of arbitrage profit from buying and selling financial contracts is ruled out. The asset budget constraint of the foreign agent can be similarly expressed as

$$\sum_j \theta_j \bar{A}^h_j = 0 \qquad\qquad (3.6)$$

Furthermore, the ex post trade balance equation in the presence of asset markets gets modified as

$$X_s = \beta_s M_s - A_s \qquad\qquad (3.7)$$

where X_s and M_s are defined to be the home net exports of C and home gross

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[10]It is important to mention here that any other choice of numeraire, e.g., $\theta_1 = 1$ is equivalent. In this case, payments for contracts are made only in state 1 in units of good C. This sort of payment mechanism is used in S-D model, as explained in Chapter II. Such a payment structure can be recovered from the present model through a linear combination of financial contracts.

imports of F respectively in state s and A_s is the aggregate domestic asset income in that state. Since the earnings from asset trade are included in the service account in the balance of payment accounting, equation (3.7) implies that imbalances in merchandise trade and trade in services may occur, but they offset each other.

As noted earlier, consumption goods are purchased once uncertainty is resolved and income is realized. Realized income in any state s consists of exogenous income and asset income. Exogenous income includes endowment income as well as the tariff revenue which is rebated back to the agents in a lump-sum fashion. Let Y_s^h and I_s^h denote the exogenous and realized income of home agent h in any state s. By definition,

$$Y_s^h = C_s^h + p_s F_s^h + TR \tag{3.8}$$

where TR is the exogenously given tariff revenue rebated back to household h and given by

$$TR = \frac{\gamma_s}{(1-\gamma_s)} X_s^a + \tau_s p_s M_s^a \tag{3.8a}$$

X_s^a, M_s^a denoting per capita aggregate trade flows. Using the balance of trade condition (3.7),

$$X_s^a = p_s M_s^a - A_s^a \tag{3.8b}$$

where A_s^a is the per capita domestic asset income in state s. Moreover,

$$I_s^h = Y_s^h + \frac{A_s^h}{(1-\gamma_s)} \tag{3.9}$$

The last term in income equation (3.9) deserves some explanation. It

indicates that to settle a contract that calls for delivery or receipt of A_s units of C in the offshore market in state s, the domestic tariff structure magnifies the net income received (or paid) by the home agent. To be specific, if $A_s<0$, the home agent must provide, including tariff costs, [$A_s/(1-\gamma_s)$] units of C or [$A_s p_s/((1-\gamma_s)\hat{p}_s)$] units of F (in C equivalent) to settle the contract. Given $p_s>\hat{p}_s$, it is cheaper for the domestic agent to settle the contract by exporting C. Similarly, if $A_s>0$, it will be more profitable to repatriate this income in terms of imports of F [= $(A_s(1-\tau_s))/\hat{p}_s$], with a domestic value (in units of C) of [$(p_s(1-\tau_s)A_s)/\hat{p}_s$] = [$A_s/(1-\gamma_s)$].

By the same reasoning, the income equation of the foreign agent h can be expressed as

$$\overline{I}_s^h = \overline{Y}_s^h + \overline{A}_s^h (1-\overline{\tau}_s) \tag{3.10}$$

It is worth pointing out here that the superficial difference between (3.9) and (3.10) arises because the domestic income is expressed in terms of its export good while the foreign income is expressed in terms of its import good. Substituting (3.8), (3.8a) and (3.8b) into (3.9), recalling arbitrage relation (3.3) and simplifying,

$$I_s^h = C_s^h + p_s F_s^h + \hat{p}_s M_s^a \frac{\eta_s}{(1-\eta_s)} + \frac{A_s^h}{(1-\gamma_s)} - \frac{\gamma_s A_s^a}{(1-\gamma_s)} \tag{3.11}$$

Noting that $\overline{X}_s^a = M_s^a$, $\overline{M}_s^a = X_s^a$ and $\overline{A}_s^a = -A_s^a$, income equation (3.10) of the foreign agent can be similarly simplified and expressed as follows:

$$\overline{I}_s^h = \overline{C}_s^h + \overline{p}_s \overline{F}_s^h + \hat{p}_s M_s^a \overline{\eta}_s + \overline{A}_s^h (1-\overline{\tau}_s) + \overline{\tau}_s \overline{A}_s^a \tag{3.12}$$

B. The Exact Optimization Problem

Asset Decision

The representative agent in the home country chooses her optimal

portfolio by solving the following optimization problem:

$$\underset{A_1^h \ldots A_S^h}{Max} \qquad \sum_I \pi_I V(I_I^h; p_I)$$

subject to asset budget constraint (3.5) and income definition (3.11),

where V(.) represents the indirect utility function of the home agent that

exhibits risk aversion, i.e., $V_{II} < 0$.

Writing the resulting first order conditions for any two states s and j in

ratio form yields

$$\frac{V_I(I_s^h; p_s)}{V_I(I_j^h; p_j)} = \left(\frac{1-\gamma_s}{1-\gamma_j}\right)\left(\frac{\theta_s/\pi_s}{\theta_j/\pi_j}\right) \quad \forall s \neq j \qquad (3.13)$$

where $V_I(s)$ denotes marginal utility of income in state s. The

interpretation of (3.13) is direct. Optimal risk allocation requires that

the ratio of the marginal utility of income across states be equated to the

ratio of effective contract prices on good C in those states weighted by

the respective probabilities.[11] Since the effective domestic cost of

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[11]The symmetry assumptions of S-D model imply that $\theta_s = \theta_j$; $\pi_s = \pi_j$ and export tariffs are not used in their model at all. Hence the optimal portfolio allocation rule (3.13) requires that marginal utility of income be equated across states.

transferring income to state s is $(1-\gamma_s)\theta_s$, the optimal choice of assets is sensitive to the ratio of export tariffs between states. Solution to this optimization problem gives rise to the equilibrium asset demand vector of the representative agent h in terms of $(\vec{\pi}, \vec{\theta}, \vec{p}, \vec{\gamma})$.

The representative agent in the foreign country solves a similar optimization problem:

$$\underset{\overline{A}_1^h \ldots \overline{A}_S^h}{\overset{Max}{}} \quad \sum_I \pi_I V(\overline{I}_I^h; \overline{p}_I)$$

subject to their asset budget constraint (3.6) and income equation (3.12). The corresponding first order conditions are given by

$$\frac{V_{\overline{I}}(\overline{I}_s^h; \overline{p}_s)}{V_{\overline{I}}(\overline{I}_j^h; \overline{p}_j)} = \left(\frac{1-\overline{\tau}_j}{1-\overline{\tau}_s}\right)\left(\frac{\theta_s/\pi_s}{\theta_j/\pi_j}\right) \quad \forall s \neq j \tag{3.14}$$

This optimization problem yields the equilibrium asset demand vector of foreign agent h in any state s, for all s in terms of $(\pi, \theta, \overline{p}, \overline{\tau})$ vector. Finally, given all agents are alike, asset market equilibrium requires

$$A_s^* + \overline{A}_s^* = 0 \qquad \forall s \tag{3.15}$$

where A_s^* and $\overline{A}_s^*$ refer to the aggregate asset position in the home country and foreign country respectively. Given the representative agent assumption, the aggregate asset demand has the same functional form as the individual asset demand. Equation (3.15) solves for equilibrium contract prices, θ_s^*.

Consumption Decision

Given the asset position, the consumption decision is taken ex post by each agent on maximizing utility subject to the budget constraint. These consumption demands are embodied in the indirect utility function and recovered by invoking Roy's identity. Goods market equilibrium then requires

$$c_s^d + \bar{c}_s^d = C_s + \bar{C}_s = C_s^T \qquad \forall s \tag{3.16}$$

$$f_s^d + \bar{f}_s^d = F_s + \bar{F}_s = F_s^T \qquad \forall s \tag{3.17}$$

where lowercase c_s^d ($\bar{c}_s^d$) and f_s^d ($\bar{f}_s^d$) denote the home (foreign) aggregate consumption demand for C and F and C_s^T(F_s^T) refers to total world endowment of C (F). One of these two market clearing equations in any state s is made redundant by invoking Walras law and equilibrium spot relative prices are solved.

Relation to Futures Contracts

Before closing our discussion of the model description, it is worth exploring briefly the relation between the financial contracts used in our model and the futures contracts. The financial decision in our model could also have been formulated by having the representative agent in each country participate in futures markets. Instead we choose to use state contingent contracts in the present model because they imply a less restrictive payoff structure.

Before investigating this issue in details, a few words about futures

contracts seem appropriate. Each unit of a futures contract on any good F, for example, entitles its buyer (seller) to receive (make) delivery of a unit of good F at a predetermined relative price in the future. Unlike with contingent financial contracts, the buyer of futures contracts is assured of a certain amount of good F regardless of the state of nature. The profit (or loss) from buying/selling futures contracts results from the discrepancy between the spot price and the contracted price.

For a two state world, there is only one independent asset demand equation in the present model, given the asset budget constraint. Hence it is always possible to replicate the payoff pattern under contingent financial contracts with futures contracts by choosing their levels appropriately. However, for a more general S state world and (S-1) asset demand equations, it turns out that the futures contracts can replicate the payoff pattern of financial contracts only if the latter exhibit a linear payoff structure. A detailed exposition is provided in Appendix A below.

C. The Role of Lerner's Symmetry Theorem

Lerner's symmetry is at the heart of many important results in trade theory. Back in 1936, A.P. Lerner showed that an import tariff of say x% has exactly the same effects on resource allocation as an export tariff of x%. This is because trade policies affect resource allocation by altering relative prices of goods on domestic markets. These relative prices move in the same direction and by the same magnitude when an import tariff or an

equal export tariff is used. This becomes clear on examining the arbitrage relation (3.3) which indicates that it is only the effective protection rate η that matters and it can be attained by any combination of r and γ.

Given the significant role that the symmetry theorem plays in analyzing the effects of commercial policy, Razin and Svensson (1983) first made an attempt to investigate whether Lerner's symmetry can be extended to a dynamic framework. Using a two good, two period model with homothetically separable preferences over time, they show that temporary import and export tariffs have differential effects on the current account. The introduction of a small import tariff, starting from a situation of free trade, improves the current account whereas the introduction of an export tariff worsens it. They cite the role of intertemporal substitution effect as the driving factor behind their results. Thus, the Lerner's symmetry breaks down for temporary tariffs. In contrast, both a permanent import tariff and a permanent export tariff have ambiguous effects on the current account.

In a recent paper, Lopez and Panagariya (1990) have extended the Razin and Svensson framework by allowing for non-zero initial trade taxes and non-separable, non-homothetic preferences over time. In this setup, they have reexamined the direction of impact of temporary trade taxes on the current account. Their study suggests that the intertemporal substitutability/complementarity between current and future consumption plays an important role in determining the trade balance effects of import and export tariffs. In general, temporary tariffs or export subsidies have

ambiguous effects on the current account.

Using our theoretical construct, we extend the Lerner's symmetry theorem to a stochastic framework instead. We show that Lerner's notion of equivalence between export and import tariffs need not extend to a stochastic framework with asset markets. In other words, it is not only the effective protection of the combination of export and import tariff that matters, but the composition of tariffs matters as well. Hence:

Proposition 3.1: Lerner's symmetry between export and import tariffs prevails in a stochastic environment with asset markets if the ratio of export (or equivalently import) tariffs between states is the same across alternative policy regimes for each country, otherwise not.

To prove this Proposition, consider two alternative policy scenarios for each country such that the effective protection rate $\eta(\bar{\eta})$ for each state is the same across alternative scenarios, though the compositions of tariffs differ. Thus:

$$(1-\tau_s^R)\,(1-\gamma_s^R) = (1-\eta_s) \qquad \forall s;\ R=I,II \tag{3.18}$$

$$(1-\bar{\tau}_s^R)\,(1-\bar{\gamma}_s^R) = (1-\bar{\eta}_s) \qquad \forall s;\ R=I,II \tag{3.19}$$

where R indexes alternative policy regimes I and II. Then Lerner's symmetry holds if the following conditions are met.

$$\frac{(1-\gamma_s^I)}{(1-\gamma_1^I)} = \frac{(1-\gamma_s^{II})}{(1-\gamma_1^{II})} \qquad \forall s \tag{3.20}$$

$$\frac{(1-\overline{\gamma}_s^I)}{(1-\overline{\gamma}_1^I)} = \frac{(1-\overline{\gamma}_s^{II})}{(1-\overline{\gamma}_1^{II})} \quad \forall s \tag{3.21}$$

Proof: see Appendix B.

The intuitive explanation of this result is direct. In the standard deterministic framework, it is the relative price of a good within the state that guides resource allocation and this relative price remains the same across policy regimes as long as the effective protection rate is the same across these regimes. However, in a stochastic framework with asset markets, agents also respond to the changes in the price of a good across states by shifting consumption from one state to another via asset markets. How this price changes across states is sensitive to the composition of tariffs, even though the effective intra-state protection of any composition is the same.

