STRATEGIC EXCHANGE RATE CO-ORDINATION:

A THREE-COUNTRY MODEL

TO

THE LORD

MY WIFE HEA-KYOUNG

AND OUR PARENTS

STRATEGIC EXCHANGE RATE CO-ORDINATION:

A THREE-COUNTRY MODEL

By

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ABSTRACT

The highly integrated nature of the global economy has increased the interdependence of macroeconomic policy between countries. The benefit of international policy co-ordination has been analyzed by many economists with optimal control and game theory techniques. In the literature, different assumptions regarding the strategic behavior of countries lead to several common equilibrium concepts as the available options to the policy authorities: Nash, Stackelberg, and cooperative equilibria. A cooperative solution generally has advantages over a non-cooperative Nash solution, and the difference is measured as the welfare gains from co-ordination. The advantages of a Stackelberg leader-follower solution over a Nash equilibrium are also often discussed.

Some common features of existing studies are that money supply policy is used in pursuing two targets in a symmetric two-country model, and that mutual gains from co-ordination are suggested. Recently, however, numerical analyses find the gains from co-ordination to be small and sometimes negative. Thus, there have been attempts to find cases where co-ordination creates large gains.

This thesis develops a Keynesian three-country model to extend this literature. Static game theory is used in a short-run analysis. The exchange rate is strategically used by the stabilization policy authorities of two small countries as a monetary policy instrument, in pursuing three targets -- the inflation rate, the balance of payments,

and the employment rate. The third country, the rest of the world, is assumed to be passive. With these new features of our framework and with representative parameter values being used in numerical simulations, we investigate several suggestions made by other authors regarding the issue of gains from policy co-ordination.

The links with the third country significantly influence the effects of the small countries' policies. Hence, the Canzoneri-Minford and Turnovsky-d'Orey suggestions that higher macroeconomic interdependence (measured as the ratio of transmission effects to own policy effects) between economies or lower trade price elasticities may increase the gains from co-ordination do not always hold. Tobin's (1978, p. 489) proposal that we should throw "*some sand in the wheels of our excessively efficient international money markets*" is examined under varying degrees of capital mobility, and it is supported by our findings. The effects of structural asymmetry between the small countries on the welfare outcome are also analyzed by allowing for asymmetric patterns in trade and capital flows. In some asymmetric patterns, one country is always better off as a Stackelberg leader, contrasting with the result of Eichengreen. The gains to both countries from policy co-ordination suggest stability of the co-ordination in these asymmetric patterns. However, the gains from co-ordination turn out to be small.

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Once upon a time, one young man had a dream to be a scholar who strolls around campus with grey hair reflecting evening twilight, a scholar of knowledge who loves only truths and belief, surrounded by knowledge-longing disciples. He decided to walk the road to learning, by giving up his established career as a central banker, many years after university graduation.

The process of completing a thesis has been a long and dark tunnel which often seemed endless. I owe my great intellectual debt to the guardian angels, the three members of my dissertation committee. This dissertation would never have been completed without their guidance. The committee chairman Professor Ken S. Chan as a big brother, Professor William M. Scarth as a strict schoolmaster, and Professor Lonnie Magee as a wise friend, devoted countless time providing keen comments and encouragement with tremendous patience and generosity. Professor Chan, especially, contributed to the initial stages of the dissertation. Finally, without my wife Hea-Kyoung's endless love and financial support, and without our parents' prayers, the young man could never have walked through the gate to the beginning of new life as a scholar.

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CHAPTER ONE: INTRODUCTION

I. Purpose of The Study

Due to growing economic integration and the resulting interdependence of economic policies among industrial countries, international policy co-ordination has become an important subject, even though successful co-ordination has been hardly achieved. There is an extensive literature dealing with this subject, and formal work in this area spread widely after the pioneering articles of Niehans (1968) and Cooper (1969).

Early writings on this issue analyzed the effect of one country's policy on the other countries, referred to as the "*transmission*" or "*spill-over*" effect. Later, using optimal control and game theory techniques, a strategic optimization approach has been adopted. The study of Hamada (1976) was the first paper in this strategic policy literature. We adopt this approach in this thesis in a three-country model.

Recently, a number of countries have experienced severe trade deficits. During the mid 1980s in particular, conflicts have developed among the U.S., Japan, and some Newly Industrialized Countries (for example, Taiwan, South Korea), where the co-ordination issue has focused on commercial policies and external policy instruments such as exchange rates. For example, to reduce its huge trade deficit, the U.S. has pressured others to appreciate their currencies. These conflicts suggest that each country's exchange rate be taken as the fundamental policy instrument to be considered in a policy co-ordination study. We focus on two small economies which pursue a current account surplus and are willing to use the exchange rate (i.e. depreciation) as a policy tool.

While our policy instrument is different from other studies, our primary question is the same as that of the existing literature: "*Can policy co-ordination between countries improve their welfare, and if so how large are these gains likely to be?*" Mutual gains from international policy co-ordination have been predicted in many studies (especially in earlier writings using static analysis). But recently, numerous studies have suggested that the size of welfare gains from co-ordination is small.[1] Even negative effects (losses) have also been implied in some cases.[2] Thus, there have been various attempts to discover which features of a macro model lead to the small gains conclusion, and to find cases where the gains from co-ordination are bigger.

Therefore, the purpose of this thesis is to extend the existing policy co-ordination literature by numerically examining some of the suggestions made in previous studies, as a part of the recent attempts to find the obstacles to obtaining large gains from co-ordination and cases where co-ordination pays. Our framework has several new features as described in the following section.

II. Key Features of The Model

We have used several assumptions that are somewhat different from existing studies. The key features of the present thesis are as follows.

A. Policy Instrument: The exchange rate is assumed to be the only instrument for the policy authorities to attain both internal (inflation, the employment rate) and external (the balance of payments) targets.[3] Most existing studies use the money supply as the instrument.

B. Number of Countries: A (standard Keynesian) three-country model is employed.[4] To my knowledge, this is the first attempt in the literature to use three countries in a theoretical model. The existing studies involve two countries. At various stages, asymmetry between two small countries in some trading patterns or in some capital account transactions is allowed.

C. Capital Mobility: No capital mobility or imperfect capital mobility is assumed.[5] Taken as a group, the existing studies span the full range of assumptions, from zero capital mobility to perfect capital mobility.

D. Aggregate Supply Specification: Nominal wage rigidity, a positively sloped aggregate supply curve, and a flexible product price (and thus a flexible real exchange rate) are assumed.

E. Time Frame of Analysis: We consider short-run only. To avoid the complexity of dynamics in a three-country setting, we permit no effect of the balance of payments on the money supply. This involves either perfect sterilization or an extremely short time period.

F. Government Behavior: The policy authorities optimize a quadratic objective function which includes three targets: the CPI inflation rate, the employment rate, and the balance of trade (or the balance of payments under capital mobility). To my knowledge, using three targets is also the first attempt of its kind in the theoretical literature. It can result in a different pattern of tradeoffs between target variables than the conventional two-target case.

III. Nature of The Game

Here, we briefly discribe the equilibrium concepts of the game and the type of shock which initiates the game.

A. Equilibrium Concepts: This thesis examines the Cournot-Nash, the Stackelberg, and the equal-split cooperative equilibria, which can "*express the options available to participating economies in the world system.*" (See Artis and Ostry, 1986, p. 17.)

The Stackelberg equilibrium is a hierarchical solution concept (see Basar and Olsder (1982), p. 125). The leader sets his strategy first and commit to it. The follower then makes his decision.

Out of the many cooperative solutions, we examine just the equal-split of the benefits from cooperation. One can argue that the equal-split cooperative solution is supported by the "*focal-point*" hypothesis.[6]

B. Type of Shock: The policy co-ordination game is initiated by a shock, the source of which can be a disturbance in the private sector or in the desired target values of the government. We will refer to the latter as a "*target shock*" (a shock to the target values, not to the target variables).

IV. Some Previous Suggestions to Be Examined

Within our framework as described above, we will examine some of the important suggestions made in previous studies as follows:

A. Canzoneri and Minford (1986) suggest that higher interdependence between two countries, measured as the ratio of transmission effect (i.e. spill-over effect of one country's money supply policy on the other country's output level, as a proportion of the policy's effect on its own level of output), could increase the size of welfare gains from co-ordination. We will examine this result by a sensitivity test of the welfare gains from co-ordination to the values of trade price elasticities. In our three-country model, we can analyze the effects of interdependence between two small countries on the gains from co-ordination between them, with a passive third country.

B. Turnovsky and d'Orey (1986) find that lower trade price elasticities of goods between two countries can increase the size of welfare gains from co-ordinating money supply policies. Their result is consistent with Canzoneri and Minford's in a two-country model. But it is not always so in our three-country model, with the exchange rate as the policy instrument.

C. Eichengreen (1985) argues that the Stackelberg leader-follower solution may not be feasible even with asymmetry between two countries,[7] because the follower gains more than the leader, so both countries prefer to be the follower rather than the leader. We will examine his finding in the present three-country framework with different patterns in trade and capital flows.

D. Tobin (1978) suggests that we should tax all inter-currency transactions ("*throw some sand in the wheels of our excessively efficient international money markets*") to reduce the "*excessive*" efficiency in capital markets, because excessively efficient capital markets restrain the capability of the national policy authorities to adjust to macroeconomic shocks. This proposal was supported by Dornbusch (1988). Tobin's proposal will be re-examined allowing for policy stabilization.

V. Main Results of The Study

From the numerical analyses in chapters three and four, we obtain the following results.

(1) The size of welfare gains from co-ordination is very small. But in general,

lower trade price elasticities induce larger welfare gains from co-ordination, confirming Turnovsky and d'Orey's result.

(2) The Canzoneri-Minford result is equivalent to that of Turnovsky-d'Orey in a symmetric two-country model, but the Canzoneri-Minford prediction does not always hold in our three-country model. The links with the rest of the world significantly influence the effects of the small countries' policies, inducing different conclusions from theirs in some cases.

(3) With no policy reaction of the authorities, massive capital flows following the shocks from the rest of the world cause large welfare losses, supporting Tobin's concern.

(4) As long as the policy authorities actively optimize their objective function using exchange rate policy, with or without co-ordination, they can reduce the welfare losses significantly. Thus we may not need to impose Tobin's tax on inter-currency transactions.

(5) With asymmetry in economic structure, the non-cooperative Stackelberg solution may be feasible (i.e., compared to the Nash equilibrium, one country gains more by taking the leadership position while the other country gains more as the follower). This result contrasts with Eichengreen's finding.

VI. Plan of The Study

This thesis contains five chapters. Chapter two provides a brief survey of the international policy co-ordination literature. We discuss the differences in the frameworks and in the results of some of the previous studies. With no capital mobility in chapter three, we investigate the Turnovsky-d'Orey and Canzoneri-Minford suggestions by a sensitivity test of the welfare gains from co-ordination. To generalize our results in comparison with theirs, we consider both a target shock and other type of shocks. By assuming asymmetric trading patterns between small countries, we are also able to examine Eichengreen's result. We discuss the size of the welfare gains from the Nash vs the cooperative equilibria, from the Nash vs the Stackelberg equilibria, and from reaction (non-cooperative or cooperative) vs no reaction of the policy authorities to a shock. In chapter four, assuming imperfect capital mobility, we examine Tobin's proposal with the external shocks from the rest of the world. We also review Eichengreen's finding by assuming asymmetric patterns in capital flows. Finally in chapter five, we summarize the main results of this thesis and conclude with suggestions for future work on this topic.

Footnotes

[1] In dynamic analyses (or static analyses using empirical models), the estimated gains from co-ordination are described as small (Oudiz and Sachs, 1984, 1985; Oudiz, 1985; Carlozzi and Taylor, 1985; Hughes Hallett, 1985; Canzoneri and Minford, 1986; and others), or modest (Turnovsky, Basar, and d'Orey, 1988). Existence of 'uncertainty' (Ghosh, 1986) in a model or 'disagreement about the true model' (Frankel, 1988; Frankel and Rockett, 1988) among policy authorities may reduce the gains from co-ordination further.

[2] See Frankel and Rockett (1988), Miller and Salmon (1985), and Rogoff (1985). Chapter two provides the detail.

[3] In most of the policy co-ordination literature, the money supply has been assigned to both internal and external targets. Only Eichengreen (1987) assigns the exchange rate to the targets within a simple qualitative analysis.

[4] For the exchange rates to be used as an effective policy instrument, we need an additional country. An equal depreciation of both symmetric countries' currencies has no effect between them, but can have an effect against the third country: One small country's balance of trade surplus is not automatically the other small country's deficit as noted in Hughes Hallett (1985), and both countries can exploit the passive third country to achieve balance of trade surpluses. The third country (the rest of the world) is assumed to be passive in the depreciation game. This is different from the literature (e.g. Canzoneri and Gray, 1985), where the rest of the world plays a game against a single small country in a two-country model.

[5] In chapter three, we assume no capital mobility as in Corden (1985), Hamada (1974, 1976), and Hamada and Sakurai (1978), to focus on the effects of trade price elasticities on the results of co-ordination. However in chapter four, we incorporate varying degrees of capital mobility assuming imperfect asset substitutability as in Oudiz and Sachs (1984), and examine Tobin's (1978) suggestion. This assumption is necessary for short-run sterilized intervention to be effective, and for capital mobility to be consistent with our assumption of the positive balance of payments target. This also allows us to assess the asymmetric patterns of capital flows among three countries, i.e. different degrees of capital mobility across capital markets. In most of the policy co-ordination literature, however, perfect capital mobility has been assumed.

[6] The "*focal-point*" hypothesis is based on the principle that serve to solve the problem of "*tacit bargaining*" over conflicting interests. Each player involved in "*tacit bargaining*" predicts the other player's expectations on the first player's expectations. A "*focal point*" for agreement is found if their expectations of each other can converge

through mutual recognition. An "*equal split*" of the gains from cooperation may be interpreted as a "*focal-point*" solution, since it is often the most obvious "*focal point*" of bargaining. See Schelling (1963) for further discussion.

[7] The same suggestion is made in Eichengreen (1987) where the Stackelberg leader-follower solution is referred to as "*Hegemonic Stability*". The term '*theory of hegemonic stability*' was coined by Keohane (1980, p. 132) who states: "hegemonic structures of power, dominated by a single country, are not conductive to the development of strong international regimes whose rules are relatively precise and well obeyed."

CHAPTER TWO

REVIEW OF THE LITERATURE

I. Introduction

Since 1975, the leaders of the largest industrial countries have been holding economic summits to exchange views on the state of the global economy and to discuss co-ordinated measures for the steady growth of an interdependent global economy.

Studies on the issue of international policy co-ordination have also been voluminous since the early 1970s. Since Niehans (1968) and Cooper (1969), early writings on this issue analyzed the transmission effect (or spill-over effect) of one country's policy on the others. Afterwards, using optimal control and game theory techniques, a strategic optimization approach has been adopted in this literature. In particular, the study of Hamada (1976) was the first of this type of approach.

One of the most important issues discussed in the literature is whether the policy authorities can obtain welfare gains from international co-ordination and if so, how large is the size of gains. In many studies, mutual gains from co-ordination have been implied. Recently however, since numerous studies in the literature have found small gains from co-ordination and even negative effects in some cases, authors have attempted to find cases where policy co-ordination pays. Another relevant issue is whether "*Hegemonic Stability*"[1] from the Stackelberg leadership of a dominant country is feasible.

To extend the literature in a different framework, this thesis will examine these issues in a Keynesian three-country model described below, assuming varying degrees of capital mobility and asymmetric patterns in trade and capital transactions.

Our model consists of eight equations (nine in chapter four) for each small country:

(1) The aggregate supply function, where real output is an increasing function of employed labor.

(2) The labor demand function, where the labor demand is negatively related to the producer's real wage.

(3) The labor supply function, where nominal wage rigidity is assumed.

(4) The LM equation, where nominal money balances are deflated by the consumer price index (CPI).

(5) The balance of trade equation, where the balance of trade is positively related to the other countries' goods price and income, and negatively related to the country's own goods price and income.

(6) The aggregate demand function (or IS equation), where real expenditure consists of consumption, investment, government expenditure (no change is assumed in short-run), and the balance of trade, and investment is negatively related to the interest rate.

(7) The market clearing equation for aggregate supply and demand. While nominal wage is fixed, commodity price is flexible in the model.

(8) The CPI equation, where the CPI is a weighted average of the goods prices of all countries.

(9) (in chapter four only) The balance of payments equation, where the balance

of payments consists of the current account and the capital account. The capital account is positively related to interest rate differential in favor of the home country.

At various points in spelling out the model we distinguish real and nominal interest rates, and this involves reference to the expected changes in inflation and in exchange rates. Our model does not involve rational expectations, so these expectations are simply taken as static exogenous constants.

In this model, we have eight endogenous variables (nine in chapter four including the balance of payments); real output, real expenditure, employment, nominal product price, nominal interest rate, CPI, real balance of trade (divided by long-run real exports), and nominal wage rate[2]. We also have three exogenous variables (four in chapter four, including the expected depreciation rate); expected inflation rate, nominal exchange rate, and nominal money supply.

Since the previous studies are very different in their models, policy instruments, target variables, number of countries (or players), time horizon, degree of capital mobility, equilibrium concepts, and size of welfare gains from co-ordination (simulation results), it is almost impossible to compare all of the papers in every aspect. Thus, our aim here will be only to briefly survey these studies in selected categories.

Section II will introduce some basic concepts of the strategic policy co-ordination games commonly used in the literature. Section III will survey the choice of different policy instruments. Sections IV and V will survey the policy authorities' objective function. In section VI, we will turn to the discussion of the number of countries (or players). Sections VII and VIII will discuss the sign of the so-called "*transmission effects*" in the literature. Section IX will discuss the effect of an asymmetry between countries on policy co-ordination. In sections X and XI, the effects of the efficient capital markets on national macroeconomic performance and on policy co-ordination, and the numerical findings about the size of gains from co-ordination will be discussed. Finally, section XII will briefly summarize this chapter with a table which highlights the key features of selected studies.

II. Basic Concepts of The Game

The policy co-ordination game arises from high interdependence in national policy-making through the transmission effects, and it is initiated by a shock to the economy or to the values of targets. Since the seminal paper of Hamada (1976), the concepts of game theory have been widely used in the policy co-ordination literature. The authorities are assumed to have several policy targets without sufficient instruments.

In a Cournot-Nash non-cooperative game, each country (player) is assumed to maximize a quadratic utility function with respect to its own policy instrument, taking the other country's policy as given. For each level of the foreign country's policy instrument, the home country can find one optimal level of its own instrument which maximizes its utility function. As shown in figure 2-1, each of these points is the tangency point between the home country's "*indifference curve*" and an imaginary vertical line which represents a given level of the foreign country's policy instrument. The set of these points constitutes the "*reaction function*" (or "*best response function*") of the home country. This function reflects the transmission effects of the foreign country's policy in its slope, and it is used to analyze the strategic interaction between two players. In figure 2-1, the RF and RF^* curves represent the reaction functions of

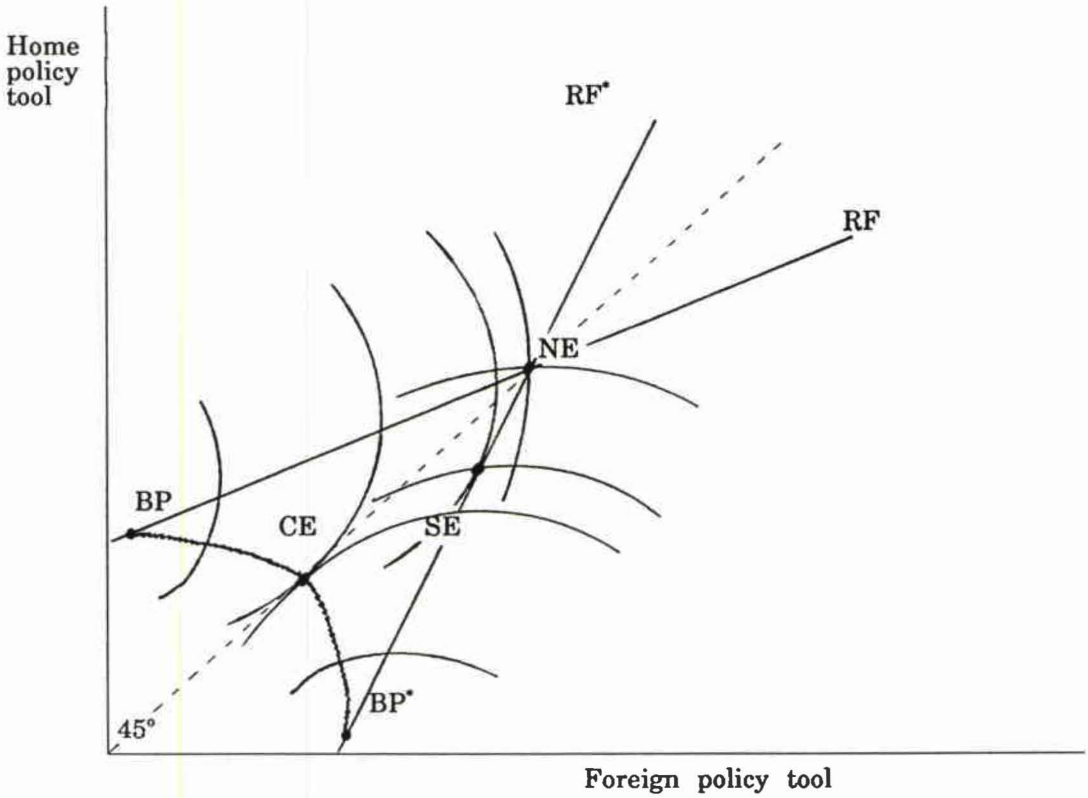

Figure 2-1 Reaction Function, Bliss Points, and Welfare Levels in Cournot-Nash, Stackelberg, and Cooperative Equilibria

two symmetric countries, where the superscript * denotes the foreign country, and the intersection point of these two curves (point NE) represents the Cournot-Nash equilibrium. The points BP and BP* are the "*bliss (or saturation) points*" of two countries at which the highest possible utility is achieved. The bliss points are always on the reaction curves, but their positions can be in other quadrants than the first one depending on the parameter values and the objective functions. The indifference curves (which are ellipses since each objective function is a quadratic function of more than two targets with different weights) that are closer to the bliss point of a country represent higher welfare levels for that country.

The cooperative (or co-ordinated) solution is achieved by maximizing the joint utility function of two countries with respect to each country's policy instrument. The locus running between the bliss points BP and BP^* is a set of tangency points between two countries' indifference curves. It represents the set of possible cooperative solutions which are *"Pareto-optimal"*, where no one country can be better off without reducing the other country's welfare level. In a symmetric-countries setting in previous studies (see Turnovsky and d'Orey, 1986), it has been suggested that the equal-split outcome (a point like CE in figure 2-1) can be a cooperative solution, with equal bargaining power of each country being assumed in joint policy-making.[3]

The Stackelberg equilibrium results from the possibility of committed strategies of a dominant country. In figure 2-1, the point SE is chosen first by the leader (domestic country) and adopted by the follower (foreign country).

Figure 2-1 shows that the welfare level at the cooperative solution is higher than at the Stackelberg solution, which in turn has advantages over the Cournot-Nash equilibrium. The difference in the welfare levels at the Cournot-Nash and the cooperative solutions is defined as the gains from co-ordination. The distance between these two equilibria is affected by both the intercepts and the slopes of the reaction curves. The size of the intercept shift is determined by the size of the shock that initiates the game, and the slope, which reflects the shape (curvature) of the utility function, is determined by the size of policy effects (a large transmission effect increases the slope).

In our numerical analysis, we shall show that the values of the target variables and of the welfare costs in both Cournot-Nash and cooperative equilibria generally increase with a larger intercept. Then the absolute difference between welfare levels at the two equilibria increases, but the ratio (Cournot-Nash vs cooperative equilibria) of these levels changes very little. That is, the absolute gains from co-ordination increase with a larger intercept of the reaction function, but the relative gains (i.e. in proportion) almost do not change.

On the other hand, with a flatter reaction function due to a smaller transmission effect, the indifference curves become more elliptical (i.e. a smaller change in own policy is required for the same change in the other country's policy, in order to remain on the same indifference curve). The difference between the two equilibria decreases in both absolute and relative size. One extreme case of this is when the slope of the reaction functions is zero, i.e. the domestic reaction curve is horizontal and the foreign reaction curve is vertical in figure 2-1. There is no interdependence between two countries, and thus one country's policy is not affected at all by the other country's policy. The utility function is a function of the own policy instrument only, and the co-ordination issue does not exist.

III. Policy Instruments

In the policy co-ordination literature, most authors assume that the central bank would control the money supply instead of the exchange rate. Hence the money supply (sometimes mixed with fiscal policy as in Oudiz and Sachs (1984), Frankel and Rockett (1988)) has been the policy instrument assigned to real output (or the employment rate) and the inflation rate, or to real output and the balance of payments targets.

The few exceptions include: The central bank discount rate (the interest rate charged by the central bank for loans to commercial banks) in Eichengreen (1985) under a fixed exchange rate regime; the exchange rate in Eichengreen (1987) within a simple qualitative model; and the interest rate in Carlozzi and Taylor (1985) in a modified Mundell-Fleming model under flexible exchange rates.

However, since the policy authorities have the option to control the exchange rate rather than the money supply as pointed out in Niehans (1984), this thesis explores the former alternative.

IV. Target Variables

The choice of target variables and their optimal values is a subjective matter. According to Frankel (1988, p. 10):

> "Some would argue that the only appropriate objective is to maximize the value of income, or consumption .... To be more correct theoretically, it is the present discounted value of consumption that should be maximized. One can then view the inclusion of the current account in the one-period analysis as foreshadowing events in all future periods. If the country maximized current consumption while running a large current-account deficit, it would have to undergo lower consumption in the future to service the debt incurred. One can view the motivation for including inflation in the same way. If higher output could be attained with no welfare costs beyond the contemporaneous resource loss from higher inflation, then the cost might be viewed as negligible. But the true cost in fact includes a higher level of inflation inherited in the future, which will eventually necessitate a recession to eliminate it. Thus a one-period objective function that includes inflation and the current account in addition to output seems to capture the relevant elements."

Another argument for including an external target in the objective function is found in Grubel (1977), Edwards (1983), Jones (1983), and Hamada (1985), who suggest that there is a certain optimal level of foreign reserves beyond which any further increase deteriorates national welfare. For example, Hamada (1985) argues that central bankers prefer balance of payments surpluses (if not excessive) to deficits when their actual foreign reserve holdings are lower than the desired levels.

In much of the policy co-ordination literature (for example, Oudiz and Sachs (1985), Miller and Salmon (1985), Turnovsky and d'Orey (1986)), only the internal target variables such as real output (or the employment rate) and the overall inflation rate are considerd in policy authorities' objective function. However, one of the external target variables (the balance of payments, the foreign reserves, and the balance of trade) is often used, too.

The choice between these external target variables depends on the type of the exchange rate system. Generally, the balance of payments or the level of foreign exchange reserves (or gold reserves) is not used as a target variable under a flexible exchange rate regime. This is because the flexible exchange rate system provides a country with more freedom to pursue other targets by relaxing the balance of payments constraint, as noted in Hamada (1985). But with capital flows, the balance of trade can be used as a target variable even under a flexible exchange rate regime, as in Oudiz and Sachs (1984), Oudiz (1985), Frankel and Rockett (1988), and Frankel (1988)). A fully flexible exchange rate regime cannot be assumed when the balance of payments or the foreign reserve stock is used as an external target variable.

We now briefly list other studies which include one of these external target variables in the objective function:

(1) The balance of payments is considered as a target variable with output in Hamada (1974), and with inflation in Hamada (1976). He uses money supply policy assuming a fixed exchange rate regime and no capital mobility.

(2) The foreign exchange (or gold) reserve stock is used as a target variable in Jones (1983) and Eichengreen (1985) under a fixed exchange rate regime.

(3) Under a flexible exchange rate system and capital mobility, however, the balance of trade is taken as a target variable in Oudiz and Sachs (1984), Oudiz (1985), Hughes Hallett (1987), Frankel and Rockett (1988), and Frankel (1988). Using large econometric models, they assign both money supply and fiscal policies to all three targets --- GNP, the inflation rate, and the balance of trade.

In our analysis, the three targets --- the CPI inflation rate, the employment rate, and the balance of trade (or the balance of payments with capital mobility) --- are considered. Given the chosen parameter values, our target for the balance of trade of each country represents 2% of GNP as in Oudiz and Sachs (1984) and Frankel and Rockett (1988).

V. Welfare Weights

Welfare weights specify the preference (marginal utility of each target) of the policy authorities, and the bargaining results may be sensitive to the values of these weights. For instance, Hughes Hallett (1987) points out that putting more weight on output in the objective function is one of the factors which can result in larger gains from co-ordination.

However, it is not an easy task to choose welfare weights since there are no explicit criteria. The issue of how to aggregate the varying preferences of society would make it more difficult. Hence, Frankel and Rockett admit the arbitrariness in choosing values for welfare weights:

> "The choice of welfare weights is necessarily more arbitrary, even, than the choice of target optima. ...... For a lack of a better alternative, we adopt the set of weights calculated by Oudiz and Sachs (1984) for the EPA model, and apply it uniformly regardless of model." (Frankel and Rockett, 1988, p. 326)

Oudiz and Sachs (1984) who made the first attempt to quantify the gains from co-ordination using large econometric models, chose the values of weights from the estimated marginal utilities of target variables at a baseline which is assumed as a Cournot-Nash equilibrium. The baseline is taken from an ex-ante simulation of their multicountry model for the period 1984-86. They then chose the weights with which the countries would have produced the estimated values of the target variables at the baseline. The authors derive two First Order Condition equations by assuming that the individual governments maximize their objective functions with respect to each policy instrument (money supply and fiscal policy). Since there are three unknowns (marginal utilities of target variables) to be solved in two equations, by normalizing the marginal utility of output, they can estimate the marginal utilities of two other target variables. From these values and the the baseline values of the target variables, they estimate the welfare weights. They compare the empirical results of money supply and fiscal policies on the three target variables between non-U.S. OECD countries (or Japan and West Germany separately) and the U.S. using various econometric models (for example, Economic Planning Agency model, Multicountry model). From the dynamic results over several years, they use only the effect in one year or the average effect in a three-year period for a static analysis, where zero or positive values are assigned for the targets. Frankel and Rockett (1988) and Frankel (1988) also adopt this method.

With no obviously better alternative, we first take the Oudiz-Sachs (1984) weights which were estimated for the U.S. objective function in the Federal Reserve Board's Multicountry model. Then, we modify them slightly considering the strategic position of NICs or less developed countries, which are assumed to be more growth-oriented and more interested in maintaing a current account surplus since their economic development has been financed by the accumulated foreign debt. That is, we assume higher weights for the balance of trade target and the employment rate (which is corresponding to output) target than the Oudiz-Sachs values.

VI. Number of Countries

Most of the previous work in the literature considers two-country models, either two symmetric small countries or one small country and the rest of the world. Only those authors who use multicountry econometric models consider more than three countries (for example, Frankel and Rockett (1988), Frankel (1988), Hughes Hallett (1985, 1987), Oudiz and Sachs (1984), Oudiz (1985), and Taylor (1985)).

By using a three-country model in our static analysis, we can analyze the effects of shocks from the passive third country -- the rest of the world (ROW) -- and the asymmetric patterns in trade and capital flows. The links of the small nations with the ROW provides different results in our analysis from the traditional two-country model. Some of our main results are attributed to this feature. Also, as pointed out in Hughes Hallett (1985), the significance of having the passive ROW is that one small country's trade surplus is not automatically the other country's deficit. Both small countries can achieve trade surpluses against the ROW by depreciating their currencies. A three-country model is more plausible than a two-country model.

VII. Transmission Effects

Transmission effects (referred to as "*total transmission effects*" in Corden (1985)) are usually defined as the effects of one country's policy on the other country's real output. In our analysis, since we include the employment rate instead of real output in the objective function, we define the transmission effects as the effects of foreign country's economic policy on the domestic employment rate.

The sign and the size of transmission effects influence the policy co-ordination outcome significantly as noted in Canzoneri and Gray (1985, p. 553):

> "The nature of the game ... depends on the relative importance of the four channels just described. The relative importance of these channels, in turn, depends, on the structural features of the economies involved ..."

Similarly, Buiter and Marston (1985) point out that the sign of the transmission effects depends on the strength of the real and financial links between countries, and that particular transmission patterns may strengthen or weaken the case for policy co-ordination. Transmission effects are also used to measure the interdependence between countries as in Canzoneri and Minford (1986), who define the extent of interdependence as the ratio of transmission effects to own effects of money supply policy.

Canzoneri and Gray (1985) suggest four possible transmission channels: an interest rate channel, a goods demand channel, a wage indexation channel, and a channel associated with the fixed dollar price of oil. In our analysis, the policy effects are transmitted through the goods demand and the interest rate channels. Exchange rate policy influences goods demand through the shifts in IS schedule (i.e. the terms-of-trade effect and the income effect) and the shifts in LM curve (i.e. a real money balance change) via the CPI linkage. Exchange rate policy also affects the capital flows (which is critical under high capital mobility), money demand, and real investment through the interest rate channel. The effects of different real and financial links between countries on the transmission effects and thus on the welfare results are analyzed by using different patterns in trade and capital flows.

Predicted Signs of Transmission Effects in The Literature

Since the signs of the transmission effects are not the same across studies, they are worth surveying. In Frankel and Rockett (1988), a negative ("*beggar-thy-neighbor*") transmission effect is found in a Mundell-Fleming model. However, they note a large amount of disagreement among various econometric models upon the policy effects on the current account and upon the sign of transmission effects. They also point out that the net capital flow may be reversed due to exchange rate "*overshooting*" in recent models (which possibly induces a positive transmission effect). Under a flexible exchange rate regime and perfect capital mobility, Canzoneri and Gray (1985), Eichengreen (1985), and Hamada (1985) suggest a negative transmission effect of monetary policy.

Eichengreen (1985) finds a positive transmission effect (a "*locomotive effect*") under a fixed exchange rate regime with perfect capital mobility. He explains (p. 159):

> "An increase in the foreign discount rate reduces the foreign money multiplier and the foreign money supply, attracting gold from the home country and depressing the world price level."

But he allows for the possibility of a negative transmission effect under a flexible exchange rate regime.

In Carlozzi and Taylor (1985), with a flexible exchange rate regime and perfect capital mobility, a small positive transmission effect is obtained: This is explained by an increase in real money balance (LM shift effect) of the home country, due to a decrease in domestic CPI level that results from a depreciation of the foreign currency by the foreign country's monetary expansion, and also attributed to the assumed small terms of trade effect. That is, the LM shift effect dominates the IS shift effect resulting in a net positive transmission effect.

Under perfect capital mobility and a flexible exchange rate regime, Turnovsky and d'Orey (1986) point out two possible signs of the transmission effects. They argue that if the trade price elasticity is high, the transmission effect of monetary policy tends to be negative, and it reduces the strategic elements of optimal policy-making. Thus the various strategic equilibria tend to be numerically close. But, if the price elasticity is low, the positive effect (via the LM curve shift) dominates over the negative effect (via the IS curve shift) for the same reason explained above for Carlozzi and Taylor. This reduces the importance of the role of the price in market clearing, thereby increasing the scope for discretionary monetary policy and thus welfare gains from co-ordination. However, they find that the negative effect case dominates for plausible parameter values. It is also interesting to note that both Carlozzi and Taylor (1985) and Turnovsky and d'Orey (1986) assume a very low price elasticity to derive the positive transmission effect.

In our framework, which involves some of the Mundell-Fleming model features, at the chosen parameter values which are taken from the empirical parameter values, the transmission effect of a depreciation in the exchange rate is negative which is consistent with Mundell-Fleming result. That is, given slope parameters of the IS/LM curves and trade price elasticities, which are within the range of values used in previous studies, the IS shift effect overrides the LM shift effect following a depreciation of the foreign currency.