For instance, given prices $(\theta_s, \hat{p}_s)$, an increase in γ_s^I (ceteris paribus) lowers the relative price of consumption of the export good C in state s as compared to the price of the same good in other states. Hence, ceteris paribus, domestic agents will shift consumption of C towards state s under regime I. Further, since the effective protection has not changed (i.e., τ_s^I decreases as γ_s^I increases), domestic agents will also substitute away from consumption of F in other states to consumption of F in state s. The preceding would be true for a small country and the only relevant effects would be the inter-state substitution. Naturally, the general equilibrium effects of any policy change would also depend on how the asset prices as well as relative goods prices will be altered in the offshore

market as consumption changes. In our symmetric framework, changes in $\bar{\gamma}^I{}_s$, given $\bar{\eta}^I{}_s$; will have similar effects on foreign agents and will affect domestic agents through induced price effects. In contrast, an equivalent decrease in $\gamma^{II}{}_s$, matched by a corresponding increase in $\tau^{II}{}_s$, will encourage substitution away from state s to other states under regime II. Only in the special case where the ratio of export or equivalently import tariffs (given the effective protection rate) between any two states is the same across alternative policy regimes, the inter-state substitution effect will also be the same regardless of the composition of tariff policy. Thus, Lerner's symmetry will hold only in this special case.

D. Implications of Non-equivalence

Positive Implications

The result of the preceding section has important positive implications. In this section we show that the counter-intuitive results obtained by S-D depend not only on the functional form they use, but also on the tariff structure they impose on the model. Using the same log utility function and making similar symmetry assumptions, we show that the ex post comparison of states yields ambiguous results when both export and import tariffs are used. Further, if only export tariffs are used, the S-D results are completely reversed and the standard policy implications are retained.

As in S-D, preferences of the representative agent in each country are given by:

$$U(c, f) = \ln(c) + \ln(f)$$

The corresponding indirect utility function is given by

$$V(I; p) = \ln I - \frac{1}{2}\ln p; \quad V_I > 0, \quad V_{II} < 0 \tag{3.22}$$

Using this functional form, home consumption demands in any state s are obtained as follows.

$$c_s^d = \frac{1}{2}I_s; \quad f_s^d = \frac{1}{2}\frac{I_s}{p_s} \tag{3.23}$$

Foreign consumption demands can be similarly derived. Following S-D, endowments of both the countries are considered state independent for now and symmetric with respect to each other. i.e.,

$$C = \overline{F}; \quad \overline{C} = F \rightarrow C^T = F^T \tag{3.24}$$

Furthermore, C^T (or F^T) is normalized to 1. Let us denote C (or $\overline{F}$) by μ and hence $\overline{C}$ (or F) by $(1-\mu)$.

To solve the model, it is convenient to start with the consumption decision first, given asset positions and then work backwards to the asset decision. Details of this solution technique are outlined in Appendix C. Following this procedure, the reduced form expressions for price and income in the home country can be expressed as below.

$$\overline{p}_s = \frac{[(1-\overline{\tau}_s)(1-\gamma_s) + D_o K_s]}{D_o + (1-\overline{\tau}_s)(1-\gamma_s)} \tag{3.25}$$

$$p_s = (\overline{p}_s/K_s) \tag{3.26}$$

$$I_s = 2\left[1 + \frac{(1-\overline{\tau}_s)(1-\gamma_s)}{D_o}\right]^{-1} \tag{3.27}$$

where by our construct,

$$K_s = (1-\eta_s)(1-\overline{\eta}_s) \tag{3.27a}$$

$$D_o = \frac{\sum_i \pi_i[(1-\mu)(1-\overline{\gamma}_i)^{-1} + \mu(1-\overline{\tau}_i)]}{\sum_i \pi_i[(1-\mu)(1-\gamma_i)^{-1} + \mu(1-\tau_i)]} \tag{3.27b}$$

Substituting expressions for I_s and p_s into (3.23) and simplifying,

$$c_s^d = \left[1 + \frac{(1-\overline{\tau}_s)(1-\gamma_s)}{D_o}\right]^{-1} \tag{3.28}$$

$$f_s^d = \left[1 + \frac{1}{(1-\overline{\gamma}_s)(1-\tau_s)D_o}\right]^{-1} \tag{3.29}$$

From equations (3.28) and (3.29), it immediately follows that

Proposition 3.2:

$$c_s^d \gtrless c_j^d \quad as \quad (1-\overline{\tau}_s)(1-\gamma_s) \lessgtr (1-\overline{\tau}_j)(1-\gamma_j)$$

$$f_s^d \gtrless f_j^d \quad as \quad (1-\overline{\gamma}_s)(1-\tau_s) \gtrless (1-\overline{\gamma}_j)(1-\tau_j)$$

Proposition 3.2[12] suggests that the comparison of consumption levels

ex post of each good across any two states s and j, in this simple case of

a log utility function, depends only on the total tariff level imposed on

that good in states s and j, given the whole vector of tariffs. The

intuitive idea becomes clear at once when equations (3.1) and (3.2) are

reexamined. Rewriting equation (3.1) for any other state j and then taking

ratios,

$$\frac{P_s^F/\overline{P}_s^F}{P_j^F/\overline{P}_j^F} = \frac{(1-\overline{\gamma}_j)\,(1-\tau_j)}{(1-\overline{\gamma}_s)\,(1-\tau_s)}$$

it follows that if the ratio of the total tariff on F between states j and

s exceeds 1, the cost of consumption of F is higher in state s relative to

state j in the home country than in foreign country. Hence we would expect

home (foreign) consumers to transfer consumption of F from s (j) to state j

(s). Similarly, rewriting equation (3.2) in ratio form,

$$\frac{P_s^C/\overline{P}_s^C}{P_j^C/\overline{P}_j^C} = \frac{(1-\overline{\tau}_s)\,(1-\gamma_s)}{(1-\overline{\tau}_j)\,(1-\gamma_j)}$$

it becomes evident that when the ratio of total tariff on C between states

s and j exceeds one, the home (foreign) consumers will shift consumption of

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[12]Noting that c_s^d (f_s^d) = 1 - c_s^d (f_s^d) in our simplified setup, it can be easily seen that for the foreign country,

$$\overline{c}_s^d \gtrless \overline{c}_j^d \quad as \quad (1-\overline{\tau}_s)\,(1-\gamma_s) \gtrless (1-\overline{\tau}_j)\,(1-\gamma_j)$$
$$\overline{f}_s^d \gtrless \overline{f}_j^d \quad as \quad (1-\overline{\gamma}_s)\,(1-\tau_s) \lessgtr (1-\overline{\gamma}_j)\,(1-\tau_j)$$

C away from state s (j) to state j (s).

Since the total tariff imposed on any good in any state depends on the actual tariff structure being implemented, from Proposition 3.2 it also follows that the ex post ranking of states in terms of consumption levels is highly sensitive to the composition of tariffs. To illustrate this point, let us extract the four state world of S-D from the existing setup by defining the states in the following manner.

Table 3.1   Four-state world in the present study

	States of Nature			
	0	1	2	3
Home	0	η	0	η
Foreign	0	0	$\bar{\eta}$	$\bar{\eta}$

From Proposition 3.2, the information in Table 3.1 is not sufficient to determine consumption patterns across states. To illustrate, consider the following cases:

Case i (*S-D Example*): $\gamma_s = \bar{\gamma}_s = 0 \quad \forall s; \quad \tau_s = \eta_s; \quad \bar{\tau}_s = \bar{\eta}_s$

From Proposition 3.2: $c_0^d = c_1^d < c_2^d = c_3^d; \quad f_0^d = f_2^d > f_1^d = f_3^d$

$$\rightarrow (c_2^d, f_2^d) \succ (c_0^d, f_0^d) \succ (c_1^d, f_1^d)$$

Hence, as in S-D, state 2, the one in which only the foreign country imposes tariffs, yields the largest realized home utility, whereas state 1,

where only the home country is policy active, yields the lowest realized home utility.

Case ii: $\tau_s = \overline{\tau}_s = 0$ $\forall s$; $\gamma_s = \eta_s$; $\overline{\gamma}_s = \overline{\eta}_s$

Assuming only export tariffs are used, Proposition 3.2 implies:

$$c_1^d = c_3^d > c_0^d = c_2^d; \quad f_1^d = f_0^d > f_2^d = f_3^d$$

$$\rightarrow (c_1^d, f_1^d) \succ (c_0^d, f_0^d) \succ (c_2^d, f_2^d)$$

Consequently, under this tariff structure, state 1 yields the highest home utility, state 2 the lowest. Further, given home tariffs, the home country is always better off when the foreign country pursues free trade. Thus, the S-D results are __reversed__ when export tariffs replace import tariffs.

Case iii: $\tau_s > 0$; $\overline{\tau}_s > 0$; $\gamma_s > 0$; $\overline{\gamma}_s > 0$ $\forall s$

We also assume[13]

$$\gamma_0 = \gamma_2 = 0; \quad \gamma_1 = \gamma_3; \quad \overline{\gamma}_0 = \overline{\gamma}_1 = 0; \quad \overline{\gamma}_2 = \overline{\gamma}_3$$

From Proposition 2, it then follows that

$$c_0^d < c_2^d; \quad f_0^d > f_2^d; \quad c_0^d < c_1^d; \quad f_0^d > f_1^d$$

As it turns out, the comparison of realized utility between states 0 and 2 depends on the relative magnitude of $\overline{\tau}$ and $\overline{\gamma}$ whereas a similar comparison

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[13]In general, given η, it will be optimal to have γ and $\overline{\gamma}$ vary across all states.

between states 0 and 1 depends on the relative magnitude of r and γ. Thus, S-D results <u>may</u> or <u>may not</u> hold when import tariffs in their model are replaced by a combination of both import and export tariffs with the same effective intra-state protection.

Apart from the specific comparison with S-D, the general point is that the equilibrium depends on the entire tariff structure.

Comparative Static Effects

The comparative static effects of a change in the export or import tariff in any state on the consumption levels can be obtained by differentiating consumption demands as given by (3.28) and (3.29) with respect to γ_k:

$$given \; \eta_k, \; \frac{\partial c_k^d}{\partial \gamma_k} > 0; \; \frac{\partial c_s^d}{\partial \gamma_k} < 0 \; \forall s \neq k; \; \frac{\partial f_k^d}{\partial \gamma_k} > 0; \; \frac{\partial f_s^d}{\partial \gamma_k} < 0 \; \forall s \neq k$$

$$given \; \tau_k, \; \frac{\partial c_k^d}{\partial \gamma_k} > 0; \; \frac{\partial c_s^d}{\partial \gamma_k} < 0 \; \forall s \neq k; \; \frac{\partial f_s^d}{\partial \gamma_k} < 0 \; \forall s$$

As noted earlier, when γ_k increases, given prices, consumption of C becomes cheaper in state k compared to all other states and agents substitute away from consumption of C in the remaining states to state k. Further, the above results also indicate that the secondary substitution through induced price effects does not offset the initial impact of a tariff change. How the consumption of F in state k changes depends in turn on whether η_k or τ_k is kept fixed. As explained earlier, when η_k is held fixed, consumption of F also increases in state k relative to other states

or equivalently, there is no direct intra-state substitution effect. However, if r_k is considered given, then an increase in γ_k also induces home agents to substitute consumption of C for F in that state. Finally, the effects of a change in $\bar{\gamma}_k$ on home consumption can be traced easily by noting that the increase in $\bar{\gamma}_k$ affects the foreign agents in a similar manner and hence affects the domestic agents in an opposite manner through the induced price effect. Other comparative static results can be obtained in a similar fashion. Some of these results are given below.

For example, for the foreign country;

$$given \ \bar{\eta}_k, \ \frac{\partial \bar{f}_k^d}{\partial \gamma_k} > 0; \ \frac{\partial \bar{f}_s^d}{\partial \gamma_k} < 0 \forall s \neq k; \ \frac{\partial \bar{c}_k^d}{\partial \gamma_k} > 0; \ \frac{\partial \bar{c}_s^d}{\partial \gamma_k} < 0 \forall s \neq k$$

implying that for the home country,

$$\frac{\partial f_k^d}{\partial \gamma_k} < 0; \ \frac{\partial f_s^d}{\partial \gamma_k} > 0 \forall s \neq k; \ \frac{\partial c_k^d}{\partial \gamma_k} < 0; \ \frac{\partial c_s^d}{\partial \gamma_k} > 0 \forall s \neq k$$

Similarly,

$$given \ \bar{\tau}_k, \ \frac{\partial \bar{f}_k^d}{\partial \gamma_k} > 0; \ \frac{\partial \bar{f}_d^s}{\partial \gamma_k} < 0 \forall s \neq k; \ \frac{\partial \bar{c}_s^d}{\partial \gamma_k} < 0 \forall s$$

$$\rightarrow \frac{\partial f_k^d}{\partial \gamma_k} < 0; \ \frac{\partial f_s^d}{\partial \gamma_k} > 0 \forall s \neq k; \ \frac{\partial c_s^d}{\partial \gamma_k} > 0 \forall s$$

The effects of a change in r_k or $\bar{r}_k$ on home consumption can be analogously derived and expressed as follows.

$$given \; \eta_k, \quad \frac{\partial c_k^d}{\partial \tau_k} < 0; \quad \frac{\partial c_s^d}{\partial \tau_k} > 0 \forall s \neq k; \quad \frac{\partial f_k^d}{\partial \tau_k} < 0; \quad \frac{\partial f_s^d}{\partial \tau_k} > 0 \forall s \neq k$$

$$given \; \gamma_k, \quad \frac{\partial c_s^d}{\partial \tau_k} > 0 \forall s; \quad \frac{\partial f_k^d}{\partial \tau_k} < 0; \quad \frac{\partial f_s^d}{\partial \tau_k} > 0 \forall s \neq k$$

$$given \; \bar{\eta}_k, \quad \frac{\partial c_k^d}{\partial \bar{\tau}_k} > 0; \quad \frac{\partial c_s^d}{\partial \bar{\tau}_k} < 0 \forall s \neq k; \quad \frac{\partial f_k^d}{\partial \bar{\tau}_k} > 0; \quad \frac{\partial f_s^d}{\partial \bar{\tau}_k} < 0 \forall s \neq k$$

$$given \; \bar{\gamma}_k, \quad \frac{\partial c_k^d}{\partial \bar{\tau}_k} > 0; \quad \frac{\partial c_s^d}{\partial \bar{\tau}_k} < 0 \forall s \neq k; \quad \frac{\partial f_s^d}{\partial \bar{\tau}_k} < 0 \forall s$$

Normative Implications

Since consumption demands are sensitive to the choice of tariffs, the expected utility of the representative agent in any country is also sensitive to this composition. Given some arbitrarily chosen effective protection sought by any government, we would expect the optimal composition to include <u>both</u> export and import tariffs. This is demonstrated below using the four state world (defined in Table 3.1 above) as an illustrative case.