VIII. Expansionary or Contractionary Cournot-Nash Equilibrium

The Cournot-Nash equilibrium is called more expansionary (contractionary) as the equilibrium output level is higher (lower). It is called "*too*" expansionary (contractionary) if the equilibrium output level is higher (lower) than the output level at the cooperative solution. The nature of the Cournot-Nash equilib-rium depends on the sign and the size of transmission effects. It also depends on the nature (positive or negative) of the shocks which initiate the game. For example, if a foreign country's monetary expansion (which follows a contractionary shock) is transmitted positively to the home country, the home country tends to react with contractionary policy to neutralize the inflationary pressure, inducing an excessively (compared with the cooperative solution) contractionary Cournot-Nash equilibrium; vice versa if the transmission effects are negative. Thus it has been frequently discussed whether the Cournot-Nash equilibrium is more expansionary or contractionary.

However, economists differ on whether the Cournot-Nash solution is more expansionary or contractionary compared with the cooperative solution. (Note that usually if Cournot-Nash equilibrium is expansionary then so is the cooperative solution.) Frankel and Rockett (1988, p. 319) argue:

> "Some of the authors in the co-ordination literature decline to take any position at all on whether the problem with the Cournot-Nash noncooperative equilibrium is that it is too contractionary or too

> expansionary, etc. They leave it for econometricians to fill in the correct parameter values at some later date."

In general, the studies which suggest a negative transmission effect find an expansionary Cournot-Nash equilibrium, while those with a positive transmission effect obtain a contractionary Cournot-Nash solution. Canzoneri and Gray (1985) predict a likely negative transmission effect which induces a competitive exchange rate depreciation following a monetary expansion under a flexible exchange rate regime, and thus a too-expansionary Cournot-Nash equilibrium. However, they note that the structural features (including the substitutability of goods, the extent to which wage rates are indexed, etc.) of the world economy determine whether the Cournot-Nash equilibrium is too expansionary or too contractionary.

Frankel and Rockett (1988) also predict a too-expansionary Cournot-Nash equilibrium, resulting from the negative net transmission effect under perfect capital mobility and a flexible exchange rate regime in a Mundell-Fleming model. However, as mentioned in section VI, they note that a net positive transmission effect is possible in some recent models (some econometric models provided this result due to exchange rate "*overshooting*" in Frankel and Rockett), which may result in a too-contractionary Cournot-Nash equilibrium. According to them (pp. 324-325, footnote 12):

> "The positive effect of a monetary expansion on the current account via currency depreciation is offset by a negative effect via higher income. In the Mundell-Fleming model the positive effect on the current account must dominate, to match the net capital outflow that results from lower interest rates, giving negative transmission abroad. But in more modern models the net capital flow may be reversed, in response to perceived overshooting of the exchange rate."

Oudiz and Sachs (1984), report both positive and negative signs of the transmission multipliers of large econometric models (Multicountry model, Economic Planning Agency model), which result in a too-contractionary Cournot-Nash equilibrium in a static analysis. Hamada (1974, 1976) also finds a too contractionary Cournot-Nash equilibrium, when the net desire for the balance of payments surplus exceeds the creation of reserves (sum of money supplies in two small countries) under a fixed exchange rate regime.

In our analysis, where the exchange rate is used as a policy variable, the Cournot-Nash equilibrium is more depreciationary than the cooperative solution. This over-depreciationary Cournot-Nash solution results in a higher employment rate than the cooperative equilibrium, given the chosen parameter values which assure a negative transmission effect.

IX. Asymmetry

The asymmetry, or differences, in economic structures and shocks or initial conditions between the countries affects the transmission effects of policies, and hence their welfare levels. Thus, it should be worthwhile to examine the "*Hegemonic Stability*" issue, i.e. the feasibility of the Stackelberg leader-follower solution. However, as pointed out in Turnovsky and d'Orey (1986), symmetric economies, specializing in the production of distinct good (imperfect substitutability) and trading a single common bond (perfect substitutability in capital), have been assumed throughout the two-country policy co-ordination literature. Only a few authors have analyzed structural asymmetry, and they vary in the way of imposing asymmetry as follows.

Hughes Hallett (1985) undertakes an empirical investigation of co-ordination with the asymmetric economies between the U.S. and the EC, using an estimated multicountry model in a dynamic framework. Using three more internal targets in addition to the three common target variables we discussed in section III, he takes seven policy instruments with which co-ordination allows the authorities to specialize in some policies where they have a comparative policy advantage. He argues (pp. 25-26):

> "Asymmetries between countries play a crucial role in determining the gains from cooperation. Three kinds of asymmetry are of interest: asymmetric policy responses (which determine policy specializations); asymmetric spillover effects (which determine bargaining strengths); and asymmetric adjustment speeds (which determine the cost of policy responses). .... the important asymmetries were larger and faster domestic policy responses in the U.S., and the dominance of U.S. monetary policy among the spillover effects. Thus the U.S. should specialise in monetary policy and the EEC in fiscal policy. For the same reasons the U.S. can make greater gains from competitive policies, while the EEC .... gains more from any sustainable cooperative arrangement. .... The gains from cooperation are nevertheless significantly larger here, for any sustainable bargain, than previous estimates which have been based on static decision procedures (Oudiz and Sachs (1984))."

Turnovsky and d'Orey (1986) assume asymmetry in a supply or a demand shock, i.e. only one country has the shock. Even with symmetry between economies, this asymmetry in the shock leads to different welfare outcomes for them. One country can be worse with an "*equal-split*" cooperative solution than with a Cournot-Nash solution. But they suggest that the country which gains from cooperation may be able to compensate the welfare-losing country to reach the "*equal-split*" solution.

Eichengreen (1985) also considers asymmetry between countries. As summarized in table 2.1, he examines the feasibility of the Stackelberg leader-follower solution in a simple asymmetric case. In an "*attempt to capture the change in* *structure of international financial markets between the end of the nineteenth century and the interwar period*" (p. 164), he assumes asymmetry in the ability of the central bank discount rates (the interest rate charged by the central bank for loans to commercial banks) to influence international capital flows. He also assumes perfect capital mobility, a fixed exchange rate regime, and a competitive struggle for gold (as reflected in the model by a shock to the gold stock target). Using the gold reserve stock and the price as target variables, he obtains the same result about the gains from co-ordination as in a symmetric case. That is, the follower gains more than the leader, so both countries prefer to be the follower, implying that Stackelberg leadership is not feasible. This is because even under asymmetry, the reaction functions of the two countries are still symmetric in his study.

Our analysis investigates asymmetry in trading patterns and in capital flows. In some asymmetric patterns, both the leader and the follower can gain from co-ordination. Compared to the Cournot-Nash equilibrium, one country gains more by playing as the leader while the other country gains more as the follower, suggesting the possibility of "*Hegemonic Stability*".

X. Capital Mobility

As mentioned above, perfect substitutability between domestic and foreign bonds has been assumed in most of the policy co-ordination literature. Only a few exceptions are found. The effect of bonds and, accordingly, the effect of capital mobility is ignored in Corden (1985), Hamada (1974, 1976), and Hamada and Sakurai (1978), who use monies as the only financial assets. Using a portfolio-balance equation, a qualitative analysis of the effects of monetary and fiscal policies with imperfect asset substitutability is undertaken by Oudiz and Sachs (1984). They show that the signs of the monetary policy multipliers are not affected by the degree of asset substitutability, but that the signs of the fiscal policy effects become ambiguous.

Meanwhile, it has been frequently argued that the integration of world capital markets constrains independent policy-making. It also creates repercussions on other countries from national policy action. Artis and Ostry (1986, p. 5) argue:

> "the sensitivity of mobile capital to the prospect of gain or loss is liable to mean that a country whose policy seems unduly adventurous, and in some way prone to inflation, will be heavily punished by the withdrawal of funds, which will result in extensive reserve losses under a fixed exchange-rate regime or in a severe exchange-rate depreciation under a regime of floating exchange rates."

Carlozzi and Taylor (1985, p. 186) also note the problem of high interdependence in national policy-making under perfect capital mobility:

> "Although the classic Mundell-Fleming models with flexible exchange rates show that perfect capital mobility need not reduce the effectiveness of monetary policy, recent research on exchange rate overshooting, on the direct inflationary effects of exchange rate depreciation, and on the beggar-thy-neighbour contractionary repercussions of domestic monetary expansion seems to have reinforced the conventional reasoning that macroeconomic goals are difficult to achieve under such circumstances."

Thus, Tobin (1978) concludes that since excessive international mobility of private financial capital is such a hindrance to efficient macroeconomic performance, then we should throw "*some sand in the wheels of our excessively efficient international money markets*" (p. 489); for example, levy a tax on all inter-currency transactions, including goods, services, and real assets. Dornbusch (1988) not only supports Tobin's suggestion but also proposes even more: "*throw rocks*" to pursue macro-economic objectives more freely; namely, have a fixed exchange rate with a dual exchange rate system for the capital account transactions to insulate it from distorting influences on trade and inflation.

These suggestions have never been tested in terms of welfare costs in previous policy co-ordination studies where perfect capital mobility has been assumed. In our analysis, assuming imperfect capital mobility, we investigate the effects of varying degrees of capital mobility on welfare costs, and also the effects on the size of welfare gains from co-ordination. We will discuss in chapter four that Tobin's tax is desirable to absorb the impact of an external shock from the rest of the world. But we find that by implementing exchange rate policy (even non-cooperative policies between countries) against the shock we can almost remove the hindrance measured by the welfare costs that are caused by the extremely efficient capital markets.

XI. Welfare Gains from Co-ordination

Many of the previous theoretical studies, using static frameworks, suggest dominance of the cooperative solution over non-cooperative solutions (for example, Hamada, 1985; Corden, 1985; Eichengreen, 1985). However, recent numerical studies find that the gains from cooperation are fairly small or even negative in some cases.

Numerous dynamic analyses (including static analyses which use empirical dynamic models) describe the estimated gains from co-ordination as small (Oudiz and Sachs, 1984, 1985; Oudiz, 1985; Carlozzi and Taylor, 1985; Hughes Hallett, 1985; Canzoneri and Minford, 1986), or modest (Turnovsky, Basar, and d'Orey, 1988). In dynamic analyses, small gains or losses from co-ordination are mainly attributed to the "*time inconsistency*" problem caused by the inability of the authorities to bind the actions of future governments and the private sector's rational anticipation of the policy effects (see Oudiz and Sachs, 1985; Miller and Salmon, 1985; Rogoff, 1985). In Rogoff (1985), for instance, a co-ordinated monetary expansion under a managed floating exchange rate regime results in a better GNP-inflation tradeoff than a unilateral expansion, since it does not involve exchange rate depreciation. It is argued that the government has more incentive to inflate (i.e. use expansionary policy), which is then anticipated by wage setters who would demand higher wage. Thus, the "*time consistent*" cooperative solution can cause severe inflation inducing a welfare loss compared with the Cournot-Nash solution.

However, Oudiz and Sachs (1985) find a counter-example in a different model where they define a time-consistent policy as one with which the current government optimizes taking as given the freedom of choice of future governments. They note that, in Rogoff (1983), the source of the time inconsistency is from the forward-looking wage setters and cooperation exacerbates the problem, but in their model the source is from the forward-looking exchange market participants (through expected depreciation) and cooperation removes the problem in a symmetric setting. The Keynesian feature of their model -- the wage change is a function of lagged CPI inflation (more sluggish labor market than asset market) -- induces this result.

Other issues which result in smaller gains from co-ordination or losses involve "*uncertainty*" in the model and "*disagreement about the true model*". Ghosh (1986), extending the Oudiz and Sachs (1985) model, points out that the gains from co-ordination can be reduced in the presence of model uncertainty (in the effects of policy instruments). He suggests that this is why there is less policy co-ordination than may be expected based on previous theoretical grounds. Even in a static analysis (using empirical models) of Frankel and Rockett (1988), "*disagreement about the true model*" between policy authorities results in welfare losses from co-ordination.

Recently therefore, there have been attempts to identify those features of the model which limit the gains from co-ordination, and to find cases where co-ordination pays. For instance, Frankel (1988) points out that "*uncertainty*" regarding the domestic benefits from the foreign policy changes and the costs of the domestic policy changes requested by the foreign country, is an obstacle to large gains. Canzoneri and Minford (1986) suggest that the degree of interdependence between economies (measured as the ratio of transmission effects to own effects of monetary policy), preferences for the targets, and the size of initial shocks which start the game, matter to the size of gains. They suggest that a higher degree of interdependence may increase the gains from co-ordination as summarized in table 2.1. In fact, in a two-country model this suggestion is consistent with Turnovsky and d'Orey's (1986) which was discussed in section VI. Hughes Hallett (1987) puts more weight on output to obtain larger gains, but notes that the weights are not the only reason for the different results. Miller and Salmon (1990) suggest that the welfare outcomes in the dynamic analyses with flexible exchange rates are critically sensitive to the initial inflationary positions of the co-ordination partners. They indicate that co-ordination pays if inflationary shocks are highly correlated, but if they are uncorrelated, co-ordination exacerbates the welfare inefficiency of the time-consistent solution, which reduces the gains from co-ordination.

In our model, we do not have dynamic features. To ease the mathematical tractability in a three-country setting, we exclude the dynamic features such as the money stock accumulation equation and rational expectations. Thus, we cannot capture the effects of the "*time-consistency*" issue on international policy co-ordination as in other dynamic studies. However, since we focus on examining the issues raised in static analyses -- the suggestions of Canzoneri and Minford (1986), Turnovsky and d'Orey (1986), and Eichengreen (1985), our results are still comparable with theirs.

Size of Welfare Gains from Co-ordination

Although numerical studies note small gains (or losses) from co-ordination, the welfare gains are not measured in the same units and there is no unanimous answer for the question, "*how small is considered as small*".

In the literature, the welfare gain is measured in different ways: for example, "*relative loss*" = (loss under Cournot-Nash)/(loss under cooperation), as in Ghosh (1986); welfare gain = the difference in the welfare costs between Cournot-Nash and cooperative equilibria, in units defined as "GNP equivalent" by normalizing the marginal utility of a one % change in GNP to one as in Oudiz and Sachs (1984), Oudiz (1985), Hughes Hallett (1985), Frankel and Rockett (1988), Frankel (1988). A loss is caused by a shock to the target or the economy and we compare the size of losses at the Cournot-Nash and cooperative equilibria to measure a welfare gain.

Alternatively, Frankel and Rockett (1988) measure the benefit to one country from discovering the true model while staying at the Cournot-Nash equilibrium. They find that the welfare gains from co-ordination are quite small compared to the gains from a unilateral switch to the optimal Cournot-Nash strategy implied by given knowledge of the correct model. They also suggest that other definitions of co-ordination, including exchange of information over time to allow learning regarding the correct model, be investigated. In their point of view, the scope for useful international co-ordination remains wide, provided it is defined more broadly than in the conventional bargaining sense.

To summarize, numerical evidence found in the previous studies suggests that the size of welfare gains from co-ordination is small. In our analysis, the size of gains from co-ordination is much smaller than in Oudiz and Sachs (1984), either in terms of "*relative loss*" as in Ghosh (1986) or in terms of the "*GNP equivalent*" units.

XII. Concluding Remarks

In this chapter, we have briefly reviewed the policy co-ordination literature in an attempt to find any systematic relation between various frameworks and their results. But, we have to admit that our survey could not serve this purpose to the desired extent, since the differences in the analytical frameworks are enormous. We have examined the differences between some studies in selected categories, and some of the findings can be summarized as follows:

(1) The strength of the real (the balance of trade through the real exchange rate) and financial (the capital flows through the interest rate) links between economies determine the transmission effects of one country's policy on the other. The sign and the size of transmission effects determine whether the Cournot-Nash equilibrium is excessively contractionary or expansionary and hence the welfare outcomes of co-ordination.

(2) Asymmetry in economic structures and shocks plays an important role in policy co-ordination. It affects the transmission effects of policy and thus the welfare outcome. It also expands the scope of co-ordination: For example, first, the authorities

can consider different policy instruments which have "*comparative advantage*" for each country, and second the "*Hegemonic Stability*" issue can be examined.

(3) The degree of capital mobility also matters significantly in policy co-ordination. It determines the effects of non-monetary financial assets on the balance of payments and thus on the size of depreciation (or appreciation) in each equilibrium, which in turn affects the balance of trade, the transmission effects, and welfare outcome of the game. Most importantly, high capital mobility constrains independence in national policy-making, which invited Tobin's proposal of throwing "*some sand in the wheels of our excessively efficient international money markets.*"

(4) Finally, numerical analyses indicate that the size of gains from co-ordination is small. Recently therefore, there have been attempts to find the obstacles to larger gains from co-ordination, and to find cases where co-ordination pays. It has been suggested that the degree of interdependence between economies, preferences for the targets, and the size of shocks and their between-country correlations matter to the size of gains from co-ordination.

In conclusion, our survey in this chapter suggests the direction of our analysis in the next main chapters. First, to reflect our recent experience of trade conflicts among industrialized countries, we will include the balance of trade (or the balance of payments with imperfect capital mobility) as an external target variable in addition to two internal target variables. In addition, we will use direct exchange rate policy rather than usual money supply policy. Hence, for the simultaneous depreciation of both countries' currencies to have effects on the balance of trade of each country, we will develop a three-country model where the small countries can exploit the third country which is assumed to be passive.

Within this framework, we will measure the size of gains from co-ordination in "*GNP equivalent*" units and examine the suggestions of some of the previous studies. In chapter three, we will investigate the following issues: Whether high interdependence between the small countries can increase the gains from co-ordination as Canzoneri and Minford (1986) find, and whether low trade price elasticities induce large welfare gains from co-ordination as Turnovsky and d'Orey (1986) suggest. As noted earlier, these suggestions are consistent in a two-country model, but this is not always true in our three-country model. We will examine them by sensitivity tests of the gains from co-ordination to the trade price elasticities. Also, assuming asymmetric trading patterns, we will examine whether "*Hegemonic Stability*" is feasible with asymmetry in the economies as questioned by Eichengreen (1985). This will be examined again in chapter four with asymmetric patterns in trade and capital flows. In chapter four, assuming imperfect capital mobility, we will examine whether efficient capital markets have harmful effects as Tobin (1978) suggests. The analytical frameworks and results of these three earlier studies are briefly summarized in comparison with ours in table 2.1 below.

Table 2.1 Summary of the Selected Studies

Selected Studies	Exchange	Targets	Number	Capital	Main Results
Canzoneri & Minford (1986)	flexible	output, inflation	two[1] (symmetric)	perfect	Higher interdependence between countries, as measured by the ratio of transmission effects to own effects, induces larger welfare gain from co-ordination.
Turnovsky & d'Orey (1986)	flexible	output, inflation	two (symmetric)	perfect	Lower trade price elasticity induces larger welfare gain from co-ordination.
Eichengreen (1985)	fixed	gold stock, price (reflect output)	two (symmetric)	perfect	Although asymmetry is assumed in the ability of discount rates (i.e. policy instruments) to influence the international capital flows, the follower still gains more than the leader from co-ordination.
Our Analysis	fixed	inflation, balance of payments, employment rate	three (two small countries, the rest of the world)	no capital flows	1. High trade price elasticities between the small countries or low trade price elasticities with the rest of the world (ROW) induce high interdependence[2]. 2. Lower trade price elasticities between the small countries and the ROW induce larger welfare gain. But with higher trade price elasticities between the small countries, the welfare gain depends on the values of trade price elasticities with the ROW; i.e. if they are low (high) the welfare gain is larger (smaller). 3. With asymmetric trading patterns, the Stackelberg solution is feasible.
				imperfect	1. For the changes in the trade price elasticities, the results are similar to the above results. 2. With asymmetric patterns in trade and capital flows, the Stackelberg solution is feasible.

Notes: 1. The nine-country Liverpool model is used to get policy multipliers. (See P. Minford (1985) for the Liverpool model.)
2. The ratio of transmission effects to own effects is used to measure interdependence between countries as in Canzoneri and Minford.
3. Canzoneri and Minford assume inherited inflation, and Eichengreen assumes a competitive struggle for gold (i.e. the target value is larger than a half of the world stock). They are the target shocks as the positive value for the balance of trade (or the balance of payments) target in our analysis, which initiate the game.

Footnotes

[1] The feasibility of a Stackelberg leader-follower solution is referred to as "*Hegemonic Stability*" in Eichengreen (1987). See footnote 7 in chapter one for more details.

[2] Although the nominal wage rate is considered as an endogenous variable, it can also be interpreted as an exogenous variable since the fixed wage rate is not determined within the model.

[3] The "*equal-split*" cooperative solution may be interpreted as the "*focal-point*" agreement between symmetric countries. See foonote 6 in chapter one for description of "*focal-point*" solution.

CHAPTER THREE

EXCHANGE RATE CO-ORDINATION WITHOUT CAPITAL MOBILITY

I. Introduction

Recently, we have experienced trade conflicts among the U.S., Japan, and some Newly Industrialized Countries such as South Korea and Taiwan. For example, to reduce its huge trade deficit, the U.S. has pressured countries with trade surpluses to appreciate their currencies. This episode suggests that the co-ordination issue has focused on an external target (the balance of trade) and on external policy instruments such as exchange rates.

In the analytical literature, however, only a few authors have included an external target in the policy authorities' objective function[1]; normally the inflation rate and real output (or the employment rate) have been chosen. Even fewer authors[2] have considered all three targets, and they used large econometric models with two policy instruments (money supply and fiscal policy) at hand.

In our analysis, all three targets -- the balance of trade (as an external target), the CPI inflation rate and the employment rate (as internal targets) -- will be considered. But only one instrument (the exchange rate) will be used strategically (applying static game theory) by the policy authorities of two small countries.

For each country's exchange rate to be used as an effective policy instrument, we need an additional country to which the small countries' policies are of little consequence. That is, a depreciation of both symmetric countries' currencies has no effect between them but has an effect against the third country. Thus, in this chapter, we will develop a three-country model which to our knowledge is the first attempt of its kind in the theoretical policy co-ordination literature. The third country, which is called *'Rest of The World'* (ROW), is assumed to be passive[3].

This is different from the existing studies (for example, Canzoneri and Gray, 1985), where the ROW plays a game against a small country in a symmetric or asymmetric pattern of a two-country model. The benefit of having the ROW is that one country's balance of trade surplus is not automatically the other country's deficit as noted in Hughes Hallett (1985). Both small countries can exploit the passive ROW to achieve balance of trade surpluses.

The strategic policy co-ordination problem is generated by some disturbances to an initial equilibrium situation. They often include a change in the authorities' desired target values. We will refer to this change in the objective function as a "*target shock*" (a shock to the target values, not to the target variables). Some recent empirical simulations and Eichengreen (1985) have examined this kind of "*target shock*",[4] so we examine a move to a more ambitious balance of trade surplus as a "*target shock*". However, to generalize the scope of our results in comparison with previous studies, we will also consider other types of (private sector/foreign) shocks.

We will consider a standard Keynesian model assuming no capital mobility in this chapter to focus on the effects of the trade price elasticities on the policy co-ordination. Some effects of capital mobility will be analyzed in the next chapter.

Using this framework, we will examine one of the main issues discussed in the literature -- whether the policy authorities can obtain significant welfare gains from policy co-ordination. Regarding this issue, we will examine several suggestions of previous studies by numerical tests.

First, Canzoneri and Minford (1986) suggest that higher interdependence between two countries, measured as the ratio of transmission effects[5] to own effects, could increase the size of welfare gains from co-ordination. They assume inherited inflation (a target shock), perfect capital mobility, and a flexible exchange rate regime; they use output and the inflation rate as target variables in a simple illustrative model. We will examine their suggestion by a sensitivity test of the welfare gains from co-ordination from different parameters of trade price elasticities. We analyze the effects of interdependence between the two small countries (as defined in section II) on the gains from co-ordination between them.

Second, Turnovsky and d'Orey (1986) argue that lower trade price elasticities of goods can increase the size of welfare gains from co-ordination. They assume a demand or a supply shock, perfect capital mobility, and a flexible exchange rate regime; they use output and the inflation rate as target variables. This suggestion is consistent with Canzoneri and Minford's in a two-country model, but not always so in our three-country model. This will be explained further in section IV.

And third, Eichengreen (1985) finds that the Stackelberg leader-follower solution[6] is not feasible even with asymmetry between two countries. He assumes a competitive struggle for gold (a target shock), perfect capital mobility, a fixed exchange rate regime, and asymmetry in the effects of the policy instruments (the central bank discount rates) between two countries; he uses the gold reserve stock and the price as target variables. Assuming asymmetry between two small countries in various trading patterns, we will examine this issue.

Based on various assumptions of the policy authorities' strate-gic behaviour, we will derive Cournot-Nash, Stackelberg, and cooperative equilibria of the static game and will compare the results in section II. The effects of asymmetry between the two small countries will also be analyzed by considering six different trading patterns in section III. The theoretical results will then be assessed by numerical simulation in section IV, and section V will conclude.

II. Model Specification

The simple Keynesian three-country model with nominal wage rigidity and no capital mobility is considered. We restrict our analysis to a short-run static time frame to avoid the analytical complexity of a dynamic model. The variables are defined in table 3.1, and the symmetric three-country model for two small countries is presented in table 3.2. The full derivation of the equations from the basic form equations which characterize the model, and the definitions for each coefficient are described in Appendix 3A.

The lower case letters, except the level of nominal interest rate (i) and the real balance of trade divided by long-run real exports (t), denote the variables in logarithmic form. The superscripts *, ^{RW}, and $\hat{}$ denote the foreign country, the third country, and the proportional deviation from the long-run equilibrium value, respectively. Since, as just noted, t and i are not measured in logs, $\hat{t}$ and $\hat{i}$ denote absolute deviations from long-run equilibrium values.

As shown in table 3.2, our model consists of the eight equations for the two identical small countries. We now present a brief description of each relationship.

Table 3.1. Definitions of Variables

Endogenous Variable			Exogenous Variables		
y^s	=	real output	c_1	$\equiv$	$\hat{p}^E$, expected inflation rate[2]
y^d	=	real expenditure			
n	=	number of employees	e	=	nominal exchange rate (log of domestic currency price of one unit of ROW currency)
s	=	nominal product price			
i	=	nominal interest rate (in natural units)			
p	=	consumer price index level	m	=	nominal money supply
t	=	real balance of trade divided by long-run real exports	w^f	=	nominal wage rate at full employment level
w	=	nominal wage rate			

Notes: 1. All variables except i and t are expressed in log form.
2. The short-run expected inflation rate is derived from the short-run target inflation rate which is constant. (See footnote 7 for the detail.)

Table 3.2. Symmetric Three-Country Model

	Home Country	Foreign Country
(3.1)	$\hat{y}^s = \alpha_1\hat{n} \quad 0 < \alpha_1 < 1$	$\hat{y}^{s*} = \alpha_1^*\hat{n}^* \quad 0 < \alpha_1^* < 1$
(3.2)	$\hat{w} - \hat{s} = -\theta_1\hat{n}$	$\hat{w}^* - \hat{s}^* = -\theta_1^*\hat{n}^*$
(3.3)	$\hat{w} = 0$	$\hat{w}^* = 0$
(3.4)	$\hat{m} - \hat{p} = \pi_1\hat{y}^d - \pi_2\hat{i}$	$\hat{m}^* - \hat{p}^* = \pi_1^*\hat{y}^{d*} - \pi_2^*\hat{i}^*$
(3.5)	$\hat{t} = [(a_1 + a_3 + b_1 + b_3)\hat{e}]]$ $- (a_1 + b_1)\hat{e}^* - (a_3 + b_3)\hat{e}^{RW}$ $- (a_1 + a_3 + b_1 + b_3)\hat{s}$ $+ (a_1 + b_1)\hat{s}^* + (a_3 + b_3)\hat{s}^{RW}$ $- (b_2 + b_4)\hat{y}^d + a_2\hat{y}^{d*} + a_4\hat{y}^{dRW}]$	$\hat{t}^* = [(a_1^* + a_3^* + b_1^* + b_3^*)\hat{e}^*$ $- (a_1^* + b_1^*)\hat{e} - (a_3^* + b_3^*)\hat{e}^{RW}$ $- (a_1^* + a_3^* + b_1^* + b_3^*)\hat{s}^*$ $+ (a_1^* + b_1^*)\hat{s} + (a_3^* + b_3^*)\hat{s}^{RW}$ $- (b_2^* + b_4^*)\hat{y}^{d*} + a_2^*\hat{y}^d + a_4^*\hat{y}^{dRW}]$
(3.6)	$\hat{y}^d = -\gamma_1(\hat{i} - \hat{c}_1) + \hat{t}$	$\hat{y}^{d*} = -\gamma_1^*(\hat{i}^* - \hat{c}_1^*) + \hat{t}^*$
(3.7)	$\hat{y}^d = \hat{y}^s$	$\hat{y}^{d*} = \hat{y}^{s*}$
(3.8)	$\hat{p} = \beta_1\hat{s} + \beta_2(\hat{e} + \hat{s}^* - \hat{e}^*)$ $+ \beta_3(\hat{e} + \hat{s}^{RW} - \hat{e}^{RW})$ where $\beta_1 + \beta_2 + \beta_3 = 1$	$\hat{p}^* = \beta_1^*\hat{s}^* + \beta_2^*(\hat{e}^* + \hat{s} - \hat{e})$ $+ \beta_3^*(\hat{e}^* + \hat{s}^{RW} - \hat{e}^{RW})$ where $\beta_1^* + \beta_2^* + \beta_3^* = 1$

Notes: The model stated here is symmetric, and the superscripts *, ^{RW}, and ^ denote the foreign country, the third country, and the proportional deviation from the long-run equilibrium value.

Equation (3.1) describes the aggregate supply function where output is an increasing function of employed labor. It is assumed that $0 < \alpha_1 < 1$.

Equation (3.2) describes the labor demand function where the labor demand is negatively related to the level of the producer's real wage.

Equation (3.3) describes the labor supply function under nominal wage rigidity. With short-run nominal wage rigidity, the model generates a tradeoff among real output, price, and the balance of trade.

Equation (3.4) describes the LM equation of the money market where the nominal balance of money is deflated by the consumer price index. For simplicity, no distinction between real income and real output is assumed in the specification of either the IS or the LM relationship in this model. This simplification represents standard practice in the policy co-ordination literature.

Equation (3.5) describes the balance of trade equation (which is the same as the balance of payments here since there is no capital mobility) as in Corden (1985), Hamada (1974, 1976), and Hamada and Sakurai (1978). Since the third country is assumed to be passive, $\hat{e}^{RW}$, $\hat{s}^{RW}$, $\hat{y}^{dRW}$ are also assumed to be zero. This assumption will be relaxed when we discuss external shocks in section IV. The values of some coefficients of (3.5), the trade or relative price elasticities, will vary to give different trade patterns in section III.

Equations (3.6)[8], (3.7), and (3.8) describe the aggregate demand or IS equation, the market clearing condition, and the consumer price index as a weighted average of the product prices of all countries, respectively.

From these equations the product price of each small country can be solved in reduced form as follows:

$$(3.9)\quad \hat{s} = \theta_1\,[C^*\gamma_1\,\hat{m} + \gamma_1^*Z\,\hat{m}^* + C^*\pi_2\gamma_1\,\hat{c}_1 + Z\pi_2^*\gamma_1^*\,\hat{c}_1^*$$

$$+ (C^*D - E^*Z)\,\hat{e} - (C^*E - D^*Z)\,\hat{e}^*]/(CC^* - ZZ^*)$$

$$(3.9)^*\quad \hat{s}^* = \theta_1^*\,[C\gamma_1^*\,\hat{m}^* + \gamma_1 Z^*\,\hat{m} + C\pi_2^*\gamma_1^*\,\hat{c}_1^* + Z^*\pi_2\gamma_1\,\hat{c}_1$$

$$+ (CD^* - EZ^*)\,\hat{e}^* - (CE^* - DZ^*)\,\hat{e}]/(C^*C - Z^*Z)$$

where C, C^*, D, D^*, E, E^*, Z, and Z^* are parametric constants defined in Appendix 3A.

A. Equilibrium Equations

Using the reduced form equations (3.9) and $(3.9)^*$, we can derive the following reduced form expressions for the target variables.

1. CPI Equilibrium

$$(3.10)\quad \hat{p} = P(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) = 0$$

or $$\hat{p} = (x_1\,\hat{e} - y_1\,\hat{e}^* + q_1\,\hat{m} + t_1\,\hat{m}^* + q_1\,\pi_2\hat{c}_1 + t_1\,\pi_2^*\hat{c}_1^*)$$

$$= 0$$

2. Balance of Trade (BOT) Equilibrium

$$(3.11)\quad \hat{t} = T(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) = 0$$

or $$\hat{t} = (x_2\,\hat{e} - y_2\,\hat{e}^* - q_2\,\hat{m} + t_2\,\hat{m}^* - q_2\,\pi_2\hat{c}_1 + t_2\,\pi_2^*\hat{c}_1^*)$$

$$= 0$$

3. Employment Equilibrium

$$(3.12)\quad \hat{n} = N(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) = 0$$

or $$\hat{n} = (x_3\,\hat{e} - y_3\,\hat{e}^* + q_3\,\hat{m} + t_3\,\hat{m}^* + q_3\,\pi_2\hat{c}_1 + t_3\,\pi_2^*\hat{c}_1^*)$$

$$= 0$$

where the coefficients x_i's, y_i's, q_i's, and t_i's ($i = 1, 2, 3$), are defined verbally in table 3.3 and algebraically in Appendix 3A.

Table 3.3. Definitions of Coefficients in Equilibrium Equations

Effects of Exchange Rate Policy	
Own-Country Effects (A domestic currency depreciation)	Cross-Country Effects (A foreign currency depreciation)
x_1 = effects of domestic policy on domestic CPI inflation rate	$-y_1$ = effects of foreign policy on domestic CPI inflation rate
x_2 = effects of domestic policy on domestic balance of trade	$-y_2$ = effects of foreign policy on domestic balance of trade
x_3 = effects of domestic policy on domestic employment rate	$-y_3$ = effects of foreign policy on domestic employment rate
Effects of Monetary Shock	
Own-Country Effects (A domestic money supply increase)	Cross-Country Effects (A foreign money supply increase)
t_1 = effects of domestic shock on domestic CPI inflation rate	$-q_1$ = effects of foreign shock on domestic CPI inflation rate
t_2 = effects of domestic shock on domestic balance of trade	$-q_2$ = effects of foreign shock on domestic balance of trade
t_3 = effects of domestic shock on domestic employment rate	$-q_3$ = effects of foreign shock on domestic employment rate

Note: x_i's, y_i's, q_i's, and t_i's (i = 1, 2, 3) are the partial derivatives of the target variables with respect to domestic and foreign exchange rates and money demand shocks.

In these reduced form equations, the cross-country effects ($-y_i$'s) of the foreign exchange rate policy on the domestic target variables are all negative given the parameter values in table 3.5 on page 62 (see Appendix 3A for algebraic analysis). The domestic policy has the same effects on the foreign target variables. As noted in chapter two, the sign and the size of transmission effect determine whether a Cournot-Nash equilibrium is expansionary or contractionary. This will be discussed later when we describe the equilibria of the game.

One of the main issues to be investigated in this chapter is Canzoneri and Minford's (1986) suggestion that higher interdependence between countries can increase the welfare gains from co-ordination. We define interdependence as the ratio of transmission effects to own effects ($-y_3/x_3$) from equation (3.12), which is consistent with Canzoneri and Minford's definition. However, we are also able to analyze the effects of interdependence on the co-ordination outcome based on the changes in structural parameters (e.g. trade price elasticities). For instance, in equation (3.5), as the trade price elasticities between the small countries ($a_1 \equiv b_1^*$ and $a_1^* \equiv b_1$) increase, interdependence ($-y_3/x_3$) increases between them. But it decreases as the trade price elasticities between the small countries and the ROW (a_3, b_3, a_3^*, and b_3^*) increase. (Interdependence between the small countries and the ROW is not defined from equation (3.12) since we do not model the ROW.) This analysis based on the structural parameters is not available in the model of Canzoneri and Minford (1986). But it allows us to compare our result with theirs since we define interdependence consistently with theirs.