Assuming that the domestic government acts in the national interest, announces tariff policy before uncertainty is resolved and commits to it, the constrained optimal export tariff (constrained by the choice of level of η) can be obtained on solving the following optimization problem:

$$\underset{\gamma}{Max}\ EV(I;p) = \sum_{i=0}^{3} \pi_i V(I_i; p_i)$$

subject to

$$(1-\gamma)(1-\tau) = (1-\eta)$$

where the level of η is arbitrarily chosen and $\bar{\eta}$ and $\bar{\gamma}$ are considered given, and we assume as before in case iii, $\gamma_0 = \gamma_2 = 0$; $\gamma_1 = \gamma_3$. Rewriting the equilibrium consumption bundles (3.28) and (3.29) for the four state case in terms of η and γ, the expected value of the corresponding indirect utility function is given by

$$
\begin{aligned}
EV(\gamma) = &2\pi_0\left[\ln\left(\frac{1}{1+1/D_0}\right)\right] + \pi_1\left[\ln\left(\frac{1}{1+(1-\gamma)/D_0}\right)\right] \\
&+\pi_1\left[\ln\left(\frac{1}{1+(1-\gamma)/[(1-\eta)D_0]}\right)\right]+\pi_2\left[\ln\left(\frac{1}{1+(1-\bar{\eta})/[(1-\bar{\gamma})D_0]}\right)\right] \\
&+\pi_2\left[\ln\left(\frac{1}{1+1/[(1-\bar{\gamma})D_0]}\right)\right]+\pi_3\left[\ln\left(\frac{1}{1+(1-\bar{\eta})(1-\gamma)/[(1-\bar{\gamma})D_0]}\right)\right] \\
&+\pi_3\left[\ln\left(\frac{1}{1+(1-\gamma)/[(1-\bar{\gamma})(1-\eta)D_0]}\right)\right]
\end{aligned}
\tag{3.30}
$$

where

$$\frac{1}{D_0} = \frac{\pi_0+\pi_2+\dfrac{(1-\mu\eta)(\pi_1+\pi_3)}{(1-\gamma)}}{\bar{M}}\ ;\qquad \bar{M} = \pi_0+\pi_1+\frac{(1-\mu\bar{\eta})(\pi_2+\pi_3)}{(1-\bar{\gamma})}$$

Assuming $\pi_i = (1/4)$ for simplicity, the optimal export tariff is then obtained on solving the following first order condition:

$$\frac{\partial EV(\gamma)}{\partial \gamma} = -\left[\frac{2}{1+D_o} + \frac{(1-\overline{\eta})}{(1-\overline{\eta})+(1-\overline{\gamma})D_o} + \frac{1}{1+(1-\overline{\gamma})D_o}\right]\frac{2\pi D_o(1-\mu\eta)}{(1-\gamma)^2 \overline{M}}$$
$$+ \left[\frac{1}{(1-\gamma)+(1-\overline{\gamma})(1-\eta)D_o}\right]\frac{2\pi D_o}{\overline{M}} \qquad\qquad (3.31)$$
$$+ \left[\frac{1}{(1-\gamma)+D_o} + \frac{1}{(1-\gamma)+(1-\eta)D_o} + \frac{(1-\overline{\eta})}{(1-\overline{\eta})(1-\gamma)+(1-\overline{\gamma})D_o}\right]\frac{2\pi D_o}{\overline{M}}$$
$$= 0$$

Clearly, equation (3.31) is non linear in γ and an analytical solution is hard to find. However, even without actually solving for γ, we can evaluate the expression in (3.31) at γ locally around zero and γ locally around η. On simplification, it turns out that

$$\left.\frac{\partial EV}{\partial \gamma}\right|_{\gamma=0} > 0 \quad \& \quad \left.\frac{\partial EV}{\partial \gamma}\right|_{\gamma=\eta} < 0$$

Hence Proposition 3.3 follows.

Proposition 3.3: Given the foreign tariff vector and the home country's effective protection, home country's expected welfare is maximized when both export and import tariffs are used.[14]

E. Extension to Production Economy

In this section, we extend our general theoretical construct to incorporate production decisions explicitly and show that the composition of tariffs would generally matter for production decisions as well. To keep our exposition simple, we consider a partial equilibrium setup and

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[14]This result is also confirmed by solving (3.31) for γ^* using numerical methods where π_i is no longer assumed to be the same across states.

analyze the effects of a random tariff policy pursued by the home government on the domestic production decision.

The domestic production possibility frontier is given by

$$Q_c = g(Q_f) \; ; \quad g'(Q_f) < 0 \tag{3.32}$$

where Q_f and Q_c denote the quantities produced of good F and C respectively. The income equation of representative agent h can be rewritten as

$$I_s^h = C_s^h + p_s F_s^h + g(Q_f^h) + p_s Q_f^h + TR_s + A_s^h/(1-\gamma_s) \tag{3.33}$$

With the possibilities of production, the sequence of decision making gets modified such that production decision is taken along with asset decision before uncertainty is resolved.[15]

The representative agent in the home country now solves the following optimization problem:

$$\underset{A_1^h \ldots A_S^h; Q_f^h}{\text{Max}} \quad \sum_I \pi_I V(I_I^h; p_I)$$

subject to asset budget constraint (3.5) where the income equation is given by (3.33).

The corresponding first order conditions yield

$$\pi_s V_I(s) \frac{1}{(1-\gamma_s)} = \sigma \theta_s \quad \forall s \tag{3.34}$$

---

[15] If production decisions are taken after uncertainty is resolved, this is analogous to having a random endowment model and nothing substantive changes.

$$\sum_{I} \pi_{i} V_{I}(i) \, [g'(Q_{f}^{h}) + p_{i}] = 0 \qquad\qquad (3.35)$$

where σ denotes the Lagrange multiplier.

Substituting (3.34) into (3.35) and rearranging, the optimal production rule is obtained as follows.

$$MRT \equiv \left| g'(Q_{f}^{h}) \right| = \frac{\sum_{i} p_{i} \theta_{i} (1-\gamma_{i})}{\sum_{j} \theta_{j} (1-\gamma_{j})} \qquad\qquad (3.36)$$

Equation (3.36) clearly indicates that the optimal allocation of resources is sensitive to the choice of export (or equivalently import) tariffs, unless γ is invariant across states. Intuitively speaking, the representative agent chooses the optimal production level of F under uncertainty by equating the marginal cost of producing F to the weighted average of spot relative price of F. In the presence of financial markets, the weight attached to any state i is essentially the effective cost of transferring income to that state. Ex post, the representative agent finds herself overproducing in some state and incurring losses while underproducing in some other state and earning excess profits. The availability of financial markets, however, enables her to smooth her income and consumption across states if optimal production rule (3.36) is followed.

Comparative Static Effect

The effect of a change in γ_s on domestic production can be obtained by differentiating (3.36) with respect to γ_s, noting that the commodity prices and contract prices are considered given in this partial equilibrium setup. This, in turn, yields

$$\frac{\partial MRT}{\partial \gamma_s} = sign\left[\left| g'(Q_f^h) \right| - p_s \right]$$

implying

$$\frac{\partial MRT}{\partial \gamma_s} \underset{<}{\overset{\geq}{=}} 0 \quad as \quad MRT \underset{<}{\overset{\geq}{=}} p_s \qquad (3.37)$$

This is graphically illustrated in Figure 3.1 below. In this figure, the curve labelled "hdabe" depicts the domestic production possibility frontier. There are two possible states of nature. States 0 and 1 are defined as in Table 3.1 above. The optimal production rule (3.36) requires that the domestic agent produces at point a. If state 0 occurs, she overproduces by the amount $(Q_{fa}-Q_{f0})$. Similarly, if state 1 is realized, she underproduces by the amount $(Q_{f1}-Q_{fa})$. If γ_1 is lowered, she increases her production of F from Q_{fa} by withdrawing resources from the production of good C. Alternatively, if γ_0 is lowered, she produces less than Q_{fa}.

In search for an intuitive explanation of this result, let us rewrite equation (3.36) as

$$\sum_i \frac{\theta_i (1-\gamma_i)}{\theta_0 (1-\gamma_0)} \left[p_i - \left| g'(Q_f^h) \right| \right] = 0 \qquad (3.38)$$

on setting $\theta_0(1-\gamma_0) = 1$, without loss of generality.
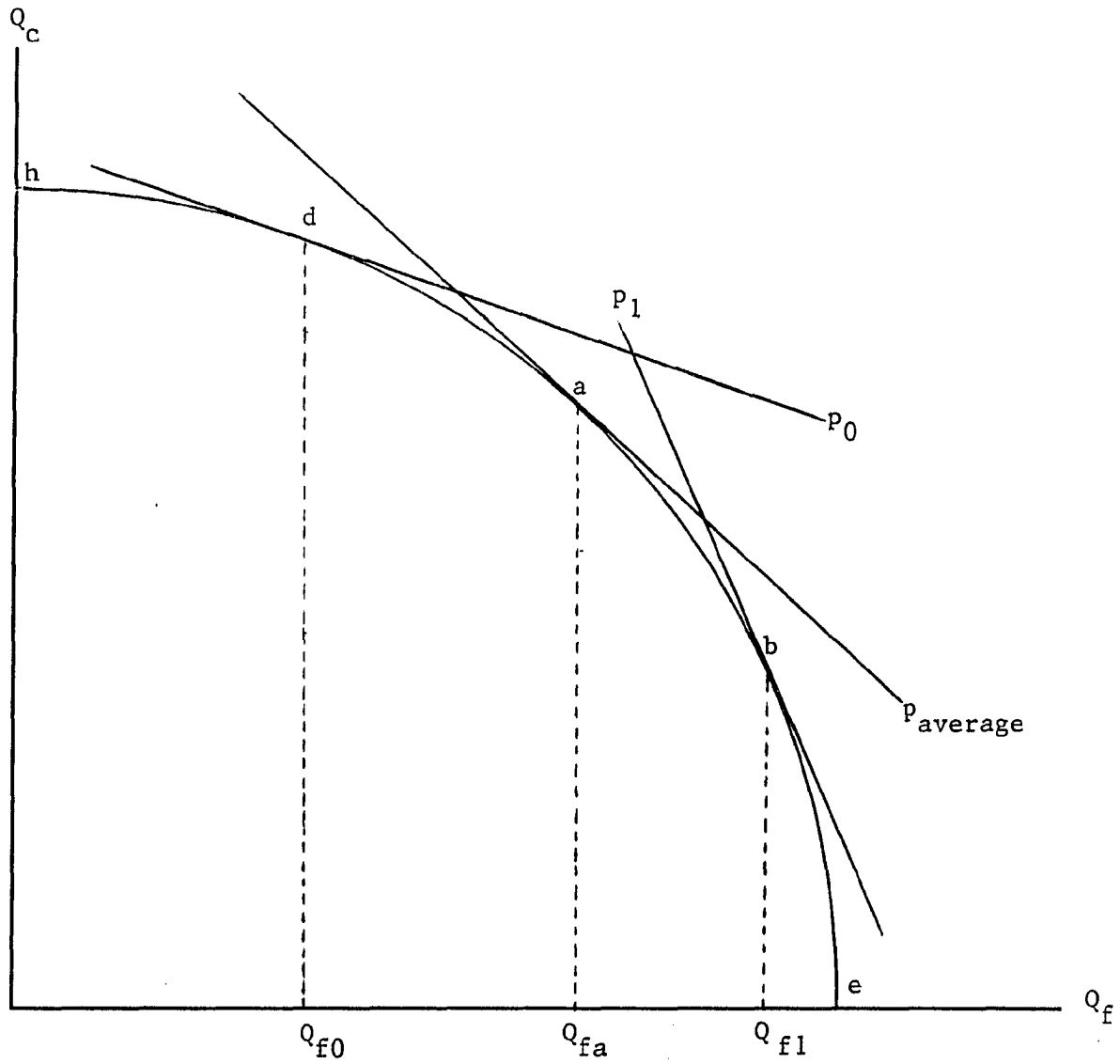
Figure 3.1 The effect of a tariff change on production decision

Then γ_i can be interpreted as the weight given to the change in income from the production of an additional unit of F in any state i. The lower is γ_i, the higher is this weight. Thus, if excess profit is made on the margin in state i from an additional unit of F, more of F will be produced as γ_i is reduced. Similarly, less of F will be produced if a loss is incurred on the margin, with a reduction of γ_i.