B. An Objective Function with Three Targets

Define the objective function as

(3.13) $U = -\{z_1(\hat{p} - \hat{p}^t)^2 + z_2(\hat{t} - \hat{t}^t)^2 + z_3(\hat{n} - \hat{n}^t)^2\}$

where the z_i's are positive weights, $z_1 + z_2 + z_3 = 1$.

In many studies as mentioned earlier, only two targets -- either the inflation rate and real output (or the employment rate), or the inflation rate and the balance of payments -- have been included in the policy authorities' objective function. In our analysis, however, the balance of trade surplus (an external target) is pursued by the policy authorities, as in Oudiz and Sachs (1984), Oudiz (1985), Frankel and Rockett (1988), and Frankel (1988), in addition to the CPI inflation rate and the employment rate (internal targets).

The objective function is an elliptical function of the policy instruments $\hat{e}$ and $\hat{e}^*$, since the second derivatives of the objective function with respect to $\hat{e}$ and $\hat{e}^*$ (which are considered as the only policy instruments in our analysis) are negative and constant. From the following first derivatives of the objective function, the second derivatives are negative: $U_{ee} < 0$, $U_{e^*e^*} < 0$, and $[U_{ee}\, U_{e^*e^*} - U_{ee^*})^2] > 0$, satisfying the maximization condition. Hence, the objective function can be transformed onto the two dimensional diagram on the $\hat{e}$ and $\hat{e}^*$ plane as an ellipse.

$$U_e = -2\{\Psi_7\, \hat{e} - \Psi_1\, \hat{e}^* - \Psi_2\, \hat{m} + \Psi_3\, \hat{m}^* - \Psi_2\, \pi_2\hat{c}_1 + \Psi_3\, \pi_2^*\hat{c}_1^* - \Psi_4\, \hat{p}^t - \Psi_5\, \hat{t}^t - \Psi_6\, \hat{n}^t\}$$

$$U_{e^*} = -2\{-\psi_7\, \hat{e} + \psi_1\, \hat{e}^* + \psi_2\, \hat{m} - \psi_3\, \hat{m}^* + \psi_2\, \pi_2\hat{c}_1 - \psi_3\, \pi_2^*\hat{c}_1^* + \psi_4\, \hat{p}^t + \psi_5\, \hat{t}^t + \psi_6\, \hat{n}^t\}$$

where $\Psi_1 = \psi_7$, and Ψ_i's & ψ_i's (i = 1, 2,..., 7) are parameters defined in Appendix 3A.

From the maximization of the quadratic objective function with respect to each country's own exchange rate, the linear policy reaction function for each of the small economies can be derived. The result, for the first country, is given as (3.14).

C. Policy Reaction Function (RF)

$$(3.14)\quad \hat{e} = E(\hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$= (\Psi_1/\Psi_7)\, \hat{e}^* + (\Psi_2/\Psi_7)\, \hat{m} - (\Psi_3/\Psi_7)\, \hat{m}^* + (\Psi_2/\Psi_7)\, \pi_2\hat{c}_1$$

$$- (\Psi_3/\Psi_7)\, \pi_2^*\hat{c}_1^* + (\Psi_4/\Psi_7)\, \hat{p}^t + (\Psi_5/\Psi_7)\, \hat{t}^t + (\Psi_6/\Psi_7)\, \hat{n}^t$$

The effects of exchange rate policy on the third country is critical for our analysis. Without the ROW, indeterminacy follows from the fact that one country's imports would be the other symmetric country's exports. A foreign policy would have the same effects as a domestic policy on domestic target variables. Then, the slope of the two countries' reaction functions would equal one, inducing no equilibrium for the game (or else there would be an infinite number of equilibria when the values of all targets are zero).

In equation (3.14) the slope of the reaction function, Ψ_1/Ψ_7, is less than one. This is derived from the result of our algebraic analysis that the own-country effects (x_i's) are unambiguously larger than the cross-country effects (y_i's) in equations (3.10), (3.11), and (3.12). (See Appendix 3A for the algebraic detail.)

Exogenous shifts to the right in either the domestic IS or LM schedule increase the domestic goods price. This induces the domestic policy authorities to depreciate, in order to neutralize the pressure on the relative price of domestic exports. On the other hand, similar shifts in the other small country reduce the relative price of domestic exports. Thus, these foreign shocks cause the domestic policy authorities to appreciate, in order to neutralize the pressure on the domestic CPI level.

As mentioned in section I, a strategic policy co-ordination problem is initiated by some shocks to an initial equilibrium situation. A shift in the policy authorities' desired target values from the long-run equilibrium values, is considered as a "*target shock*". With this shock, the reaction functions can have non-zero intercepts as in figure 3-1 on page 53. Without this target shock or other shocks to the economy, the intercepts are zero, in which case the Cournot-Nash solution and the cooperative solution coincide with the bliss (the optimum) points at the origin. An expansionary target shock shifts the reaction function upward (e.g. for the home country, higher $\hat{e}$ for given $\hat{e}^*$), inducing more depreciationary tendency of the policy authorities.

From the reaction functions and the utility functions of the two small countries we can derive Cournot-Nash, Stackelberg, and cooperative equilibria as in Appendix 3A. In the next subsection, we will analyze the differences in exchange rates and welfare levels in these alternative equilibria for the case in which the Cournot-Nash equilibrium is more depreciationary than the bliss points. Note that the bliss points can be more depreciationary than the Cournot-Nash equilibrium depending on the parameter values or welfare weights.

D. Equilibria of The Game

1. Cournot-Nash Equilibrium (NE)

Each country is assumed to set its policy to maximize its utility based on zero conjectural variation. (That is, each country myopically assumes the other country's policy to be fixed.) Figure 3-1 shows a non-cooperative Cournot-Nash equilibrium at the intersection of two reaction curves (RF and RF*) which represent equation (3.14) for two small countries.

As noted in Frankel and Rockett (1988), a negative transmission effect of policy leads to a positively sloped reaction function and thus to an expansionary Cournot-Nash equilibrium. Given the parameter values in table 3.5, the transmission effect of exchange rate policy is negative. Thus, in figure 3-1, the slopes of the reaction functions are positive and the NE is more depreciationary (and thus more expansionary) than the cooperative equilibrium. This is because both small countries tend to depreciate their own currencies to improve their balance of trade at the cost of inflation and a high employment rate. But, it should be noted again that with different parameter values and welfare weights it is possible for the Cournot-Nash solution to be less expansionary than the cooperative solution.

2. Stackelberg Equilibria (SE)

Let us consider three possible solutions as Basar and Olsder (1982) suggest.[9] First, a "*stalemate solution*", where each player prefers to play the follower waiting for the other player to take the leadership first, although the leadership is preferred to the Cournot-Nash solution. Second, a "*concurrent solution*", where one player prefers the leadership while the other player prefers the followership, generating a stable solution. And third, a "*nonconcurrent solution*", where each player prefers to take the leadership itself.

The Stackelberg equilibrium is introduced when "*one of the players has the ability to enforce his strategy on the other player(s)*" (see Basar and Olsder, 1982, p.125), while it takes into account the counterpart's position as a Cournot-Nash player. Based on this assumption, the Leader conjectures the Follower's reaction function and maximizes its utility subject to the opponent's reaction function. That is, the Leader sets its policy at the tangency point of its indifference curve and the Follower's reaction curve, such as SE and SE^* in figure 3-1. In our example for symmetric countries, the results are less depreciationary than the NE as shown in figure 3-1. The Follower reaps more gain than the Leader, namely, $(U_F - U_N) > (U_{L*} - U_N^*)$ and $(U_F^* - U_N^*) > (U_L - U_N)$, resulting in the "*stalemate solution*". The subscripts N, L, F, and C denote Cournot-Nash equilibrium, Stackelberg leader, Stackelberg follower, and cooperative equilibrium respectively.

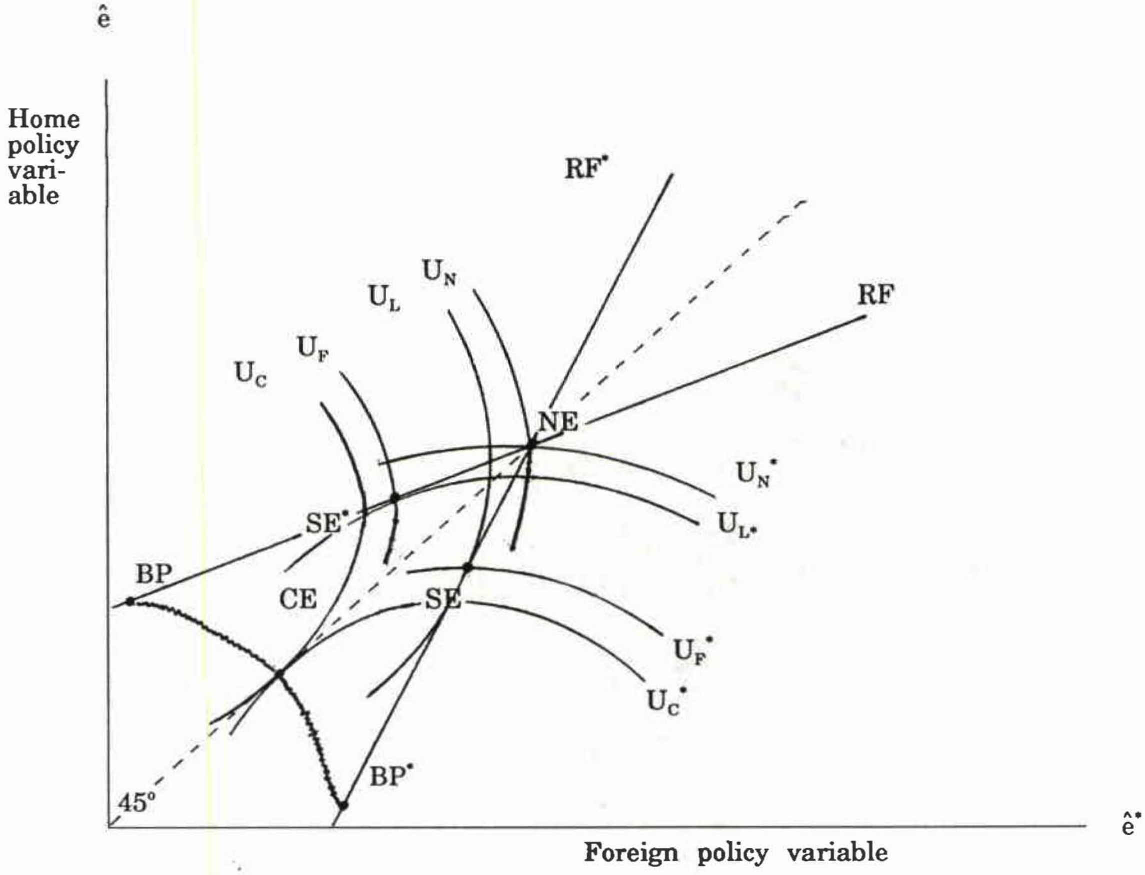

Figure 3-1 Welfare Levels in Alternative Equilibria

Notes: 1. RF = reaction function, BP = bliss point.
2. Subscripts N, L, F, and C denote Cournot-Nash equilibrium, Stackelberg leader, Stackelberg follower, and cooperative equilibrium respectively.
3. U_N (U_N^*) = Welfare level of the home (foreign) country at the NE.
4. U_L (U_F) = Home country's welfare level at the SE (SE*) as the Leader (Follower).
5. U_{L*} (U_F^*) = Foreign country's welfare level at the SE* (SE) as the Leader (Follower).
6. U_C (U_C^*) = Welfare level of home (foreign) country at the CE.

3. Cooperative Equilibrium (CE)

The cooperative solution results from joint policy-making of the two small countries to optimize their joint objective function. As in a symmetric-countries setting of previous studies, a cooperative solution such as CE in figure 3-1 is achieved by maximizing the joint utility function, $V = 1/2\ U + 1/2\ U^*$ (which implies equal bargaining power of each country), with respect to each country's policy instrument.[10] This equal-split cooperative solution has advantages over other non-cooperative solutions for both countries as shown in figure 3-1, i.e. $U_C > U_F > U_L > U_N$ and $U_C^* > U_F^* > U_L^* > U_N^*$. Thus, in principle, the equal-split solution is preferred by both countries.

However, this equal-split equilibrium is only one of the many possible cooperative solutions. In figure 3-1, the locus running through BP, CE, and BP* is a set of tangency points between the two countries' indifference curves. It represents the set of possible cooperative solutions which are "*Pareto-optimal*", where no one country can be better off without reducing the other country's welfare level. Other possible cooperative solutions require the weights in the above joint utility function to be asymmetric, reflecting the bargaining power of each country. In our analysis, we use the equal-split solution as the cooperative solution between two small countries following the "*focal-point*" theory[11] and the common practice in this literature. Even with asymmetry in trading patterns between small countries, we use equal-split (which can be interpreted as the most obvious solution according to the "*focal-point*" hypothesis) as the cooperative solution for simplicity of numerical analysis. Note that, in asymmetric case, our focus is on the feasibility of the Stackelberg solution, not on the cooperative solution.

III. Trading Patterns and Asymmetry

In an open macro model, the transmission of price effects is channeled via the trade (or relative) price elasticity of demand for exports and imports. In a two-country model, since one country's exports are the other country's imports, an increase in the trade price elasticity of one country's exports must result in symmetric effects on their reaction functions. Hence, it is impossible to impose asymmetric trade price elasticities in a two-country model. In our three-country model, however, we can impose asymmetry between two countries by assigning different trade price elasticities, to their exports to or imports from the ROW as described in patterns II, III, V, and VI below.

These trading patterns are based on the following assumptions: First, the trade price elasticity of a large country's import demand from other countries is higher than a small country's; and second, the trade price elasticity of demand for the small country's exports is higher than for the large country's exports.[12] The different trade price elasticities in these trading patterns reflect the strength of real links between countries on which the transmission effect is dependent.

A. Symmetric Case (Pattern I)

Both Home and Foreign countries are small countries and the ROW is a large country. The trade price elasticity of one small country's demand for the other small country's goods is lower than the trade price elasticity of the ROW demand for both small countries' goods. But it is higher than the price elasticity of either small country's demand for the ROW goods.

Thus, $a_3 = a_3^* > a_1 (\equiv b_1^*) = a_1^* (\equiv b_1) > b_3 = b_3^*$ in this pattern (see figure 3-2 for definitions). For reasonable parameter values which generate the negative transmission effects, the reaction functions are same as those in figure 3-1. The alternative trading patterns, pattern I to VI, are defined in table 3.4.

B. Asymmetric Cases

Let us consider the following four possible changes in trade price elasticities compared to pattern I.

Case 1 ($b_3 > b_3^*$): The trade price elasticity of the Home country's import demand for the ROW exports (b_3) is higher than that of the Foreign country's (b_3^*). For example, the Home country produces relatively more substitutes for imports from the ROW than the Foreign country.

Case 2 ($a_3^* > a_3$): The trade price elasticity of the ROW import demand for the Foreign country's exports (a_3^*) is higher than that for the Home country's exports (a_3). For example, the ROW produces relatively more substitutes for the Foreign country's exports than for the Home country's.

Case 3 ($a_1^* (\equiv b_1) > a_1 (\equiv b_1^*)$): The trade price elasticity of the Home country's import demand for the Foreign country's exports (b_1) is higher than that of the Foreign country's import demand for the Home country's exports (b_1^*).

Case 4 ($a_3^* = b_3^* = 0$): The trade price elasticities between the Foreign country and the ROW are zero. For example, the Foreign country only trades some price inelastic goods with the ROW, or possibly does not trade with them at all.

In pattern II below, only the first case is considered. In patterns III and IV below, only the second and the third cases are considered respectively. In pattern V, however, we consider both the second and the third cases. Finally in pattern VI, we

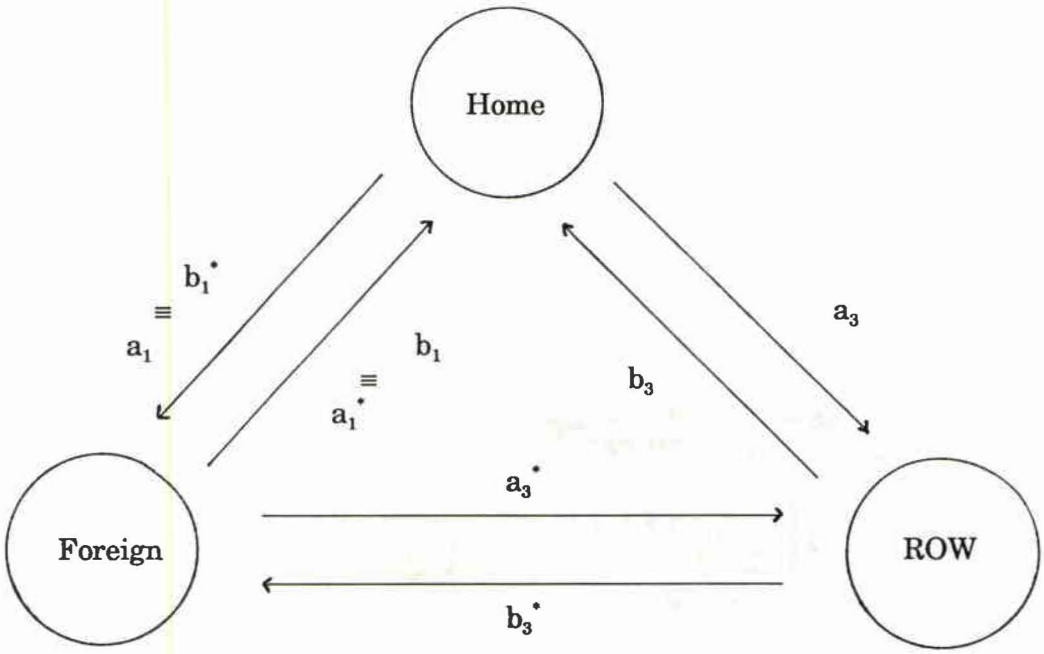

Figure 3-2 Flows of Goods among Three Countries
Note: The arrows are implying the direction of the goods flows, and the letters represent the price elasticities of those flows.