This concludes our discussion of the effects of exogenous tariffs in a stochastic world with asset markets. To sum up, the main theme of this Chapter is that Lerner's notion of equivalence between export and import tariffs does not extend to a stochastic framework with asset markets unless the ratio of export (or equivalently) import tariffs between states is the same for alternative tariff structure. This result, in turn, has important positive and normative implications. We relax the assumption of exogenous tariffs next and examine the nature of optimal policy.

IV. ENDOGENOUS TARIFFS: NATURE OF OPTIMAL POLICY

A. The Economic Environment

In the analysis thus far, the tariff policy was treated as exogenous. Hence the randomness in government policy was considered ad hoc in nature. In this chapter, we endogenize tariff policy so as to discuss and compare the nature of optimal policy in a stochastic environment with or without asset markets and under alternative tariff structures. We assume that the randomness in tariff policy arises from true uncertainty about the state of nature and is reflected in random endowments. This can be justified by noting that quite often in the real world the tariff levels are tied to the volume of exports or imports which, in turn, depend on the endowment levels (or the production as the case may be) of the export or import goods. Further, we assume that the government acts in the (national) public interest and chooses the optimal levels of tariffs so as to maximize the domestic welfare.[16]

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[16]In other words, we use "optimal tariff type argument" in the present study to justify the imposition of tariffs. An alternative approach would be to incorporate "public choice" considerations and focus on the private interests and incentives of the individuals who make up a government. In that case, the randomness in government policy may arise from the uncertainty about the political process itself as suggested by S-D.

Assumptions

Some of the assumptions made earlier are modified.

1. To keep things simple, we consider a special case where only the home country is policy active.

2. The same log utility function is used to indicate preferences but the symmetry assumptions about endowment are no longer maintained.

3. The world endowment levels of C and F are no longer normalized to 1.

Policy Regimes

We discuss the nature of optimal intervention in such a setup with three alternative policy regimes. Under regime I, the government uses import tariffs only and asset markets are assumed absent. In the absence of asset markets, the tariff structure does not matter and hence import tariffs are equivalent to the effective protection rate. This regime is chosen to highlight the role of asset markets. When there is scope for inter state trade, the introduction of asset markets is likely to be welfare improving, especially if appropriate trade policies are used. Under regime II, the home government once again uses only import tariffs, but this time asset markets are present. This regime is selected to replicate the S-D case. Finally, regime III depicts our case where the home government uses a combination of export and import tariffs with asset markets present. As demonstrated in the previous Chapter, regime II constitutes a special case of regime III and is obtained on setting the export tariff vector to zero in regime III.

Sequence of Decision Making

Irrespective of the policy regime, decision making takes place in the following sequence:

(i) The home government announces its optimal state contingent tariff policy[17] and commits to it[18] , given the expectations about future endowment levels;

(ii) the representative agent in each country takes asset decisions under regimes II and III based on the announced policy;

(iii) uncertainty is resolved and actual endowment levels and their prices are observed;

(iv) consumption decisions are made, given asset positions and (predetermined) tariff levels.

It is worth noting here that although time does not enter explicitly in our model, it does so implicitly since the ordering in which decisions are made is important.

---

[17]Although state contingent tariffs constitute the first best policy in a world of uncertainty, they may not be feasible in practice due to the lack of information or flexibility on part of the government.

[18]In a setup where private decisions take place in two stages (for instance, financial and/or production and then consumption decision), the government may find it beneficial to alter the tariff level ex post once financial (and/or production) decisions are made and uncertainty is resolved. This, in turn, will give rise to time consistency issues which are discussed in Chapter V. In this Chapter, we abstain from these issues by assuming that policies that are announced are also pursued.

B. Solution Method

To solve, the backward optimization technique is used as outlined in Appendix C. On combining steps (ii) through (iv), the reduced form income and price equations are obtained as functions of endowment levels as well as policy parameters. Optimal policy instruments are then determined by maximizing the expected value of the indirect utility function of the home agent, given the income and price equations. The optimal tariff policy under each of these regimes is derived below.

Regime I

Following the method suggested above, the reduced form income and price equations of the home country in the absence of asset markets are obtained as follows.

$$I_i = \frac{C_i^T(\alpha_i + \beta_i)}{1 - \frac{1}{2}\eta_i(1 - \beta_i)} \tag{4.1}$$

$$p_i = \left[\frac{1 + \dfrac{\eta_i(1 - \alpha_i)}{2(1 - \eta_i)}}{1 - \dfrac{\eta_i(1 - \beta_i)}{2}} \right] \frac{C_i^T}{F_i^T} \tag{4.2}$$

where α_i and β_i denote the home shares of the export and import good respectively in their world endowment and can be expressed as

$$\alpha_i = \frac{C_i}{C_i^T}; \quad \beta_i = \frac{F_i}{F_i^T}$$

Substituting (4.1) and (4.2) into (3.22), we get

$$V(s) = \frac{1}{2}\ln(C_s^T F_s^T) + \ln(\alpha_s + \beta_s) - \frac{1}{2}\ln\left[1 - \frac{\eta_s(1-\beta_s)}{2}\right]$$
$$- \frac{1}{2}\ln\left[1 + \frac{\eta_s(1-\alpha_s)}{2(1-\eta_s)}\right]$$

$$(4.3)$$

Optimal $\vec{\eta}$ is then determined on maximizing the expected value of (4.3), in

terms of $(\vec{\alpha}, \vec{\beta})$ as given below.[19]

$$(1-\eta_s) = \left[\frac{(1-\alpha_s)(1+\beta_s)}{(1-\beta_s)(1+\alpha_s)}\right]^{\frac{1}{2}} \quad \forall s \qquad (4.4)$$

Equation (4.4) indicates that the comparison of the optimal import tariff

across states under regime I depends on the home shares of both exportable

and importable. Finally, substituting (4.4) into the expected value of

$V(s)$ in (4.3) and simplifying,

$$EV^I = \sum_i \frac{1}{2}\pi_i \ln(C_i^T F_i^T) + \sum_i \pi_i \ln(\alpha_i + \beta_i) + \ln(2)$$
$$- \sum_i \frac{1}{2}\pi_i \ln(1+\beta_i) - \sum_i \pi_i \ln(1+r_i^{\frac{1}{2}}) - \sum_i \frac{1}{2}\pi_i \ln(1+\alpha_i)$$

$$(4.5)$$

where

$$r_i = \left[\frac{(1-\beta_i)(1-\alpha_i)}{(1+\beta_i)(1+\alpha_i)}\right] \qquad (4.5a)$$

Equation (4.5) represents the maximum expected welfare that can be attained

---

[19]In the absence of asset markets, any cross state effect resulting
from the imposition of a tariff is absent. Hence the first order
conditions which determine $(\eta_1 \ldots \eta_s)$ are all separable and can be
solved analytically.

under regime I.

Regimes II and III

On simplification, the reduced form income and price equations in the presence of asset markets can be expressed as follows.

$$I_s = \frac{2 C_s^T N}{N + R(1-\gamma_s)} \tag{4.6}$$

$$P_s = \left[\frac{N + R\frac{(1-\gamma_s)}{(1-\eta_s)}}{N + (1-\gamma_s)R} \right] \frac{C_s^T}{F_s^T} \tag{4.7}$$

where

$$N = \sum_I \pi_I (\alpha_I + \beta_I) ; \quad R = \sum_I \frac{\pi_I}{(1-\gamma_I)} [(1-\alpha_I) + (1-\beta_I)(1-\eta_I)] \tag{4.7a}$$

Substituting (4.6) and (4.7) into (3.22) as before, the indirect utility function can be rewritten as

$$V(s) = \frac{1}{2}\ln(C_s^T F_s^T) + \ln\left[\sum_I \pi_I(\alpha_I+\beta_I)\right] + \ln(2) - \frac{1}{2}\ln[N+R(1-\gamma_s)] \\ - \frac{1}{2}\ln\left[N + \frac{R(1-\gamma_s)}{(1-\eta_s)}\right] \tag{4.8}$$

Optimal $(\vec{\eta}, \vec{\gamma})$ are obtained on maximizing the expected value of V.[20] The resulting first order conditions, on simplification, yield

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[20]Given effective protection as defined in footnote 7 above, this is equivalent to choosing the optimal export and import tariff vector.

$$\left.\frac{\partial EV}{\partial \eta_s}\right|_{\overline{\gamma}} = 0 \quad \Rightarrow \quad \frac{1}{N\left(\frac{1-\eta_s}{1-\gamma_s}\right)^2 + R\left(\frac{1-\eta_s}{1-\gamma_s}\right)} = (1-\beta_s)\, h_0 \quad \forall s \tag{4.9}$$

$$\left.\frac{\partial EV}{\partial \gamma_s}\right|_{\overline{\eta}} = 0 \quad \Rightarrow \quad \frac{(1-\gamma_s)^2}{N(1-\eta_s) + R(1-\gamma_s)} + \frac{(1-\gamma_s)^2}{N + R(1-\gamma_s)}$$
$$= h_0[(1-\alpha_s) + (1-\beta_s)(1-\eta_s)] \quad \forall s \tag{4.10}$$

where

$$h_0 = \sum_j \frac{\pi_j (1-\gamma_j)}{R}\left[\frac{1}{N(1-\eta_j) + R(1-\gamma_j)} + \frac{1}{N + R(1-\gamma_j)}\right] \tag{4.10a}$$

The optimal policy instruments under regime III (denoted by $\vec{\gamma}^{III}, \vec{\tau}^{III}$) are obtained on solving the system of equations embodied in (4.9) and (4.10) simultaneously while the optimal instruments under regime II (denoted by $\vec{\tau}^{II}$) are obtained on solving only the set of equations embodied in (4.9), having set $\vec{\gamma}$ to zero. Further, recalling from Chapter III that it is only the relative (across state) export tariffs that matter for asset decisions, we can arbitrarily set $(1-\gamma_0)$ to 1. However, due to the non linear nature of (4.9) and (4.10), analytical expressions for optimal instruments are hard to find.

Even without solving the set of equations embodied in (4.9), it is possible to make some observations regarding the nature of the optimal import tariff solution. A closer inspection of equation (4.7a) reveals that the expression denoted by R depends on the mean value of α, (say α^e) and the distribution of β and η when export tariffs are not used. The expression N always depends on the mean values of α and β, α^e and β^e, regardless of the policy regime. This, in turn, implies that the

expression h_0 in (4.10a) depends on α^e, β^e as well as the distributions of β and η under regime II. Thus, the optimal solution of η_s under regime II, as given by equation (4.9), will also depend on α^e, β^e, β_s and the distribution of β. For any given distribution of β, the optimal import tariff in any state s will be the same across different combinations of endowment shares, regardless of the distribution of home share in the world endowment of its exportable, provided its mean share in exportable is the same across these cases. It is worth noting however that this feature of the optimal import solution is sensitive to the simple log utility function used and need not generalize to any other functional form.

C. Comparison Across States

A closer inspection of (4.9) and (4.10) also reveals that although an analytic solution is not feasible, one can still compare the relative values of the optimal instruments across states. For instance, using (4.9) for any two states, k and s,[21] it can be verified that the relative value of import tariffs between states s and k depends only on the relative magnitude of the β's in those two states. This is because the whole endowment vector influences the optimal choice of r in any state in a symmetric fashion, as they are embodied in N and R. Hence:

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[21]Noting that $(1-r_s) = (1-\eta_s)/(1-\gamma_s)$

Proposition 4.1: Under either regime II (where only import tariffs may be used) or regime III (where both import and export tariffs are used);

$$\tau_k^* \lessgtr \tau_s^* \text{ as } \beta_k \gtrless \beta_s, \quad \forall s \neq k$$

In words, in the presence of asset markets, the optimal import tariff (under either regime II or III) in any state k is smaller (larger) than that in state s as the home country's share of the total world endowment of its importable good is larger (smaller) in state k than in state s. This contrasts with the earlier rule (under regime I) obtained in the absence of asset markets, where the shares of <u>both</u> import and export goods influence the relative values of optimal import tariffs across states.

To compare the relative values of export tariffs under regime III, we substitute (4.9) into (4.10) and simplify further. Then (4.10) can be rewritten as

$$\left.\frac{\partial EV}{\partial \gamma_s}\right|_{\eta} = 0 \implies \frac{(1-\gamma_s)^2}{N+R(1-\gamma_s)} = h_0(1-\alpha_s) \quad \forall s \tag{4.11}$$

As before, this implies that the comparison of the optimal export tariff across states depends only on the home country's share in the world endowment of its exportable good in those states and does not directly depend upon its share of the other good, although the complete solution involves shares of each good in all the states, as embodied in N and R. Hence:

Proposition 4.2: Under regime III (where both export and import tariffs are used);

$$\gamma_k^* \gtrless \gamma_s^* \ as \ \alpha_k \gtrless \alpha_s \quad \forall s \neq k$$

Furthermore, Propositions 4.1 and 4.2, taken together, indicate that the comparison of the effective protection η across states under regime III depends upon the endowment shares of both exportable and importable in those states, as under regime I.

The intuitive explanation for Proposition 4.1 or 4.2 lies in the fact that a rise in the import or export tariff also hurts the home country by reducing the volume of trade. The higher is the home share of the importable (exportable) in state k relative to state s, the lower (higher) is the volume of trade in the importable (exportable) good in state k than in state s. Hence we would expect the home government to impose a lower (higher) import (export) tariff in state k than in state s.[22]

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[22]Although we have not considered a regime where the home government uses export tariff only in the presence of asset markets, the preceding discussion suggests that such a regime would represent a mirror image of regime II. The expression for R in (4.7a) will depend on the distribution of α and γ as well as the mean import share, β^e. Substituting (4.7a) into (4.10a), h_0, in turn, will depend on the mean shares in importable and exportable as well as the distribution of α and γ. Finally, on substituting into (4.7a) and (4.10a) into equation (4.11), the optimal value of export tariff in any state s will be expressed in terms of β^e and the distribution of α.

D. Comparison Across Regimes

In addition to comparing the optimal values of export or import tariffs across states under any regime, we also compare the optimal policies across regimes in this section. This, in turn, enables us to comment on the nature of the first best policy in our model as well as the role of asset markets.

The First Best Policy

Welfare comparisons across different regimes are not simple, since the optimal policies under regimes II and III cannot, in general, be solved analytically. However, even without actually solving for optimal tariffs under these regimes, we can argue that the home country's expected welfare under regime III must be at least as high as that under regime I or regime II. This is because by properly choosing the additional instrument $\vec{\gamma}$ under regime III, it is always possible to reduce asset trade in this regime to a level such that it results in a solution equivalent to regime I or regime II. Hence regime III constitutes the first best policy in our stochastic framework with asset markets.

The intuitive idea underlying this claim becomes clear when one takes into account the fact that in a stochastic world, goods are redefined to incorporate the state of nature in which they are made available. Hence in a world of two goods and S possible states, there are, in fact, 2S goods

and (2S-1) relative prices. The corresponding first best policy calls for (2S-1) instruments. In addition to S import tariffs as in S-D model, extra instruments are needed to tax asset trade and are provided by export tariffs in the present model. In the absence of export tariffs, the existing import tariffs are used as imperfect substitutes to capture market power in asset markets and hence the associated welfare level is lower under regime II.

The Role of Asset Taxes

One may wonder why export taxes are used in the present model to tax asset trade. This can be attributed to the particular choice of the numeraire good in the present model. Since good C is used as the numeraire which, by our assumption, is the export good for the home country, taxing the real asset income (measured in units of C) is analogous to taxing the export good in our model.

An alternative characterization of the present model may proceed by allowing the home government to tax the asset income accruing to the home agents directly before uncertainty is resolved. Once uncertainty is realized, the government can choose either an import or an export tariff to influence the consumption decision of the home agents, given that the composition of tariffs does not matter ex post.

Ranking of Second Best Policies

Comparison of regimes I and II, in view of the above discussion, involves ranking two second best policies and nothing conclusive can be said. Regime I depicts a second best world because it is constrained by the absence of asset markets, although there remains potential gain from trading in these markets. In contrast, adequate policy instruments are not used under regime II with asset markets and this results in a second best world once again. In particular, it is no longer possible to replicate the regime I solution with regime II and it is conceivable that if only import tariffs are used, then expected welfare under regime II with asset markets can be lower than that under regime I without asset markets. Hence:

Proposition 4.3: If only import tariffs are used, the addition of asset markets may lower the expected utility of the policy active country.

Since an analytical solution for regime II is not feasible in general, we prove Proposition 4.3 by an example. Let us impose some structure on regime II by assuming that the home country's share in the world endowment of F is constant across states (i.e., $\beta_k = \beta \ \forall \ k$). From Proposition 4.1 , it then follows that

$$(1-\eta_k) = (1-\tau_k) = (1-\eta) \quad \forall k$$

The first order condition used to solve optimal policies under regime II (given by 4.9) then consists of only one equation and can be solved analytically using the definitions of N, R and h_0 from equations (4.7a) and (4.10a) respectively. This implies

$$(1-\eta^{II}) = \left[\frac{(1-\alpha^\theta)\ (1+\beta)}{(1+\alpha^\theta)\ (1-\beta)} \right]^{\frac{1}{2}} ; \quad \alpha^\theta \equiv \sum_I \pi_I \alpha_I \tag{4.12}$$

If α_i is also constant across states, this naturally reduces to the same solution as for regime I under this special case. Otherwise, the maximum expected welfare with regime II is obtained on substituting (4.12) into the expected value of (4.8) as follows.

$$EV^{II} = \sum_I \frac{1}{2} \pi_I \ln(C_I^T F_I^T) + \ln(\alpha^\theta + \beta) + \ln(2)$$
$$- \frac{1}{2}\ln(1+\beta) - \ln(1+r^{\theta\frac{1}{2}}) - \frac{1}{2}\ln(1+\alpha^\theta) \tag{4.13}$$

where

$$r^\theta = \frac{[(1-\alpha^\theta)\ (1-\beta)]}{[(1+\alpha^\theta)\ (1+\beta)]} \tag{4.13a}$$

Recalling equation (4.5), the maximum welfare attainable under regime I, and comparing with (4.13), we find that the difference in expected utility across regimes I and II hinges upon the order in which expectations are taken, i.e.,

$$E[V^I] - E[V^{II}] = E[G(\alpha_I)] - G[E(\alpha)]$$

where

$$G(\alpha_I) = \ln(\alpha_I + \beta) - \frac{1}{2}\ln(1+\alpha_I) - \ln(1+r_I^{\frac{1}{2}}) \tag{4.14}$$

and r_i is defined in (4.5a) above.

Applying Jensen's inequality, it then follows that

$$E[V^I] \gtrless E[V^{II}] \quad as \quad G_{\alpha\alpha} \gtrless 0$$

where the double subscript denotes the second derivative of G with respect to α. Differentiating (4.14) twice, it can be verified that $G_{\alpha\alpha}$ depends on the parametric values of α_i and β and cannot be signed in general. Case (3) in Table 4.1 below provides a specific example where the expected utility is higher under regime I than regime II and in this case, the addition of asset markets indeed lowers expected utility.

E. Simulation Results

Failing to obtain analytical solutions for regimes II and III, we present some simulation results in this section. We consider four different combinations of the home country's share of exportable and importable in a two state world (defined by state 0 and state 1) and compare expected welfare across all three policy regimes. In regime III, γ_0 is set equal to zero without loss of generality, as explained earlier. In the first case, α's and β's are assumed constant across states and as a result, there is no potential gain from asset trade. This example is used as a useful benchmark case. In the second case, α's are assumed invariant between states while β's are not. Hence asset trade occurs due to the difference in the home share of the importable across states. In contrast, β's are assumed constant across states in the third case while α's vary. Thus, trade occurs due to the difference in the home country's share in the

total world endowment of the exportable across states in this case.
Finally, the last case considers a more general scenario where both α and β
vary across states.

α and β always lie between 0 and 1. Further, α and β being the home
shares in the exportable and importable respectively, it follows that $\alpha > \beta$.
We construct the four cases by choosing α and β such that $\alpha^\theta = 0.8$ and $\beta^\theta =$
0.3 always, regardless of the distribution of α and β.

The non-linear equations are solved using an iterative technique. We
start with an initial guess value of the root and then improve upon it
using the Newton-Raphson formula. The algorithm is written in Fortran. A
detailed description of the Newton method is provided in Appendix D.

The simulation results are presented in Table 4.1 below. A close
inspection of these results reveals the following features.

1. The expected welfare level under regime III is always at least as high
as that under regime I or regime II regardless of endowment shares, as was
expected.

2. The first case also demonstrates that in the absence of any scope for
inter-state trade, the asset market has no role to play. Hence it is not
surprising that the optimal levels of policies and the associated welfare
levels are the same with or without asset markets in this case.

3. Comparison of regimes I and II also confirms that the introduction of
asset markets need not always be welfare improving, when adequate
instruments are not used, although there is scope for inter state trade.
In particular, when export tariffs are not used (Regime II), the

Table 4.1   Comparison of precommitment solutions across policy regimes

Case	α_0	α_1	β_0	β_1	Policy I	Policy II	Policy III
(1)	0.8	0.8	0.3	0.3	$\eta_0=\eta_1=0.5457$	$\eta_0=\eta_1=0.5457$	$\eta_0=\eta_1=0.5457$
						$\tau_0=\tau_1=\eta_0=\eta_1$	$\tau_0=\tau_1=\eta_0=\eta_1$
							$\gamma_0=\gamma_1 = 0.0$
					$EV^* = 1.8613$	$EV^* = 1.8613$	$EV^* = 1.8613$
(2)	0.8	0.8	0.1	0.5	$\eta_0 = 0.6315$	$\tau_0=\eta_0=0.6167$	$\tau_0=\eta_0=0.6167$
					$\eta_1 = 0.4226$	$\tau_1=\eta_1=0.4327$	$\tau_1=\eta_1=0.4327$
							$\gamma_0=\gamma_1=0.0$
					$EV^* = 1.8495$	$EV^* = 1.8684$	$EV^* = 1.8684$
(3)	0.62	0.98	0.3	0.3	$\eta_0 = 0.3400$	$\tau_0=\eta_0=0.5457$	$\eta_0 = 0.3244$
					$\eta_1 = 0.8630$	$\tau_1=\eta_1=0.5457$	$\eta_1 = 0.8721$
							$\tau_0=\tau_1=0.3244$
							$\gamma_1 = 0.8108$
					$EV^* = 1.8814$	$EV^* = 1.8613$	$EV^* = 1.9183$
(4)	0.62	0.98	0.1	0.5	$\eta_0 = 0.4646$	$\tau_0=\eta_0=0.6167$	$\tau_0=\eta_0=0.4289$
					$\eta_1 = 0.8259$	$\tau_1=\eta_1=0.4327$	$\eta_1 = 0.8406$
							$\gamma_1 = 0.8105$
							$\tau_1 = 0.1588$
					$EV^* = 1.8152$	$EV^* = 1.8684$	$EV^* = 1.9251$

NOTES: This simulation assumes $C^T_0=6, C^T_1=8, F^T_0=4, F^T_1=5, \pi_0=\pi_1=0.5$.
EV* refers to the maximum expected utility under each regime.

introduction of asset markets is most likely to reduce welfare when there is significant variation in α (share of exportable), but β is constant across states (case 3).

4. It is also interesting to note that in the second case, expected utility is always the same with asset markets, even when adequate policy instruments are not used. Since the home country's share of the exportable is the same across states in this case, from Proposition 4.2 it follows that $\gamma_1 - \gamma_0 = 0$. Therefore, although additional instruments are available, they are never used.

5. When only import tariffs are used, their optimal levels and the associated welfare levels are the same between cases (1) and (3) or between cases (2) and (4). This is due to the fact that the optimal import tariffs, under regime II, depend on the distribution of the home country's share of importable and the mean share of exportable, as explained earlier.

These conclusions are likely to be retained regardless of the world endowment levels or the probability distribution vector since any comparison of expected welfare across regimes primarily depends upon the parametric values of α and β.

To sum up, we endogenize tariff policy in this Chapter by making endowments random and examine the nature of optimal policy in a stochastic world with asset markets. The key points are that the first best policy calls for both export and import tariffs and the addition of asset markets need not be welfare improving when adequate policy instruments are not used. However, our discussion in this Chapter presupposes that government

policies that are announced are also pursued. We relax this assumption in
the next Chapter and address the time consistency issues explicitly.

V. ENDOGENOUS TARIFFS AND TIME CONSISTENCY

A. General Idea

Although the debate over "rules versus discretion" has played a
critical role in shaping the macroeconomic policies in the past decade,
relatively little attention has been paid to this issue in the trade policy
literature. Thus, in this chapter, we grant the government of the policy
active country the discretionary power to alter the tariff levels once
financial decisions are made and address the time consistency issues
inherent in such a framework. First, a few words about time consistency
seem appropriate.