Table 3.4 Relative Price Elasticities in Alternative Trading Patterns

Trading Patterns	Change from Pattern I	Order of Relative Price Elasticities
I		$a_3 = a_3^* > a_1 = a_1^* > b_3 = b_3^* > 0$
II	b_3 (+)	$a_3 = a_3^* > a_1 = a_1^* > b_3 > b_3^* > 0$
III	a_3^*(+)	$a_3^* > a_3 > a_1 = a_1^* > b_3 = b_3^* > 0$
IV[3]	a_1^*(+)	$a_3 = a_3^* > a_1^* > a_1 > b_3 = b_3^* > 0$
V	a_3^*(+),a_1^*(+)	$a_3^* > a_3 > a_1^* > a_1 > b_3 = b_3^* > 0$
VI	a_3^*(-),a_1^*(-)	$a_3 > a_1 = a_1^* > b_3 > 0$, $a_3^* = b_3^* = 0$

Note: 1. $a_1 \equiv b_1^*$ and $a_1^* \equiv b_1$.
2. (+) and (-) denote an increase and a decrease in the size of each price elasticity from the corresponding price elasticity in pattern I.
3. In pattern IV, two countries are asymmetric in the trade price elasticities, but symmetric in the slopes of the reaction functions. Thus, it will be referred to as a symmetric pattern in later analysis.

consider only the last case.

Before we discuss the slopes of the reaction functions for each trading pattern, it should be noted that this slope is determined mainly by the policy effects on the BOT, the size of which is much larger than the effects on the other target variables (see table 3.9 on page 85). Thus we focus on the effects of exchange rate policies on the balance of trade, in our discussion of the slopes of the reaction functions.

1. Pattern II: $a_3 = a_3^* > a_1(\equiv b_1^*) = a_1^*(\equiv b_1) > b_3 > b_3^* > 0$.

Without specific parameter values, we cannot compare the effects of a change in b_3 on the slopes of the two countries' reaction functions; we have to rely on a simulation test.

In this pattern, the effects of the Home country's policy on its own balance of trade (x_2) are larger than in pattern I, due to the increased trade price elasticity of the ROW exports. But the increased income of the Home country induces more import from the Foreign country. This increases the own and cross-country effects of the Foreign country's policy (x_2^* and y_2), and decreases the cross-country effects of the Home country's policy (y_2^*). Thus, the Foreign country's reaction function ($d\hat{e}^*/d\hat{e}$) could be flatter or steeper than the Home country's ($d\hat{e}/d\hat{e}^*$) depending on the economic structure (parameter values). (Note that the slope of the Home (Foreign) country's reaction function is measured as $d\hat{e}/d\hat{e}^*$ ($d\hat{e}^*/d\hat{e}$) in the $\hat{e}$ and $\hat{e}^*$ plane.)

However, in a two-country Mundell-Fleming model, it is generally assumed that the positive direct price effect on the current account dominates the negative indirect income effect of a monetary expansion, giving a negative transmission effect, as pointed out in Frankel and Rockett (1988). Hence, the Home country's reaction function is presumed to be flatter than the Foreign country's. This presumption will be used as a criterion when we choose parameter values for simulation in the next section.

2. Pattern III: $a_3^* > a_3 > a_1(\equiv b_1^*) = a_1^*(\equiv b_1) > b_3 = b_3^* > 0$.

The result of this pattern is a simple mirror image of that of pattern II. Thus, analogously to pattern II, we presume that the Foreign country has a flatter reaction function than the Home country.

3. Pattern IV: $a_3^* = a_3 > a_1^*(\equiv b_1) > a_1(\equiv b_1^*) > b_3 = b_3^* > 0$.

The change in the trade price elasticity of the Home country's demand for the Foreign country's exports affects both countries symmetrically. Thus, their reaction functions are symmetric.

The change in a_1^* ($\equiv b_1$) increases both the cross-country effects of the Foreign country's policy (y_2) and the own effects of the Home country's policy (x_2) on the domestic balance of trade. Hence, the relative size of the changes in these effects determines whether their symmetric reaction functions are flatter or steeper than in pattern I. If $\Delta y_2/\Delta x_2 > y_2/x_2$ (or $\Delta y_2/y_2 > \Delta x_2/x_2$), then the slope is steeper, and vice versa. We presume that $\Delta y_2/y_2 > \Delta x_2/x_2$, because the x_2 includes the direct price effect on the ROW while the change in a_1^* ($\equiv b_1$) affects only the trade between two countries. Thus the slope is likely to be steeper than in pattern I, inducing a more depreciationary equilibrium.

4. Pattern V: $a_3^* > a_3 > a_1^*(\equiv b_1) > a_1(b_1^*) > b_3 = b_3^* > 0$.

The result of this pattern is a combination of the results in patterns III and IV. We cannot predict whether NE will be more or less depreciationary than in pattern I, because it is determined by the strength of the impact of a_1^* ($\equiv b_1$) and a_3^* on the policy effects. However, as in pattern III, the Foreign country is presumed to have a flatter reaction function than the Home country, since the change in a_1^* ($\equiv b_1$) affects the slopes of both countries' reaction functions symmetrically as in pattern IV.

5. Pattern VI: $a_3 > a_1$ ($\equiv b_1^*$) $= a_1^*$ ($\equiv b_1$) $> b_3$, $a_3^* = b_3^* = 0$.

Since the Foreign country has almost no trade with the ROW, the effects of the Foreign country's depreciation (x^{2*}) decrease, making the Foreign country's GNP lower than it was in pattern I. Hence, the Foreign country imports less from the Home country, diminishing the effects of the Home country's policy (x_2 and y^{2*}), and increasing the cross-country effects of Foreign country's policy (y_2).

As mentioned for pattern II, the direct impact (through the price effect) of the changes in a_3^* and b_3^* on the Foreign country's policy effects should be larger than the indirect impact (through the income effect) on the Home country's policy effects. Here, we presume that the Home country's reaction function is flatter than the Foreign country's. This presumption, together with that of pattern II, will be used as a criterion when we choose parameter values in the next section.

Note that, with lower a_3^* and b_3^*, the reaction functions are steeper (i.e. $d\hat{e}/d\hat{e}^*$ ($d\hat{e}^*/d\hat{e}$) is bigger for the Home (Foreign) country's reaction function), and thus the NE is more depreciationary than in pattern I.

IV. Simulation Test

As mentioned earlier, the reaction functions' slopes vary with parameter values. The choice of parameters used in our simulation is limited to those that give results consistent with the presumptions in section III.

A. Test Procedure

1. Step 1: For each of nine structural parameters, high and low values which

appear to be sensible according to other numerical studies are assigned, creating $2^9 = 512$ parameter vectors.

2. Step 2: In pattern II, the reaction function of the Home country, which has a higher trade price elasticity of demand for the ROW goods, is presumed to be flatter than the Foreign country's. Also in pattern VI, the Foreign country, which trades only some price-inelastic goods (or no trade at all) with the ROW, is presumed to have a steeper reaction function than the Home country. We use these presumptions as criteria in selecting parameter values: Only 128 out of 512 parameter vectors satisfy these criteria. For each parameter, we choose one particular value (from the two optional values in table 3.5) which appears in the 128 parameter vectors most frequently.

3. Step 3: With this chosen parameter vector, we examine the following issues by numerical analysis: (1) Whether higher interdependence between countries, measured as the ratio of transmission effects to own effects, can increase the welfare gains from co-ordination as Canzoneri and Minford (1986) suggest; (2) whether lower trade price elasticities can increase the welfare gains as Turnovsky and d'Orey (1986) argue; (3) whether the Stackelberg leader-follower solution is feasible under asymmetry between economies, which is not obtained in Eichengreen (1985).

B. Choice of Values

1. Values for Parameters: Following the first two steps we choose a set of parameter values as shown in table 3.5.

The trade price elasticity of the ROW demand for the small countries' exports (a_3) is assumed to be higher than the trade price elasticity between small

Table 3.5 Parameter Values

Parameters	Optional Values Low	High	Chosen Values
α_1	0.4	0.7	0.7
β_1	0.4	0.75	0.75
γ_1	1.5	3.0	3.0
π_1	0.5	1.0	1.0
π_2	0.5	1.0	0.5
a_2	1.0	2.0	1.0
a_1 $(=b_1)$	1.5	2.0	1.5 ($a_1^*(\equiv b_1) = 1.8$ in P IV & P V)
a_3	3.0	5.0	3.0 ($a_3^* = 0.6$ in P III & P V, 0 in P VI)
b_3	0.3	0.6	0.3 ($b_3 = 0.6$ in P II, $b_3^* = 0$ in P VI)

Notes: 1. Home and foreign economies are equal in size and are symmetrically parameterized.
2. $\beta_2 = \beta_3 = (1 - \beta_1)/2$ and $a_2 = b_2 = a_4 = b_4$ (equal income elasticity).
3. $\beta_1 = 0.75$, $\pi_1 = 1.0$, $\pi_2 = 0.5$ are the same values taken by Oudiz and Sachs (1985).
4. The values of some trade price elasticities change in different patterns as indicated above in parentheses.
5. See table 3A.2 in Appendix 3A for parameter definitions.

countries (a_1). Also, the trade price elasticity of the small countries' import demand for ROW exports (b_3) is assumed to be very inelastic. This choice is based on the assumption made in section III about the trade price elasticities between countries of different size.

The trade price elasticities (a_1, a_3, b_3) and the sensitivity of investment to the real interest rate (γ_1) are within the range of values taken by other authors; for example, Oudiz and Sachs (1985), Miller and Salmon (1985), Carlozzi and Taylor (1985), and Turnovsky and d'Orey (1986). But the income elasticity of goods demand (a_2) is chosen equal one, which is the upper value considered by these authors. Note that this comparison is made using our version of Dornbusch aggregate demand equation (see footnote 8).

2. Values for Targets: The target values are not required to estimate the exchange rate policy effects (multipliers), but they do affect the values of target variables and the national welfare level in each equilibrium. For instance, excessively expansionary targets induce too depreciationary equilibria and deteriorate welfare levels. Although the choice of target values is arbitrary, without a better alternative, we adopt similar values as in Oudiz and Sachs (1984):[13]

(a) $\hat{p}^t = p^{St} - p^L = \ln(P^{St}/P^L) = 0$; zero inflation rate.

(b) $\hat{t}^t = t^{St} - t^L = t^{St} = T^{St}/X^L = 0.1$; the short-run target BOT surplus is 10% of the long-run exports. This is referred to as a "*target shock*" which starts the game.[14]

(c) $\hat{n}^t = n^{St} - n^L = \ln(N^{St}/N^L) = 0$; full employment rate.

Note that an increase in each target value shifts the bliss point in the $(\hat{e}, \hat{e}^*)$ space (see figure 3-1). When the target values increase, the reaction function's intercept also increases without changing its slope.

3. Values for Weights: We have three weights for the three target variables in the objective function (z_1, z_2, and z_3 for $\hat{p}^t$, $\hat{t}^t$, and $\hat{n}^t$).

As noted in chapter two, the choice of weights is an arbitrary one in the literature.[15] Oudiz and Sachs (1984), who made the first attempt to quantify the gains from co-ordination in large-scale macroeconometric models, chose the welfare weights using conditions involving the estimated marginal utilities of target variables at a baseline. The baseline is taken from an ex-ante simulation of the multicountry model for the period 1984-86, and it is assumed to be a Cournot-Nash equilibrium. By assuming that the individual governments maximize their objective function with respect to each policy instrument (money supply and fiscal policy), the authors derive two first-order-condition equations with three unknowns (marginal utilities of target variables) to be solved. Then, by normalizing the marginal utility of output, they estimate the marginal utilities of the other two target variables. Given these values and the values of the target variables at the baseline, welfare weights can be estimated. Frankel and Rockett (1988) and Frankel (1988) also adopted this method to choose welfare weights.

With no obviously better alternative, first we take the weights which were estimated in Oudiz and Sachs (1984) for the U.S. using the Federal Reserve Board's Multicountry model; i.e. the weights for inflation, current account, and output are (0.84, 0, 0.16). But, we are particularly interested in the game between the authorities of NICs or less developed countries, whose objective is rather growth-oriented and whose economic development has been financed by the accumulated foreign debt. Hence, we assume higher weights for the BOT target and the employment rate (which is corresponding to output) target than their values. That is, we choose $(z_1, z_2, z_3) = (0.45, 0.1, 0.45)$ for illustrative purpose, which induces a sensible position of the bliss point on a diagram such as figure 3-1, in the sense that the bliss point is less depreciationary than the NE.

We have tried several sets of weights to test the sensitivity of the welfare outcome to the values of weights: $(z_1, z_2, z_3) = (0.98, 0.01, 0.01)$, $(0.01, 0.98, 0.01)$, $(0.01, 0.01, 0.98)$, $(0.8, 0.1, 0.1)$, $(0.1, 0.8, 0.1)$, $(0.1, 0.1, 0.8)$, $(0.49, 0.01, 0.49)$, $(0.45, 0.1, 0.45)$, $(0.35, 0.3, 0.35)$, and $(0.3, 0.4, 0.3)$. The different weights result in some differences in welfare outcomes as shown in table 3A.3 of Appendix 3A. Especially, when the weight for the balance of trade increases, the welfare gains from co-ordination decrease substantially either in proportion $((-U_N)^{1/2}/(-U_C)^{1/2})$ or in "*GNP equivalent*" units (see the next section).

C. Size of Welfare Gains from Co-ordination

As in previous studies, we will examine here whether the authorities can gain from policy co-ordination (i.e. by adopting the cooperative equilibrium instead of Cournot-Nash). We will also measure the gains from implementing policy (whether cooperative or not) compared with no policy reaction to the shock (a target shock or a shock to the economy). We will first discuss the measurement of welfare gains. Then we will examine the Canzoneri-Minford (1986) and Turnovsky-d'Orey (1986) suggestions by testing the sensitivity of gains to the size of the trade price elasticities.

1. Measurement of Welfare Gains

The welfare loss (or cost) is caused by the shocks to the target values or the economy. If there is no shock, the target variables have the same values as in the long-run equilibrium. The welfare loss is then zero.

The welfare gain of reacting to this shock has been measured in different ways. For example, Ghosh (1986) uses $(-U_N)/(-U_C)$ = (loss under Cournot-Nash)/(loss under cooperation), a "*relative loss*". Oudiz and Sachs (1984), Oudiz (1985), Hughes Hallett (1985), and Frankel and Rockett (1988) measure $(U_C - U_N)$ as a welfare gain in units defined as "*GNP equivalent*", by normalizing the marginal utility of GNP to one.

However, we measure the difference in the square roots of the welfare costs between the Cournot-Nash and the cooperative equilibria, $(-U_N)^{1/2} - (-U_C)^{1/2}$, as gains from co-ordination. For simple illustration, let us suppose an equal x% point deviation in each target which would create a welfare loss of $z_1x^2 + z_2x^2 + z_3x^2$ in the objective function (3.13), where z_i's are the welfare weights. This sums to x^2 since the sum of the weights is one. Because $-U = x^2$ in this example, knowing the value of the welfare cost (-U), the weighted average percentage point deviation in targets (x) can be computed by taking a square root of this welfare cost, i.e. $x = (-U)^{1/2}$.

Therefore, no matter what the source of the deviation is, the welfare unit (say, $(-U)^{1/2} = 1\%$) can be interpreted as equivalent to 1.49% change in the employment rate from its target value of zero, using the formula $\hat{n} = (1/z_3)^{1/2}\ (-U)^{1/2}$, where $z_3 = 0.45$. Then, since $\hat{y} = 0.7\ \hat{n}$ based on our parameter values, it is equivalent to a 1.04% change in GNP from its target value of zero.[16] This method is similar to the concept of "*compensating variation*" in welfare economics. $(-U_N)^{1/2}/(-U_C)^{1/2}$, similar to Ghosh (1986), is also used as an alternative measurement of gains from co-ordination.

We define $(-U_o)^{1/2} - (-U_N)^{1/2}$ as the welfare gain from non-cooperative policy implementation compared to no policy reaction to a shock by the authorities. U_o is the benchmark welfare level where there is no policy reaction and U_N is the corresponding value after a Cournot-Nash reaction of both countries. Suppose the policy authorities exogenously shift the balance of trade target from zero to 10% surplus, but undertake no policy. With no policy action, the target variables stay at the previous long-run equilibrium value (i.e. at zero). Then, since we assume zero for the inflation and employment rate targets and 10% for the balance of trade target $\hat{t}^t$, $(-U_o)^{1/2}$ is simply computed from the balance of trade target in the objective function; i.e. $(-U_o)^{1/2} = \{z_2\,(\hat{t}^t)^2\}^{1/2}$. Thus, for the various trade price elasticities, $(-U_o)^{1/2}$ is constant as shown in table 3.7.

2. Size of Welfare Gains and Trade Price Elasticity

The trade price elasticity of demand between the small countries has a significant impact on the transmission effects of policy, and thus on the extent of interdependence between them. Canzoneri and Minford (1986) suggest that higher interdependence between the two countries could increase the size of welfare gains from co-ordination. They assume inherited inflation (a target shock), perfect capital mobility, and a flexible exchange rate regime, considering output and the inflation rate as target variables.

They define interdependence as the ratio of transmission effects to own effects of money supply policy on real output. Here, we define it as the ratio of cross-country effects to own effects of exchange rate policy on the employment rate, $-y_3/x_3$, because we use the employment rate instead of real output as a target, and because we use the exchange rate as the instrument of monetary policy. Since Canzoneri and Minford use money supply policy under a flexible exchange rate regime, their suggestion can be interpreted differently at the applied level from our results, where exchange rate policy is used under fixed exchange rate regime. But, by defining interdependence between countries in terms of the ratio of transmission effects to own effects which is reflected in the slope of the reaction function, we may be able to compare our results with theirs.