A policy is said to be time consistent if it is optimal at every point
in time. Therefore, any policy rule, assuming precommitment to that rule
is possible, is necessarily time consistent. On the other hand, the
problem of inconsistency arises if the optimal policy evaluated today, is
no longer optimal when reexamined at a later date. This is likely to be
the case in an economy where there is a time lag between various decisions
taken by the private sector.[23] This is because once some decisions are
taken by the private sector (say production or financial decision or both)

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[23]It is important to emphasize here that although we deal with a
static framework in the present study, the sequence in which decisions are
made is important. Hence the time consistency issues remain germane.

based on the previously announced policy, the government usually has an incentive to revise its policy since its information set changes. If the government also has sufficiently discretionary power to do so, the pre-announced policy is no longer "credible" or time consistent. However, repeated inconsistency cannot persist. Hence a time consistent solution soon emerges which not only requires that the ex post policy be chosen optimally but also that the agents' expectations (about the future government policy) be correct.

Some recent studies (e.g., see Eaton and Grossman, 1985 or Staiger and Tabellini, 1987) discuss the time consistency issues in models in which tariffs are used as second best instruments to redistribute income from those with low marginal utility of income to those with high marginal utility of income. In contrast, Lapan (1988) and Maskin and Newberry (1990) address the time consistency issues inherent in the standard optimal tariff type argument. I will discuss these last two papers briefly, in an effort to relate the present research to the existing literature.

Lapan (1988) uses a static framework. The main theme of his paper is that in a world where there is a time lag between production and consumption decisions, the government of the large domestic country always has an incentive to raise the import tariff level ex post. This is because the optimal import tariff rate equals the reciprocal of the foreign export price elasticity of supply and this export supply curve is less elastic ex post. Hence the ex ante optimal tariff is not a time consistent policy. A consistent equilibrium however leads to a sub-optimal outcome (compared to

the precommitment equilibrium) in the sense that all countries are worse off ex post. The foreign (domestic) producers, correctly anticipating a future tariff higher than the ex ante optimum, respond by reducing (increasing) production. As a result, there is little trade and specialization. One alternative is to supplement the time consistent tariff policy with a more credible policy instrument, such as a production tax on the domestic production of importable. By restricting domestic production and thereby encouraging foreign production, such a policy is likely to raise welfare in both countries and help the economies move towards the optimal outcome.

In the same spirit, Maskin and Newberry (1990), investigate the dynamic inconsistency of optimal tariffs on oil, an exhaustible natural resource. The suppliers of oil decide on their current sale today based not only on the current oil prices but also on the predicted future oil prices which, in turn, depends on the future levels of the tariff imposed by the oil importing country. If the government of the importing country can irrevocably precommit to its announced time path of tariff, the so-called "open loop strategy" (i.e., tariff assuming precommitment) is time consistent. But Maskin and Newberry argue, as does Lapan, that the optimal open loop strategy is dynamically inconsistent in the sense that the large importer of oil will always find it beneficial to change the time path of tariff in the midstream. How this time path is going to be changed will depend on the rate at which the importing country trades off current versus future oil in consumption. If the importing country places greater weight

on future consumption (say U.S.), its government may announce today an exceptionally low tariff for the future so as to induce the suppliers to sell then. However, once the future period comes, there is nothing preventing it from raising the tariff levels and making the suppliers regret that they did not sell all their oil in the first period.

Maskin and Newberry also demonstrate that the dynamically consistent solution leads to an inferior outcome compared to the open loop strategy and discuss in this context the role that the future contracts on oil can play in overcoming the dynamic inconsistency problem. In particular, when the importing country places greater weight on future consumption, one way out is to buy future contracts on oil today so as to convince the supplier that the large importer has no incentive to raise tariffs and lower the market price in the future period. And if the level of future contracts is wisely chosen by the importing country, the ex ante optimum solution can be replicated by the time consistent solution.[24]

In a perfect foresight world of Maskin and Newberry or Lapan, the number of future contracts are government administered and not market determined. There is no economic rationale behind holding these contracts and these are merely used as tautological devices by the policy active government to improve upon the time consistent solution. In contrast, in our stochastic environment, the risk averse individuals participate in financial markets primarily to insure against uncertain income streams and

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[24]In an unpublished manuscript, Lapan (1988) also notes that under perfect foresight, the future contracts alter the time consistent equilibrium and can be used to achieve the ex ante optimum.

the optimal number of contracts is determined endogenously within the model.[25] Moreover, in the presence of spot markets, there is a time lag between the financial and consumption decisions taken by agents. This clearly provides an incentive for the policy active government to alter the tariff levels, given the equilibrium level of financial contracts. In this backdrop, we feel that a new dimension can be added to the existing literature by examining how the market determined levels of financial contracts may alter the time consistent policy ex post. We pursue this issue by extending our present framework as follows.

B. Extension of Basic Model

The simple structure as described in Chapter IV is used once again. i.e., only the home country is assumed policy active and a log utility function is used to represent the preferences. However, the home government, in this extended version, has the ability to revise tariff levels. In view of this, the sequence of decision-making gets modified as follows.

Sequence of Decision Making

(i)   The home government announces its optimal state contingent tariff

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[25]As indicated in Chapter III, we prefer using contingent financial contracts as opposed to future contracts, since the former implies a less restrictive payoff structure.

policy, given the expectations about the future endowment levels;

(ii) the representative agent in each country takes asset decisions based on their expectations about the revised tariff policy, regardless of government announcements;

(iii) uncertainty is resolved and actual endowment levels and their prices are realized;

(iv) tariff decisions are taken ex post by the home government, given the asset positions of the agents;

(v) actual consumption decisions are made based on the revised tariff levels.

Intuitively speaking, we can think of this sequential decision-making process as a "strategic" interaction between the policy active government and the private agents in both countries. At every stage, while choosing its optimal strategy, each player assumes that the other will act in its own best interests in the subsequent stages. In solving such a sequential "game", it is only important to know when the last opportunity occurs to announce the optimal level of a strategy variable, since it is the last opportunity which carries irreversibility with it. In this sense, the previously announced optimal tariff at step (i) is strategically irrelevant, although technically feasible.

It is instructive to note here that the policy active government is indifferent ex post between choosing an export tariff, an import tariff or any combination thereof. To put it differently, it is only the effective protection rate that matters for time consistent solution at step (iv).

This is because after uncertainty is resolved, the standard deterministic framework prevails and Lerner's symmetry holds. However, the agents asset decisions are still sensitive to the composition of tariffs as already explained in Chapter III. This, in turn, implies that the agents take their financial decision, in this extended framework, based upon their perception of the composition of government policy. Thus, the tariff structure matters for time consistent solution as well.

Implicit in the above mentioned sequence of decision making is the notion that the government can precommit to the use of a particular tax instrument (i.e., an ad valorem tariff policy in our case), though not to the particular level of this instrument. This can be rationalized on the ground that any change in the nature of tax instruments is likely to be costlier than a mere change in the levels of tax instrument currently in use. This, in turn, also raises the point that in general it is costly to change even the levels of existing policy instruments. These are real costs, ranging from the administrative costs of changing the paperwork to the punishment costs for violating the terms of international treaties like GATT (General Agreements on Tariffs and Trade). Hence policy credibility is a matter of degree in the real world and is usually determined by the cost of making policy changes. In the present study, we abstain from these issues concerning the role of policy adjustment costs in time consistency and focus instead on the role of the financial structure for time consistent policy.

Solution Technique

Assuming that agents take the expected tariff policy into account in deciding their asset position, and that their expectations are correct, imply that it is possible to optimize backwards. Hence the backward optimization technique as outlined in Appendix C is used once again. First the optimal income and price equations are obtained in step (v), given the optimal effective protection rate ex post as well as the optimal asset positions. Next the time consistent policy is obtained at step (iv), given the optimal asset positions, on maximizing the realized utility of the domestic agent and substituting the optimal income and price equations from step (v). The asset decisions, on the other hand, are made ex ante at step (ii) following the optimization process outlined in chapter III. The difficult task remains in substituting the solution values obtained at steps (v) and (ii) back into step (iv) so as to obtain the reduced form equations for time consistent tariffs.

C. The Role of Financial Structure

From the outline of the solution procedure, it becomes clear that the financial structure is likely to play an important role in determining the time consistent policy ex post. In other words, how the government is going to set its policy later will depend on whether financial contracts on the export good or the import good or any combination of these goods are used. Thus, there will be an infinite set of time consistent solutions,

one for each financial structure. This feature of time consistent solution marks a significant departure from the precommitment solution where the composition of asset income does not matter.

Let W and Z denote the number of contingent contracts bought (or sold) on good C and F respectively. Each costs (pays) the buyer (seller) θ_s and ϕ_s[26] units, respectively, of good C in the offshore market[27] in all the states for each unit of these contracts. Then the aggregate domestic real asset income, A_s (measured in units of C) is expressed as

$$A_s = W_s + \bar{p}_s Z_s$$

The corresponding asset budget constraint (analogous to equation (3.5)) is given by

$$\sum_I A_i \theta_i = \sum_I (\theta_i W_i + \phi_i Z_i) = 0 \tag{5.1}$$

From equation (5.1), it follows that if only contracts on C are used, i.e., $Z_s=0 \ \forall \ s$;

$$\sum_I \theta_i W_i = 0 \tag{5.2}$$

whereas if contracts on F are used, i.e., $W_s=0 \ \forall \ s$;

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[26]Note that arbitrage requires $\hat{p}_s=(\phi_s/\theta_s)$

[27]In this simplified setup where the foreign country is policy inactive, this is analogous to having settlement take place on the foreign soil; i.e., $p_s = \bar{p}_s \ \forall \ s$.

$$\sum_i \phi_i Z_i = 0 \tag{5.3}$$

Next we solve the present model under alternative financial structure. Essentially two types of financial structure are used. In the first case, the agents of both countries are allowed to trade only in financial contracts on the home export good C while in the second case, they trade only in contracts on the home import good F. On combining steps (iv) and (v) of the decision-making sequence, the time consistent tariffs are obtained as functions of endowment shares and financial contracts as follows.

When <u>financial contracts on C are used</u>; the optimal tariff ex post in any state s is given by

$$(1-\eta_s^c) = \left[\frac{(1-\alpha_s-W_s/C_s^T)(1+\beta_s)}{(1+\alpha_s+W_s/C_s^T)(1-\beta_s)} \right]^{1/2} \quad \forall s \tag{5.4}$$

On the other hand, if the agents <u>trade only in contracts on good F</u>,

$$(1-\eta_s^c) = \left[\frac{(1+\beta_s+Z_s/F_s^T)(1-\alpha_s)}{(1-\beta_s-Z_s/F_s^T)(1+\alpha_s)} \right]^{1/2} \quad \forall s \tag{5.5}$$

where the superscript c refers to the time consistent level of tariffs. Comparing equations (5.4) and (5.5) above with (4.4), the optimal level of precommitment tariffs under regime I without asset markets, it becomes clear that if the equilibrium levels of contracts are zero (as would be the case if endowment shares are such that there is no gain from inter-state trade), the time consistent solution will coincide with precommitment

solution.

The financial optimization problem, as outlined in Chapter III, on simplification, yields

$$A_s = X_s^T D_0 - m_s X_s^T \tag{5.6}$$

where

$$D_0 = \sum_j \pi_j m_j; \quad m_s = \frac{Y_s(1-\gamma_s)}{X_s^T}; \quad X_s^T = Y_s(1-\gamma_s) + \overline{Y}_s \tag{5.6a}$$

Equation (5.6) indicates that depending on the agents' perception about the tariff structure to be used, the asset demands will vary.

A closer inspection of equations (5.4), (5.5) and (5.6) reveals that in general it will be hard to obtain reduced form equations for time consistent tariffs, under either financial structure. However, by imposing additional structure on the model, we can generate some interesting predictions, even without actually solving the model.

Suppose the agents trade in contracts on C and they expect the government to impose import tariffs only. On setting $\eta_s = \tau_s$, $\gamma_s = 0$ and combining equations (5.2),(5.4),(5.6) as well as the optimal income and price equations obtained at step (v) (not shown here); the reduced form equation for time consistent import tariffs can be simplified as

$$(1-\tau_s^C) = \left[\frac{[1+\beta_s - D_0\{2-\tau_s(1-\beta_s)\}](1+\beta_s)}{[1-\beta_s + D_0\{2-\tau_s(1-\beta_s)\}](1-\beta_s)} \right]^{1/2} \tag{5.7}$$

where

$$D_0 = \frac{\sum_j \pi_j (\alpha_j + \beta_j)}{2\left[\sum_j \pi_j \left(1 - \frac{1}{2}\tau_j (1-\beta_j)\right)\right]} \qquad (5.7a)$$

From equations (5.7) and (5.7a), it is clear that the optimal import tariffs imposed by the home government ex post in any state s depends on its mean shares in the world endowment of its exportable and importable good (α^e, β^e), the home share of importable in that particular state (β_s) as well as the distribution of shares of importable across states $(\vec{\beta})$.

Such a solution has two interesting features. First, the time consistent tariffs will be the same between any two states s and j as long as the home shares of importable are the same in these states. Second and more interesting, given $\vec{\beta}$, the time consistent import tariff vector will be the same regardless of the distribution of export shares, as long as α^e remains the same across alternative distributions of endowment shares. From these two features, it then follows that if the distribution of β is such that $\beta_s = \beta_j = \beta^e$ $\forall$ s, the ex ante optimum tariff is also time consistent. This can be verified on substituting $\beta_s = \beta_j = \beta^e$ into equations (5.7) and (5.7a) and noting that on simplification, (5.7) reduces to equation (4.12) (evaluated at the mean shares). Hence we have the following proposition:

Proposition 5.1: When financial contracts on the <u>home export</u> good are used and agents expect the home government to impose <u>import</u> tariffs, the ex ante optimum tariff is also time consistent regardless of the distribution of home shares in the world endowment of its exportable, provided that the home country's share in the total world endowment of its import good is invariant across states.

As it turns out, a similar conclusion can be derived when the agents trade in financial contracts on F and expect the government to impose export tariffs ex post. To see this clearly, we proceed as before and obtain the reduced form equation for time consistent export tariffs (on combining (5.3),(5.5),(5.6) and the optimal income and price equations at step V) as follows.

$$(1-\gamma_s^c) = \left[\frac{\left[1-\alpha_s+2D_0\left\{1+\frac{1}{2}\frac{\gamma_s}{(1-\gamma_s)}(1-\alpha_s)\right\}\right](1-\alpha_s)}{\left[1+\alpha_s-2D_0\left\{1+\frac{1}{2}\frac{\gamma_s}{(1-\gamma_s)}(1-\alpha_s)\right\}\right](1+\alpha_s)} \right]^{1/2} \tag{5.8}$$

where

$$D_0 = \frac{\sum_j \pi_j(\alpha_j+\beta_j)}{2\left[\sum_j \pi_j\left\{1+\frac{1}{2}\frac{\gamma_j}{(1-\gamma_j)}(1-\alpha_j)\right\}\right]} \tag{5.8a}$$

As before, close inspection of (5.8) and (5.8a) reveals that the optimum export tariffs in any state s depends on $\alpha^e, \beta^e, \alpha_s$ and $\vec{\alpha}$. If the home country's share in the world endowment of its exportable remains the same across states, the time consistent export tariffs also remain invariant across states. Moreover, if $\alpha_s = \alpha_j = \alpha^e \ \forall \ s$, the ex ante export tariffs are also time consistent irrespective of the distribution of β. Hence Proposition 5.2:

Proposition 5.2: If financial contracts on the <u>home import</u> good F are used and agents expect the home government to use <u>export</u> tariffs, the ex ante optimum tariff is also time consistent; regardless of the distribution of its shares in the world endowment of its importable, provided that the home country's share in the world endowment of its export good always remains at its mean level.[28]

It is worth emphasizing here that these conclusions are sensitive to the simple log utility function used and need not generalize to any functional form. Nevertheless, these results clearly demonstrate the crucial role that financial structure plays in influencing the time consistent policy ex post. Moreover, these results also suggest that for certain combinations of endowment shares, the optimal (market determined) levels of financial contracts can sustain the precommitment solution as time consistent.

D. Simulation Results

Failing to obtain analytical solutions for time consistent tariffs, we resort to simulation methods once again. The Newton updating formula (as described in Appendix D) is used to improve upon the initial guess. To provide comparisons with precommitment tariffs (as obtained in Chapter IV), the same combinations of endowment shares are considered for a two state world and the agents are assumed to trade only in financial contracts on

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[28]It turns out that the optimal export (import) tariffs when financial contracts on home export (import) good used, in general, depend on the distribution of both α and β. Thus, it becomes difficult to obtain reduced form equations for time consistent tariffs in these cases.

good C.[29]

For the sake of completeness, an additional policy regime is used and the regimes are redefined as follows. Under regime I, the home government uses only import (or equivalently export) tariffs as before in the absence of financial markets. Under regime II, it imposes only import tariffs with asset markets, the S-D case. We redefine regime III as the scenario where the home government uses only export tariffs in the presence of asset markets. Finally, regime IV depicts the situation where the government uses both export and import tariffs in some arbitrary combination, given the asset markets. i.e., $\gamma = kr$ (say) and we set $k = 1$.

The simulation results are presented in Table 5.1 below. A careful examination of these results reveal some interesting features.

1. Case (1) depicts a scenario where there is no role for asset markets since both endowment shares are the same across states. In the absence of asset trade, there is no real difference between ex ante optimum and ex post optimum tariffs. Hence, the optimal precommitment and time consistent tariffs and the associated welfare levels are always the same under regimes II, III and IV. Further, the optimal policies with asset markets are also identical to those without these markets, in the absence of any scope for inter-state trade.

2. The expected welfare levels with precommitment policies are always at least as high as those with time-consistent policies, for each regime.

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[29]It is important to note here that the simulation results in this chapter are limited in scope since alternative financial structures are not considered.

Table 5.1   Comparison of precommitment and time consistent solutions

Case	α_0	α_1	β_0	β_1	Policy I	Policy II (precommit)	Policy II (time consist)
(1)	0.8	0.8	0.3	0.3	$\eta_0=\eta_1=0.5457$	$\eta_0=\eta_1=0.5457$	$\eta_0=\eta_1=0.5457$
						$\tau_0=\tau_1=\eta_0=\eta_1$	$\tau_0=\tau_1=\eta_0=\eta_1$
					$EV^* = 1.8613$	$EV^* = 1.8613$	$EV^* = 1.8613$
(2)	0.8	0.8	0.1	0.5	$\eta_0 = 0.6315$	$\tau_0=\eta_0=0.6167$	$\tau_0=\eta_0=0.6837$
					$\eta_1 = 0.4226$	$\tau_1=\eta_1=0.4327$	$\tau_1=\eta_1=0.3473$
					$EV^* = 1.8495$	$EV^* = 1.8684$	$EV^* = 1.8632$
(3)	0.62	0.98	0.3	0.3	$\eta_0 = 0.3400$	$\tau_0=\eta_0=0.5457$	$\tau_0=\eta_0=0.5457$
					$\eta_1 = 0.8630$	$\tau_1=\eta_1=0.5457$	$\tau_1=\eta_1=0.5457$
					$EV^* = 1.8814$	$EV^* = 1.8613$	$EV^* = 1.8613$
(4)	0.62	0.98	0.1	0.5	$\eta_0 = 0.4646$	$\tau_0=\eta_0=0.6167$	$\tau_0=\eta_0=0.6837$
					$\eta_1 = 0.8259$	$\tau_1=\eta_1=0.4327$	$\tau_1=\eta_1=0.3473$
					$EV^* = 1.8152$	$EV^* = 1.8684$	$EV^* = 1.8632$

NOTES: This simulation assumes $C^T_0=6, C^T_1=8, F^T_0=4, F^T_1=5, \pi_0=\pi_1=0.5$.
EV* refers to the maximum expected utility under each regime.

across policy regimes

Policy III (precommit)	Policy III (time consist)	Policy IV (precommit)	Policy IV (time consist)
$\eta_0 = \eta_1 = 0.5457$	$\eta_0 = \eta_1 = 0.5457$	$\tau_0 = \gamma_0 = 0.3260$	$\tau_0 = \gamma_0 = 0.3260$
$\gamma_0 = \gamma_1 = \eta_0 = \eta_1$	$\gamma_0 = \gamma_1 = \eta_0 = \eta_1$	$\tau_1 = \gamma_1 = 0.3260$	$\tau_1 = \gamma_1 = 0.3260$
		$\eta_0 = \eta_1 = 0.5457$	$\eta_0 = \eta_1 = 0.5457$
$EV^* - 1.8613$	$EV^* - 1.8613$	$EV^* - 1.8613$	$EV^* - 1.8613$
$\gamma_0 = \eta_0 = 0.5457$	$\gamma_0 = \eta_0 = 0.7439$	$\tau_0 = \gamma_0 = 0.3922$	$\tau_0 = \gamma_0 = 0.4630$
$\gamma_1 = \eta_1 = 0.5457$	$\gamma_1 = \eta_1 = 0.1253$	$\tau_1 = \gamma_1 = 0.2366$	$\tau_1 = \gamma_1 = 0.1485$
		$\eta_0 - 0.6306$	$\eta_0 - 0.7117$
		$\eta_1 - 0.4173$	$\eta_1 - 0.2750$
$EV^* - 1.8613$	$EV^* - 1.8287$	$EV^* - 1.8654$	$EV^* - 1.8588$
$\gamma_0 = \eta_0 = 0.3244$	$\gamma_0 = \eta_0 = 0.4604$	$\tau_0 = \gamma_0 = 0.1950$	$\tau_0 = \gamma_0 = 0.2973$
$\gamma_1 = \eta_1 = 0.8721$	$\gamma_1 = \eta_1 = 0.7152$	$\tau_1 = \gamma_1 = 0.5170$	$\tau_1 = \gamma_1 = 0.3732$
		$\eta_0 - 0.3520$	$\eta_0 - 0.5062$
		$\eta_1 - 0.7667$	$\eta_1 - 0.6071$
$EV^* - 1.9183$	$EV^* - 1.8925$	$EV^* - 1.8795$	$EV^* - 1.8703$
$\gamma_0 = \eta_0 = 0.3244$	$\gamma_0 = \eta_0 = 0.6584$	$\tau_0 = \gamma_0 = 0.2696$	$\tau_0 = \gamma_0 = 0.4199$
$\gamma_1 = \eta_1 = 0.8721$	$\gamma_1 = \eta_1 = 0.2280$	$\tau_1 = \gamma_1 = 0.4364$	$\tau_1 = \gamma_1 = 0.1640$
		$\eta_0 - 0.4664$	$\eta_0 - 0.6635$
		$\eta_1 - 0.6824$	$\eta_1 - 0.3011$
$EV^* - 1.9183$	$EV^* - 1.8077$	$EV^* - 1.8659$	$EV^* - 1.8350$

This need not be the case in general since we are comparing two second best policies under every regime. It is important to emphasize here that the precommitment policy, in our construction, always represents a second best situation due to the lack of adequate policy instruments. In contrast, the optimal policy ex post involves time consistency issues and is therefore second best. It is conceivable that a time consistent policy may lead to higher expected welfare than the corresponding precommitment policy in our setup for different combinations of endowment shares.

3. Only for the third case, the precommited import tariff policy is also time consistent and the associated expected welfare levels are the same. This directly follows from Proposition 5.1 above.

4. It is instructive to look at the optimal solutions under regime III since the time consistent export tariff (when financial contracts on C are used) depends on the entire distribution of the home country's share in the world endowment of its exportable and importable. Comparing the optimal solutions under regime III with those for regime I, it turns out that when the government has the ability to alter export tariffs, it is worse off with the introduction of asset markets under cases (2) and (4), although there clearly remains potential gains from trading in these markets. This result is especially intriguing in view of the fact that the precommited export tariffs always lead to higher expected welfare when asset markets are explicitly introduced.

We close our discussion by recalling our main finding in this Chapter; i.e., the financial structure plays an important role in influencing the

time consistent policy ex post. To put it differently, the composition of asset income also matters for time consistent solution. Furthermore, for specific combination of endowment shares, the endogenously determined levels of financial contracts can sustain the ex ante solution as time consistent. However, the simulation results are limited in scope since alternative financial structures are not considered and should be interpreted with caution.

VI. SUMMARY AND CONCLUSIONS

An attempt is made in the present study to analyze the impact of financial markets for trade policy under conditions of uncertainty. This is a relatively new area of research and has gained considerable importance lately due to the rapid development and growing integration of financial markets in recent years. When the agents encounter the possibility that a policy change may occur, they have incentives to insure the policy risks they face. The availability of financial markets explicitly provide these risk sharing opportunities by permitting agents to transfer resources over time as well as across states of nature. Consequently, the opportunities to trade in these markets can completely change the effects of government policies.

A fascinating illustration is provided by Stockman and Dellas (1986) where they have shown that when government's import tariffs are random and agents trade in contingent commodity claims, a large country is better off in realized utility sense when the foreign country imposes tariff than if it does. We build upon and extend Stockman-Dellas type of framework in the present study to examine the role of tariff structure and the nature of optimal policy in a stochastic framework with asset markets. Further, we address the time consistency issues that arise when the governments cannot commit to their previously announced policies and in this context, examine the role that the financial structure plays in influencing time consistent

tariffs.

After introducing the topic and reviewing the literature in Chapter I and sketching an outline of Stockman-Dellas framework in Chapter II, we develop our own theoretical model in Chapter III. The two most distinguishing features of our model are that governments of both home and foreign country use a combination of random export and import tariffs and agents trade in financial contracts, with the provision of spot trading in consumption goods. A log utility function is used to represent the preferences of the agents. The main results of Chapter III suggest that: (i) the structure of commercial policy (i.e., import or export tariffs) matters, so that Lerner's symmetry theorem does not extend to a stochastic framework with asset markets; (ii) the Stockman-Dellas conclusions that the home country's realized utility is higher in those states where its own import tariff is zero (and the foreign import tariff is positive) do not hold when export tariffs are used; (iii) in general, it is optimal to use both import and export tariffs in such a framework. Some comparative static results are also provided which indicate how consumption levels vary across states in response to changes in export or import tariffs. Finally we point out that tariff structures will generally matter for production decisions as well.