To be consistent with Canzoneri and Minford, we analyze the effects of interdependence between the small countries (the co-ordinating partners) on the gains from co-ordination. Interdependence between the small countries ($-y_3/x_3$) increases as the trade price elasticities between them ($a_1 \equiv b_1^*$ and $a_1^* \equiv b_1$) increase. But it decreases as the trade price elasticities between the small countries and the ROW (a_3,

b_3, a_3^*, and b_3^*) increase.

Turnovsky and d'Orey (1986) suggest that lower trade price elasticities of goods can increase the size of welfare gains from co-ordination. They assume a demand or a supply shock, perfect capital mobility, and a flexible exchange rate regime, using output and the inflation rate as target variables. Although their suggestion is consistent with that of Canzoneri and Minford in a two-country model, it is not always so in our three-country model.

In a two-country model, the positive transmission effects of a monetary expansion in Canzoneri and Minford imply a low trade price elasticity as pointed out in Turnovsky and d'Orey. In the transmission effects, the negative terms of trade effect is dominated by the positive income effect (including the LM shift effect). A lower trade price elasticity reduces the own effects of money supply policy while increasing the positive transmission effects, and therefore inducing higher interdependence. Even if the transmission effects are negative as in Turnovsky and d'Orey, the lower trade price elasticity reduces the own effects a lot more than the transmission effects, increasing interdependence. For example, using Turnovsky-d'Orey model and parameters, the degrees of interdependence are 0.087, 0.032, -0.030, and -0.024 for the trade price elasticities 0, 0.1, 1, and 2.

In our three-country model, the positive own effects depend on the overall trade and the negative transmission effects mainly depend on the trade between the small countries. A decrease in the trade price elasticity between the small countries lowers the degree of interdependence, because the proportion of decrease in the transmission effects is larger than that of the own effects. But, a decrease in the trade price elasticity between the small countries and the ROW results in higher interdependence between the small countries, for the opposite reason. This change will be illustrated later using an extreme example.

Let us now examine the Canzoneri-Minford and Turnovsky-d'Orey suggestions regarding the welfare gains from co-ordination with various levels of trade price elasticities. In this following section we consider only the symmetric case: Both small countries have a "*target shock*" (positive BOT target), and have the same trade price elasticities in each case. Hence, we ignore the notation for foreign parameters, *, for simplicity of exposition, where a_1 ($\equiv b_{1*}$) = a_{1*} ($\equiv b_1$), a_3 = a_{3*}, b_3 = b_{3*} in figure 3-2.

We choose 0.1 for low and 5 for high values of the trade price elasticities. Then, by alternating these values for a_1, a_3, and b_3 respectively, eight sets of values are generated and used in tables 3.6 and 3.7. We show the sensitivity of welfare gains to the changes in these trade price elasticities in table 3.7. Table 3.8, which is derived from tables 3.6 and 3.7, summarizes our results regarding the suggestions of Canzoneri and Minford (1986) and Turnovsky and d'Orey (1986).

Before we summarize the major results of this section, it should be pointed out again that Turnovsky and d'Orey's suggestion is not always consistent with that of Canzoneri and Minford in our three-country framework. In our model, a high trade price elasticity with the ROW (a_3 or b_3) induces low interdependence between the small countries. Taking an extreme example, if a_3 or b_3 increases to infinity, the own effects increase infinitely due to a trade surplus against the ROW, and the increased income reduces the negative transmission effects. In fact, with this extremely large trade price elasticity with the ROW, the transmission effects are likely to be positive and would increase. In either case, the ratio of the transmission effects to the own effects approaches zero; i.e. most of the exchange rate policy effects are against the

Table 3.6 Changes in Selected Variables with Various Trade Price Elasticities

Values of (a_1,a_3,b_3)	Selected Variables				
	Exchange Rate (% change)	Interest Rate ($\hat{\imath}$, %)	Inflation Rate (%)	Balance of Trade (ratio, %)	Employment Rate (% change)
(0.0,0.0,0.0)	15.8908	0.7752	1.5503	1.1627	-1.6611
(0.1,0.1,0.1)	20.4435	2.1192	2.1475	5.2698	-1.5541
(5.0,0.1,0.1)	39.8275	4.1286	4.1837	10.2665	-3.0277
(0.1,5.0,0.1)	2.3203	2.8121	0.5944	9.2478	1.1595
(0.1,0.1,5.0)	2.3203	2.8121	0.5944	9.2478	1.1595
(5.0,5.0,0.1)	2.2998	2.7872	0.5892	9.1662	1.1492
(5.0,0.1,5.0)	2.2998	2.7872	0.5892	9.1662	1.1492
(0.1,5.0,5.0)	1.3796	2.7591	0.5017	9.1553	1.2541
(5.0,5.0,5.0)	1.3731	2.7462	0.4993	9.1125	1.2483

Notes: 1. The exchange rate ($\hat{e}$) and the employment rate ($\hat{n}$) are percentage changes from the long-run rates; the inflation rate ($\hat{p}$), the interest rate ($\hat{\imath}$), and the balance of trade ($\hat{t}$) are the percentage point deviations from the long-run levels, where $\hat{t}$ is BOT/(long-run exports) ratio.
2. Welfare weights $(z_1,z_2,z_3) = (0.45, 0.1, 0.45)$ are used.
3. Symmetric trading pattern (pattern I) is considered.

passive ROW. On the contrary, a high trade price elasticity between the small countries (a_1) induces high interdependence between them. For instance, if a_1 approaches infinity, the size of negative transmission effects almost equals the size of overall own effects, inducing interdependence to be around one; i.e. most of the policy effects are against the other small country. Note that interdependence is

Table 3.7 Sensitivity of Size of Gains to Trade Price Elasticities

Values of (a_1,a_3,b_3)	Inter-depend-ence $(-y_3/x_3)$	Welfare Costs (%) $(-U_0)^{1/2}$	Welfare Costs (%) $(-U_N)^{1/2}$	Welfare Gains (%) $(-U_0)^{1/2} - (-U_N)^{1/2}$	Welfare Gains (%) $(-U_N)^{1/2} - (-U_C)^{1/2}$	Welfare Gains $(-U_N)^{1/2}/(-U_C)^{1/2}$
(0.0,0.0,0.0)	-0.4519	3.16228	3.18322	-0.02094	0.10913	1.0354989
(0.1,0.1,0.1)	-0.4465	3.16228	2.32370	0.83858	0.01629	1.0070607
(5.0,0.1,0.1)	-1.1278	3.16228	3.46534	-0.30306	1.15793	1.5018319
(0.1,5.0,0.1)	0.2010	3.16228	0.90584	2.25644	0.00028	1.0003058
(0.1,0.1,5.0)	0.2010	3.16228	0.90584	2.25644	0.00028	1.0003058
(5.0,5.0,0.1)	-0.4899	3.16228	0.90557	2.25671	0.00001	1.0000132
(5.0,0.1,5.0)	-0.4899	3.16228	0.90557	2.25671	0.00001	1.0000132
(0.1,5.0,5.0)	0.1128	3.16228	0.94467	2.21761	0.00013	1.0001376
(5.0,5.0,5.0)	-0.2812	3.16228	0.94454	2.21774	0.00000	1.0000010

Notes: 1. 1% change in welfare costs or gains is interpreted as equivalent to around 1.04% change in GNP, using the formula $\hat{y} = \alpha\,(1/z_3)^{1/2}\,(-U)^{1/2}$.
2. $(-U_0)^{1/2}$ is the welfare cost caused by a change in the balance of trade target from zero to 10%, while implementing no policy inducing no change in the target variables; assuming zero for other targets, it is simply computed from the balance of trade target in the objective function, i.e. $(-U_0)^{1/2} = \{z_2\,(\hat{t}^t)^2\}^{1/2}$. Thus, for the various trade price elasticities, $(-U_0)^{1/2}$ is constant.
3. Interdependence is measured as the ratio of cross-country effects to own effects of policy on the employment rate, $-y_3/x_3$, since we use the employment rate instead of real output as a target.
4. See notes 2 and 3 of table 3.6.

normally less than one, and we measure the degree of interdependence between the small countries, and not between the small countries and the ROW.

The following results are obtained:

First, in general, lower overall trade price elasticities induce larger gains from

Table 3.8 Welfare Gains vs trade price Elasticities and Interdependence

	Increase in a_1 (0.1 to 5.0)
Low a_3, b_3 (0.1,0.1)	1. Increases interdependence (-0.45 to -1.13) 2. Increases welfare gain (0.01629 to 1.15793) 3. Turnovsky and d'Orey's suggestion is not supported 4. Canzoneri and Minford's suggestion is supported 5. Exchange rate at NE increases (20.4% to 39.8%)
High a_3, b_3 (5.0,5.0)	1. Increases interdependence (0.11 to -0.28) 2. Decreases welfare gain (0.00013 to 0.0) 3. Turnovsky and d'Orey's suggestion is supported 4. Canzoneri and Minford's suggestion is not supported 5. Exchange rate at NE decreases (1.38% to 1.37%)
	Increase in a_3 & b_3 (0.1 to 5.0)
Low a_1 (0.1) High a_1 (5.0)	1. Decreases interdependence (0.45 to -0.11 with a low a_1) (1.13 to 0.28 with a high a_1) 2. Decreases welfare gain (0.01629 to 0.00013 with a low a_1) (1.15793 to 0.0 with a high a_1) 3. Turnovsky and d'Orey's suggestion is supported 4. Canzoneri and Minford's suggestion is supported 5. Exchange rate at NE decreases (20.4% to 1.38% with a low a_1) (39.8% to 1.37% with a high a_1)

Notes: 1. $(-U_N)^{1/2} - (-U_C)^{1/2}$ is used for welfare gains.
2. Interdependence is measured as the ratio of cross-country effects to own effects of exchange rate policy on the employment rate, $-y_3/x_3$, since we use the employment rate instead of real output as a target.

co-ordination in support of Turnovsky and d'Orey's result. In table 3.7, if we compare the welfare gains from co-ordination (the last two columns) by moving from the bottom line to the second andthe first lines, the size of gains increases with lower trade price elasticities. As shown in table 3.6 (for the same lines just mentioned), the BOT is much lower (i.e. further from the new target) with lower trade price elasticities, while the unemployment rate and inflation are higher, raising the tradeoffs among the target variables, and therefore,increasing the absolute welfare losses compared to the high trade price elascities case. When the overall trade price elasticities are low, the small countries' exchange rate policies have weaker effects against the ROW, and the small countries are more dependent on each other's policy. Thus, policy co-ordination can reduce the welfare losses more effectively here than in the case of higher trade price elasticities.

Second, as shown in table 3.8, when the trade price elasticities with the ROW (a_3 and b_3) increase given the same trade price elasticity between the small countries (a_1), interdependence between the small countries decreases as do the benefits of policy co-ordination. (In tables 3.6 and 3.7, this case is seen by moving from the second (third) line to the second last (bottom) line.) With lower interdependence between the small countries, one country's policy has less effects on the other country's economy and on its policy making. Hence the benefit of policy co-ordination decreases, supporting both Turnovsky-d'Orey and Canzoneri-Minford suggestions. In other words, since the small countries' policies have stronger effects on the passive ROW with higher trade price elasticities, the small countries can shift the impact of the target shock (BOT surplus) to the passive ROW, reducing the gains from co-ordination between the small countries.

When the trade price elasticity between the small countries (a_1) increases given the same trade price elasticities with the ROW (a_3 and b_3), support for the Turnovsky-d'Orey and Canzoneri-Minford suggestions depends on the values of the a_3 and b_3 coefficients. When the a_3 and b_3 parameters are low, the small countries are relatively more dependent on the policy of each other. A higher a_1 enhances interdependence and the welfare gains from co-ordination significantly, contradicting (supporting) Turnovsky and d'Orey's (Canzoneri and Minford's) result. (In tables 3.6 and 3.7, this case is seen by moving from the second line to the third line.)

When the a_3 and b_3 parameters are high, the small countries' policies have stronger effects on the ROW and the small countries depend less on each other's policy. A higher a_1 (seen by moving from the second last line to the bottom line) increases interdependence but slightly decreases the welfare gains from co-ordination, contradicting (supporting) Canzoneri and Minford's (Turnovsky and d'Orey's) suggestion. This is because, with very high trade price elasticities in overall trade, the effects of exchange rate policy are so strong that a less depreciation is required for the small countries to achieve the BOT surplus. Then, the values of inflation and over-employment rates are smaller (see the bottom line in table 3.6), inducing the overall welfare costs to be smaller. Thus, the absolute welfare gains from co-ordination slightly decrease. (Generally, larger welfare costs at the Cournot-Nash and the cooperative equilibria result in a larger difference between them, implying larger absolute welfare gains from co-ordination.)

This result provides a counter example to the findings by the above authors. In our three-country model, the levels of the trade price elasticities with the ROW significantly affect the degree of interdependence between small countries and the gains from co-ordination between them.

Third, non-cooperative policy can lead to more welfare losses than no policy; $(-U_o)^{1/4} < (-U_N)^{1/4}$ as shown in table 3.7 (in the first and the third lines). This would not occur if each country were able to response to its shock while the other country implements no policy, i.e. every point on the reaction curve is optimal for given position abroad. When the overall trade price elasticities are zero in table 3.6 (at the first line), a depreciation of domestic currency increases own inflation rate. Although the same policy of the foreign country has a deflationary effect on the domestic CPI level, it is dominated by own policy effect. Then, through LM shift effect, the domestic employment rate decreases and the domestic balance of trade increases due to a small indirect income effect against the ROW. Thus, compared with the no policy reaction case, although the negative gap in the external target is lowered a little at the Cournot-Nash equilibrium, the positive gap in the inflation and the negative gap in the employment rate are larger, inducing higher welfare costs.

In table 3.7 (at the third line), the degree of interdependence between the small countries is larger than one, when the trade price elasticity between small countries is large while the trade price elasticities with the ROW is very small. Since the small countries' policies have little effect on the ROW, a large depreciation is required for both countries to achieve the BOT surplus at the Cournot-Nash equilibrium (see the third line in table 3.6). Thus, the inflation rate increases and the unemployment rate also increases due to LM shift effect. Note that the negative LM shift effect is larger than the positive IS shift effect on the employment rate, as is indicated by the degree of interdependence (larger than one) which is measured as the ratio of cross-country effect to own effect of exchange rate policy on the employment rate. Again, although the gap in the external target is lowered the gaps in the internal targets increase, inducing higher welfare losses compared with the no policy reaction case.

To conclude this section, it should be noted that we also have examined the Turnovsky-d'Orey and Canzoneri-Minford suggestions with various types of shocks (other than the target shock), and obtained much the same result. The effects of various shocks such as a monetary shock, demand and supply shocks, and the external shocks from the ROW, on the target variables and the reaction function is described in Appendix 3B.

We now discuss why these shocks lead to qualitatively the same result regarding the Turnovsky-d'Orey and Canzoneri-Minford suggestions, by using a diagram such as figure 2-1 or figure 3-1. First we discuss how these shocks commonly affect the welfare costs at Cournot-Nash and cooperative equilibria, and then we discuss how the values of trade price elasticities affect these welfare costs given any type of shock.

A shock (regardless of the type, and the same shock to both countries) shifts the position of the objective function in ($\hat{p}$, $\hat{t}$, $\hat{n}$) 3-dimensional space. Then, the position of the bliss point and the intercept of the reaction function shift on the $\hat{e}$ and $\hat{e}^*$ plane, but the shape (curvature) of the objective function and thus the slope of the reaction function remain the same. Hence, although the size of intercept shift varies with different types of shocks, the welfare costs at Cournot-Nash and cooperative solutions change by an almost equal proportion. That is, the ratio of the welfare costs between the Cournot-Nash and the cooperative equilibria $((-U_N)^{1/2}/(-U_C)^{1/2})$ is approximately the same, although the absolute difference between them $((-U_N)^{1/2}$ - $(-U_C)^{1/2})$ may vary with the type of shocks.

On the other hand, given any type of shock, the values of the trade price elasticities affect not only the size of intercept shift but also the slope of the reaction function. Generally, lower trade price elasticities magnify the effects of shocks; i.e. the shift in the intercept of the reaction function is larger, increasing the welfare costs at the Cournot-Nash and the cooperative equilibria by an equal proportion. But the shape of objective function (hence the reaction function's slope) also changes which in turn changes the pattern of tradeoffs (or marginal rate of substitution) between the target variables. At our parameter values, the distance between the Cournot-Nash and the cooperative equilibria increases with lower trade price elasticities as do the gains from co-ordination. In table 3.7, the value of the last column $((-U_N)^{1/2}/(-U_C)^{1/2})$ is much closer to one in the bottom line with high trade price elasticities, than in the second line with low trade price elasticities.

Therefore, regardless of the types of shocks, we obtain the general results regarding the Canzoneri-Minford and Turnovsky-d'Orey suggestions as shown in table 3.8.

D. Effects of Exchange Rate Policy in Alternative Trading Patterns

Now, we examine Eichengreen's (1985) result regarding the feasibility of the Stackelberg leader-follower solution. He suggests that the Stackelberg solution is not feasible even in an asymmetric case. He uses the gold reserve stock and the price as target variables; he assumes a competitive struggle for gold, perfect capital mobility, a fixed exchange rate regime, and asymmetry in the effects (on capital flows) of the policy instruments (the central bank discount rates) between two countries. By considering asymmetry between countries in trading patterns, we will examine the feasibility of the Stackelberg leader-follower solution, and of the equal-split cooperative solution under asymmetry. A target shock (a positive BOT target) is assumed again. For each pattern, the effects of exchange rate policies on the values of selected variables and welfare levels in alternative equilibria are reported in Appendix 3C.

Exchange Rate Policy Effects and Slopes

At our parameter values, the effects of own exchange rate policy on domestic target variables are more than twice as large as the cross-country effects of a foreign policy, i.e. $y_j/x_i > 1/2$, as shown in table 3.9. Hence, the slopes of the reaction function and of the other three equilibrium equations, (3.10), (3.11), and (3.12), are less than 1/2. Since the reaction function's slope is a weighted average of the slopes of the three equilibrium equations, at least one of them is steeper than the reaction function unless they all have equal slope.