In Chapter IV, we endogenize tariff policy by assuming that endowments are random and tariffs are chosen optimally. Here we compare the values of optimal policies across states within any regime as well as optimal policies across regimes. The comparison of optimal policies across states

reveals that whether the export (import) tariff in any state is higher or lower than that in any other state depends only on the policy active country's share in the world endowment of the exportable (importable), although the complete solution depends on the shares of both the goods in all the states in the presence of asset markets. To compare optimal policies across regimes, simulation method is used. Our simulation results indicate that the expected welfare when both export and import tariffs are used is at least as high as that when only import tariffs are used, with or without asset markets. However, if commercial policy is restricted to import tariffs, the introduction of asset markets can be welfare deteriorating, even though there remains potential gains from engaging in inter-state trade.

In Chapter V, we outline the potential time consistency issues inherent in such a framework. With the provision of spot trading in consumption, the policy active government usually has an incentive to revise tariff policy after financial decisions are made and this has real effects. Using simulation results, we show that the tariff structure matters for time consistent solution as well, since agents asset decisions are sensitive to their perception of the composition of government policy. More interesting, the financial structure plays a critical role in determining the time consistent policy ex post. In particular, we demonstrate that if agents trade in financial contracts on the home exportable (importable), the ex ante optimum import (export) tariff is also time consistent, provided the home country's shares in the world endowment

of its importable (exportable) remains invariant across states. Finally, our simulation results also indicate that the precommitment policy always gives rise to at least as high expected utility as time consistent policy, when financial contracts on C are used. However, this need not be the case always, since both the policies are perceived second best in the present setup.

A. Extensions

An obvious extension of the present research would be to incorporate production decisions explicitly and analyze time consistency issues once again. As Lapan (1988) pointed out, time consistency issues seem germane even in a deterministic world where there is a time lag between production and consumption decisions. Thus, it is worth exploring how our results will change in a production economy with asset markets, where both the production and asset decisions are taken before uncertainty is resolved and government cannot precommit its commercial policy.

Also we have not included the policy adjustment costs in analyzing time consistency issues. In practice, policy credibility is a matter of degree rather than something that exists or not. The degree of such credibility is determined by the cost of making policy changes. It is conceivable that whether or not the government revises its policy ex post will depend on the benefits from revised tariffs net of cost of changing tariffs vis-a-vis benefits from ex ante tariffs. In view of this, another

possible extension of present research can proceed by examining the role that policy adjustment costs can play in alleviating the time consistency problems.

Finally, we have assumed complete asset markets throughout the present study despite the fact that in real world, some insurance market or other is usually missing. The incompleteness of financial markets can be due to imperfect information like "moral hazard" and "adverse selection" or this can be attributed to various forms of government restrictions still prevailing in these markets. Hence another interesting extension of the present study would be to investigate the impact of "incomplete" financial markets.

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APPENDIX A

Let M denote the number of futures contracts on good F. By convention, M>0 indicates that the domestic agents are net buyers of future contracts. As with financial contracts, the settlement of futures contracts is assumed to take place in the offshore market. Let $\hat{p}_m$ indicate the predetermined (offshore) relative price of F as specified in the futures contract.

The representative agent in the home country chooses the optimal number of futures contracts by solving the following optimization problem:

$$\underset{M^h}{Max} \qquad \sum_I \pi_i V(I_i^h; p_i)$$

subject to

$$I_i^h = Y_i^h + \frac{M^h(\hat{p}_i - \hat{p}_m)}{(1 - \gamma_i)} \qquad\qquad (A.1)$$

The income equation of the domestic agent is derived using the same logic as before in the case of financial contracts.

The representative agent in the foreign country chooses a similar optimization problem:

$$\frac{Max}{M^h} \qquad \sum_I \pi_i V(\overline{I}_i^h; \overline{p}_i)$$

subject to

$$\overline{I}_i^h = \overline{Y}_i^h + \overline{M}^h (\beta_i - \beta_m)(1 - \overline{\tau}_i) \tag{A.2}$$

Further, given the representative agent assumption, futures market equilibrium requires

$$M^* + \overline{M}^* = 0 \tag{A.3}$$

where M^* and $\overline{M}^*$ denote the optimal aggregate holdings of futures contracts in home and foreign country respectively. Equation (A.3) determines $\hat{p}_m$.

Let $A^{h*}(\overline{A}^{h*})$ and $M^{h*}(\overline{M}^{h*})$ be the optimal solutions in the home (foreign) country with state contingent financial contracts and futures contracts respectively. Comparing the optimal income equation (A.1) with (3.9), it becomes clear that the return from holding financial contracts can be replicated by futures contracts if

$$M^{*h}(\beta_i - \beta_m) = A^{*h}_i \qquad \forall i \tag{A.4}$$

or equivalently,

$$\overline{M}^{*h}(\beta_i - \beta_m) = \overline{A}^{*h}_i \qquad \forall i$$

using asset market equilibrium conditions (3.15) and (A.3) respectively. Further, substituting (A.4) into asset budget constraint (3.5) and simplifying,

$$\sum_I \theta_i \beta_i = \beta_m \tag{A.5}$$

which, in turn, determines θ^*_i.

When there are two states, there is only one independent equation in M^* on combining (A.4) and (A.5) and summing over h. Hence M^* can be uniquely determined and contingent payment pattern is replicated. However, for more than two states, M^* is uniquely determined only if

$$\frac{A_s}{A_j} = \frac{\hat{p}_s - \hat{p}_m}{\hat{p}_j - \hat{p}_m} \qquad \forall \, s \neq j \tag{A.6}$$

This, in turn, requires that A^*_i be linear in $\hat{p}_i$.

APPENDIX B

Given the same intra-state effective protection across regimes (η^I_s = η^{II}_s, $\bar\eta^{II}_s$ = $\bar\eta^{II}_s$ ∀ s), the consumption allocation for each state will be the same for the two regimes if, and only if, net asset trades for each state are the same for the two regimes (A^I_s = A^{II}_s, $\bar A^I_s$ = $\bar A^{II}_s$ ∀ s). Supporting this solution requires that (i) (internal and world) relative commodity prices for each state be equal across regimes; (ii) internal (home and foreign) relative inter-state asset prices be the same across regimes; and (iii) that the net value of asset trades, evaluated at world prices, be equal (to zero) for both regimes. It does not <u>necessarily</u> require world asset prices for each state to be equal across regimes. Define:

$$X^i_s = \left(\frac{1-\gamma^i_s}{1-\gamma^i_1}\right), \quad i = I, II; \quad \mu_s = \frac{X^{II}_s}{X^I_s} \qquad (B.1)$$

and ($\bar X^i_s$, $\bar\mu_s$) is defined symmetrically. By definition, μ_1 ($=\bar\mu_1$) = 1. Also define:

$$\sigma^i_s = (\theta^i_s / \theta^i_1); \quad i = I, II; \quad \sigma^i_1 = 1 \qquad (B.2)$$

In (B.2), σ^i_s is the world relative price of A_s (compared to A_1) under regime i. From the FOCs determining optimal asset positions ((3.13) and (3.14)), preserving internal relative asset prices implies:

$$(\sigma_s^I / \sigma_s^{II}) = \mu_s = \bar{\mu}_s \quad \forall s \tag{B.3}$$

Finally, the asset budget constraint (3.5) implies:

$$\sum_s \sigma_s^{II} A_s = \sum_s \sigma_s^I A_s = \sum_s \mu_s \sigma_s^{II} A_s = 0 \tag{B.4}$$

(where no regime superscripts appears on the A_s under the assumption of identical allocations).

Clearly, if $\mu_s = \bar{\mu}_s = 1 \; \forall \; s$, the two regimes are functionally equivalent, so Lerner's symmetry theorem (as modified) holds. If $\mu_s \neq 1$ for some s, then for arbitrary $\bar{\mu}_s$, the two regimes will yield different outcomes. However, it is possible (though a singularity) for (B.4) to hold even if $\mu_s \; (= \bar{\mu}_s)$ is not identically equal to 1 (provided there are more than two states). Intuitively, if the $\mu_s \; (=\bar{\mu}_s)$ vector is chosen to preserve domestic internal asset prices and the net value of asset trades (at world asset prices), the resulting allocation will be unaltered even though world asset prices change.

APPENDIX C

In the second stage, income and price equations are obtained, given the asset position, as follows. Substituting the consumption demand for good C from (3.23) into the goods market equilibrium condition (3.16) and using the income definitions (3.11) and (3.12) (summed over all agents), balance of trade condition (3.7), the arbitrage relation (3.3) and finally noting that $M - \bar{X}$; the equilibrium spot relative price in the foreign market is solved as follows.

$$\bar{P}_s = \frac{(1+K_s-\bar{\eta}_s) - (\mu-\bar{A}_s)(1-K_s)(1-\bar{\eta}_s)}{2-\bar{\eta}_s-\mu(1-K_s)} \tag{C.1}$$

Substituting $\bar{p}_s$ in (3.11) and (3.12) (summed over agents) and once again recalling arbitrage relation (3.3), the income equations (in terms of $\bar{A}_s$) are then obtained as

$$I_s = \frac{2[1-\mu\bar{\eta}_s-\bar{A}_s(1-\bar{\eta}_s)]}{2-\bar{\eta}_s-\mu(1-K_s)} \tag{C.2}$$

$$\bar{I}_s = \frac{2(1-\bar{\eta}_s)(1+\bar{A}_s) + 2\mu(K_s-1+\bar{\eta}s)}{2-\bar{\eta}_s-\mu(1-K_s)} \tag{C.3}$$

The home and foreign aggregate asset demands are obtained in the first stage on solving the optimization problems as outlined in the text and summing over agents. This, in turn, yields

$$A_s^{\cdot} = \frac{\pi_s}{\theta_s}\left[\sum_j \theta_j(1-\gamma_j)Y_j\right] - (1-\gamma_s)Y_s \tag{C.4}$$

$$\bar{A}_s^\bullet = \frac{\pi_s}{\theta_s}\left[\sum_J \frac{\theta_J \bar{Y}_J}{(1-\tau_J)}\right] - \frac{\bar{Y}_s}{(1-\tau_s)} \tag{C.5}$$

Then asset market equilibrium condition (15) implies

$$\theta_s = \frac{(\pi_s/X_s^T)}{\sum_I (\pi_i/X_i^T)} \tag{C.6}$$

where

$$X_s = I_s(1-\gamma_s) ; \quad \bar{X}_s = \frac{\bar{I}_s(1-\bar{\gamma}_s)}{(1-\bar{\eta}_s)} ; \quad X_s^T \equiv X_s + \bar{X}_s \tag{C.6a}$$

Substituting (C.6) back into (C.4) and (C.5), the reduced form asset demands are obtained as

$$A_s^\bullet = X_s^T \sum_I \frac{\pi_i L_i}{X_i^T} - L_s \tag{C.7}$$

$$\bar{A}_s^\bullet = X_s^T \sum_I \frac{\pi_i \bar{L}_i}{X_i^T} - \bar{L}_s \tag{C.8}$$

where, by our construct,

$$L_s = Y_s(1-\gamma_s) ; \quad \bar{L}_s = \frac{\bar{Y}_s}{(1-\tau_s)} ; \quad L_s^T \equiv L_s + \bar{L}_s = X_s^T$$

It then follows from (C.8) that

$$\sum_J \pi_J \frac{\bar{A}_J}{X_J^T} = 0 \tag{C.9}$$

Let us define $D_0 = X_i/\dot{X}_i$ which can be shown to be invariant across states. Substituting (C.6a), (C.2) and (C.3) in D_0, $\dot{A}_i$ can be expressed in terms of D_0 which, in turn, is plugged into (C.1) through (C.3) to obtain equations

(3.25), (3.26), (3.27). Finally, (C.9) is used to solve for D_o.

APPENDIX D

Let Y = f(x) be a non-linear function of x. To find the <u>roots</u> of the equation f(x) = 0, we proceed as follows. Let x = x_i be some initial guess value of x. Then the successive approximations of x are obtained as

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}; \quad f' \neq 0 \quad \forall i$$

using the Newton-Raphson formula, where f'(x) denotes the first derivative of f(x) with respect to x. If these iterations produce approximations that approach the solution more and more closely at every step, the iterative method is said to <u>converge</u>.

The Newton-Raphson formula may be derived analytically using the following Taylor series approximation of the function f(x).

$$f(x_{i+1}) = f(x_i+h) = f(x_i) + hf'(x_i) + \frac{h^2}{2!}f''(x_i) + \ldots = 0$$

Neglecting all terms of second and higher degree in h and simplifying,

$$h = -\frac{f(x_i)}{f'(x_i)}$$

This method can be easily extended to a two variable case.

Graphically, the Newton-Raphson updating formula implies that the initial guess value (x_i) is updated by that point where the slope of the tangent to the curve y = f(x) at x_i intersects the x-axis and this process is repeated until convergence.

As it turns out, the Newton method is very sensitive to the choice of initial guess. If the initial guess is not near the root, it may lead to an endless cycle. In the present study, the initial guesses are always provided using the grid search technique. We evaluate the objective function (underlying the first order condition, $f(x)=0$) at equally spaced points over the entire range of x and choose that x for which the objective function is at its maximum.