From these equilibrium equations we can derive three target-equilibrium equations as in figure 3-3. Each equation represents the equilibrium exchange rates which give the target value for each corresponding target variable. The vertical gaps between the reaction function and the target-equilibrium equations reflect the deviations of the target variables from the target values. That is, the negative (positive) gap(s) between the reaction function and the BOT (the CPI and the employment rate) target-equilibrium equation(s) implies that $\hat{t} < \hat{t}^t$ ($\hat{p} > \hat{p}^t$ and $\hat{n} > \hat{n}^t$) with the optimal policy along the reaction function.

The effects of exchange rate policies and the slopes derived from them in six different trading patterns are reported in table 3.9. The slopes of the reaction functions are qualitatively consistent with the presumed directions in section III.

In pattern I, the two countries are symmetric (identical). The reaction function's slope is almost equal (smaller at fourth decimal place) to the slope of the BOT target-equilibrium equation. But it is flatter than the CPI target-equilibrium equation and steeper than the employment rate target-equilibrium equation as in figure 3-3. Thus if the policy authorities keep depreciating along the reaction

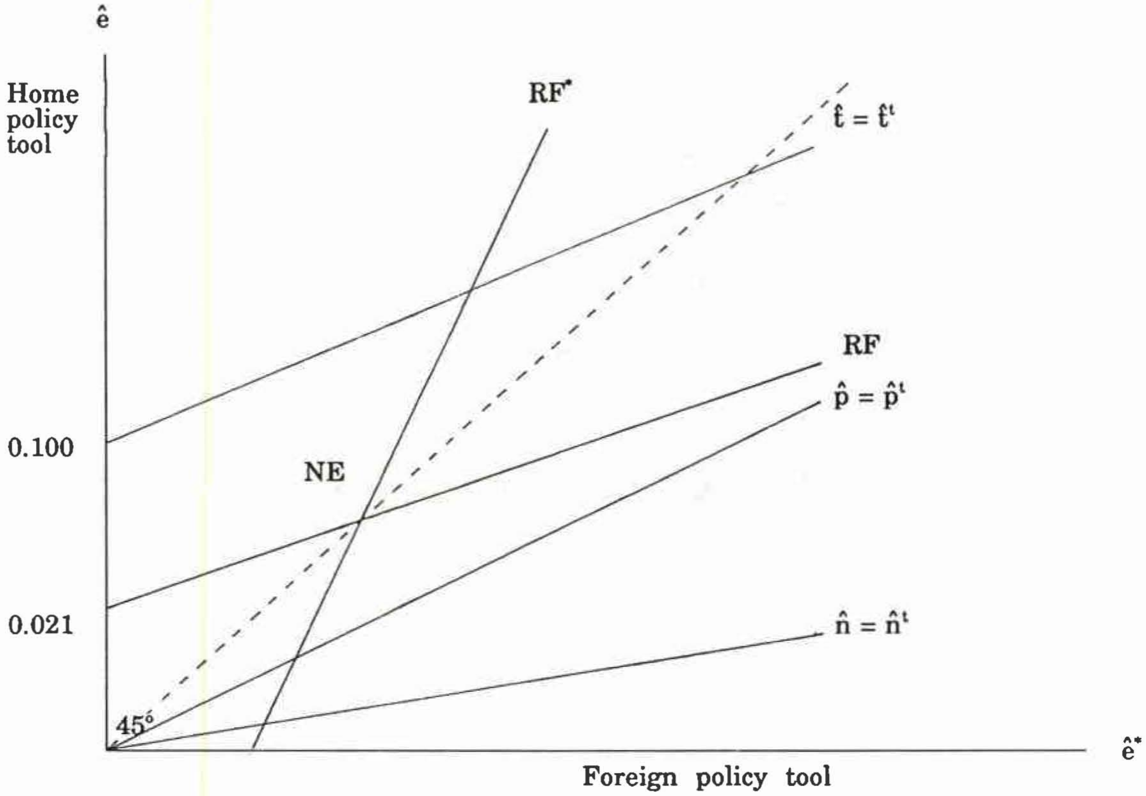

Figure 3-3 Target Equilibrium Equations

functions, there are tradeoffs among the target variables. That is, the deviations $(\hat{t}^t - \hat{t})$ and $(\hat{n} - \hat{n}^t)$ increase, but the deviation $(\hat{p} - \hat{p}^t)$ decreases.

For both countries, CE < SE_L < SE_F < NE and $U_N < U_L < U_F < U_C$: The Cournot-Nash equilibrium exchange rate is the most depreciationary and the worst in welfare level among them; the Stackelberg Leader's exchange rate is less depreciationary than the Follower's and the Follower gains more than the Leader, which is consistent with the finding of Eichengreen (1985); and the cooperative (equal-split) equilibrium is the least depreciationary and the one yielding the highest level of welfare, although the size of the gain is very small $((-U_N)/(-U_C) = 1.0000071)$.

Table 3.9 Exchange Rate Policy Effects on Target Variables and Slopes in Alternative Trading Patterns.

	Trading Patterns[1]					
	I	II	III	IV	V	VI
1. Policy Effects[2]						
		Own-Country Effects				
x_1	0.3515	0.3578	0.3517	0.3556	0.3558	0.3502
x_1^*	0.3515	0.3517	0.3578	0.3556	0.3618	0.2736
x_2	4.4569	4.6280	4.4587	4.5882	4.5903	4.4346
x_2^*	4.4569	4.4587	4.6280	4.5882	4.7569	2.3313
x_3	0.4791	0.5063	0.4793	0.5009	0.5012	0.4763
x_3^*	0.4791	0.4793	0.5063	0.5009	0.5277	0.1408
		Cross-Country Effects				
y_1	0.1446	0.1442	0.1427	0.1487	0.1467	0.1682
y_1^*	0.1446	0.1427	0.1442	0.1487	0.1482	0.1491
y_2	1.6847	1.6747	1.6540	1.8160	1.7845	2.0656
y_2^*	1.6847	1.6540	1.6747	1.8160	1.8048	1.8089
y_3	0.1668	0.1652	0.1629	0.1886	0.1845	0.2156
y_3^*	0.1668	0.1629	0.1652	0.1886	0.1868	0.1866
2. Slopes[3]						
S_p	0.411222	0.402986	0.405676	0.417990	0.412427	0.480413
S_p^*	0.411222	0.405676	0.402986	0.417990	0.409696	0.545041
S_t	0.377995	0.361859	0.370966	0.395801	0.388744	0.465784
S_t^*	0.377995	0.370966	0.361859	0.395801	0.379404	0.775905
S_n[4]	0.348141	0.326271	0.339785	0.376510	0.368158	0.452614
S_n^*	0.348141	0.339785	0.326271	0.376510	0.353974	1.325309
SRF	0.377419	0.361109	0.370364	0.395398	0.388314	0.465531
SRF*	0.377419	0.370364	0.361109	0.395398	0.378831	0.770996

Notes: 1. The trading patterns are defined in table 3.4.
2. The policy effects x_i's and y_i's are defined verbally in table 3.2 and algebraically in Appendix 3A.
3. $S_p = y_1/x_1$, $S_t = y_2/x_2$, $S_n = y_3/x_3$, SRF = $(z_1x_1y_1 + z_2x_2y_2 + z_3x_3y_3) / (z_1x_{12} + z_2x_{22} + z_3x_{32})$ are the slopes of the three quilibrium equations for CPI, BOT, the employment rate, and the reaction function respectively, where $z_1 = 0.45$, $z_2 = 0.10$, $z_3 = 0.45$.
4. $-S_n$ $(= -y_3/x_3)$ measures the degree of interdependence between small countries.

The same result is obtained for both countries in patterns II, III, IV, and V, and this will be referred to as the standard result.

In pattern II, the trade price elasticity of the Home country's import demand for the ROW exports increases. Both small countries' reaction functions are flatter than in pattern I, but the Home country's reaction function is flatter than the Foreign country's. The equilibria are less depreciationary than in pattern I, because the effects of the Home country's policy increases and so does the indirect income effect for the Foreign country's balance of trade.

In pattern III, the trade price elasticity of the ROW demand for Foreign country's exports increases. Both small countries' reaction functions become flatter than in pattern I, but the Foreign country's reaction function is flatter than the Home country's. The result in this pattern is simply the mirror image of that in pattern II as shown in table 3.9.

In pattern IV, the trade price elasticity of the Home country's import demand for the Foreign country's exports increases. The reaction functions of both countries become steeper than in pattern I symmetrically, but the equilibria are less depreciationary (although the difference is minimal) than in pattern I. This is because, although interdependence between the two countries increases, the overall trade price elasticities are so large that a less depreciation is required than in pattern I to achieve the balance of trade surplus.

In pattern V, which is a combination of patterns III and IV, the reaction functions of both countries become steeper than in pattern I. But, the Foreign country's reaction function becomes flatter than the Home country's, since the effects of the Foreign country's policy increase through overall trade, while the effects of the

Home country's policy increase through the trade between them. The equilibria are less depreciationary than in pattern IV, because the effects of the Foreign country's policy are larger in this pattern and thus the indirect income effect for the Home country's balance of trade increases.

Finally in pattern VI, the import demand between the ROW and the Foreign country is price inelastic (for example, we can consider even no trade between them). Both small countries' reaction functions become much steeper than in pattern I, but the Foreign country's reaction function is a lot steeper than the Home country's. Thus, the equilibria are much more depreciationary than in pattern I. For the Home country, CE < SE_F < SE_L < NE and $U_C < U_N < U_L < U_F$, and for the Foreign country, the standard result is retained for the exchange rates but $U_N^* < U_F^* < U_L^* < U_C^*$. This result is illustrated in figures 3-4 and 3-5, where the locus running through the points BP, CE, and BP^* is the Pareto-efficient contract curve.

From this result, it should be noted that this pattern leads to the leadership of the Foreign country in keeping with the "*Hegemonic Stability*" hypothesis. For the Home (Foreign) country, the followership (leadership) is superior solution to the leadership (followership). Also the Leader (the Foreign country) can gain more than the Follower (the Home country) compared to the Cournot-Nash solution; $(U_L^* - U_N^*)/U_N^* = 0.13\%$ and $(U_F - U_N)/U_N = 0.028\%$. This result contrasts with Eichengreen's (1985) result that both countries may prefer to be the Follower because the Follower gains more than the Leader even with asymmetry.

This contradiction is attributed to the following reasons: We generate asymmetry between countries by changing the values of the structural parameters (trade price elasticities), and the size of change is significantly large in pattern VI

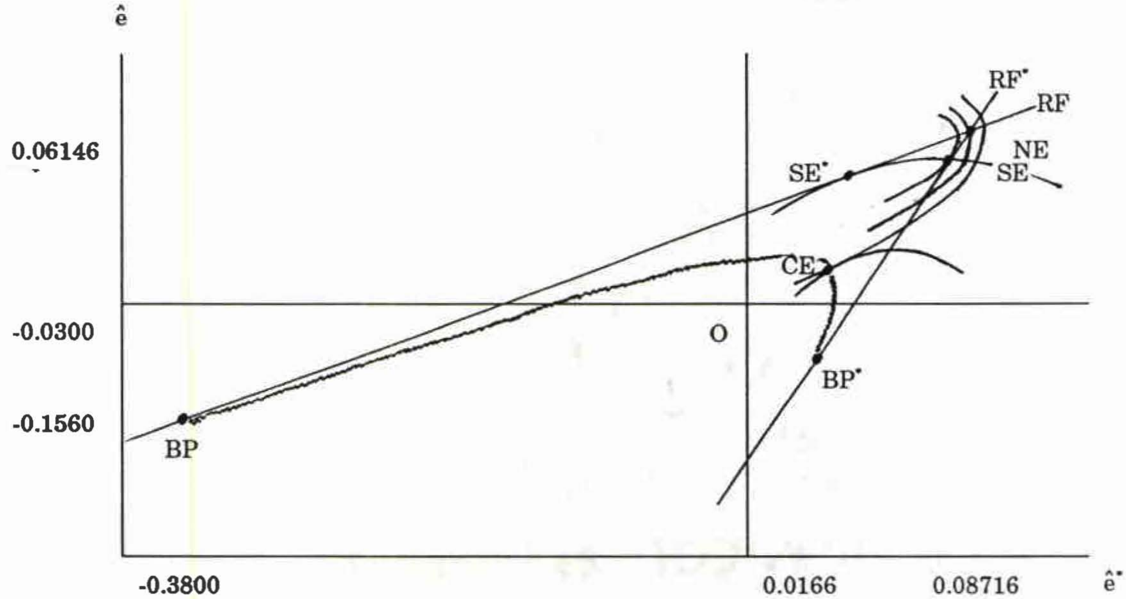

Figure 3-4 The Result in Pattern VI

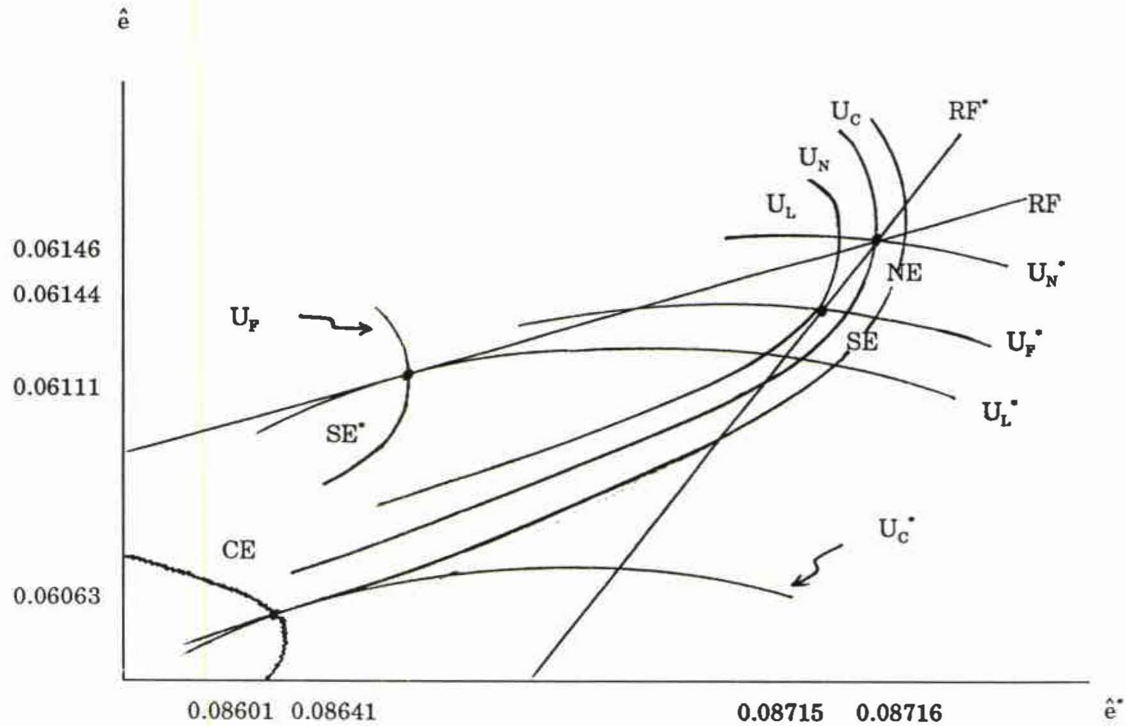

Figure 3-5 Close Up of Figure 3-4

where we obtain the contrasting result. The different parameter values change the size of the policy effects which determine the shape (curvature) of the objective function. As discussed in chapter two, the shape of the objective function determines the slope of the reaction function and the size of welfare gains from co-ordination. In Eichengreen however, the asymmetry is imposed by assuming different policy effects of central bank discount rates on the money supply between two countries. As he points out, this asymmetry induces symmetric reaction functions for both countries, and all of the conclusions obtained under symmetry continue to hold. Our stable solution is called a "*concurrent solution*" and Eichengreen's result is called a "*stalemate solution*" as defined in Basar and Olsder (1982).

V. Concluding Remarks

In this chapter, we have developed a three-country model to examine the policy co-ordination problem between two small economies, which do not have sufficient instruments at hand for reconciling conflicting targets. We used the exchange rates as a single policy instrument for the three targets -- the inflation rate, the balance of trade, and the employment rate.

Using this framework, we have investigated Turnovsky and d'Orey's (1986) suggestion that a lower trade price elasticity can increase the welfare gains from co-ordination, and Canzoneri and Minford's (1986) that high interdependence (the ratio of transmission effects to own effects of money supply policy) can increase the gains from co-ordination. Considering asymmetric trading patterns, we also have examined Eichengreen's (1985) result that the Stackelberg leader-follower solution is not feasible even with asymmetry between countries.

Several results are summarized as follows:

(1) The size of welfare gains from co-ordination is very small. But in general, lower overall trade price elasticities result in larger welfare gains, confirming the suggestion of Turnovsky and d'Orey. Since the small countries' exchange rate policies have weaker effects against the ROW with lower trade price elasticities, the balance of trade decreases significantly while inflation and the unemployment rate increase substantially. Thus, the tradeoffs among the target variables increase, as do the absolute welfare losses. Then, when there is higher interdependence between the small countries, policy co-ordination can reduce the welfare losses more effectively than with the higher trade price elasticities, since there is a greater initial welfare loss to be reduced.

(2) Interdependence between the small countries, as defined here, decreases when the trade price elasticities with the ROW increase. The gains from co-ordination also decrease, supporting both the Turnovsky-d'Orey and Canzoneri-Minford suggestions. The small countries can shift the welfare losses caused by a shock to the passive ROW.

However, when the trade price elasticities between the small countries increase, support for the suggestions depends on the levels of the trade price elasticities with the ROW. Interdependence now increases between the small countries. If the trade price elasticities with the ROW are low, the gains from co-ordination increase in contrast with (supporting) the suggestion of Turnovsky and d'Orey (Canzoneri and Minford). But if the trade price elasticities with the ROW are high, then the gains from co-ordination decrease slightly, contradicting (supporting) the suggestion of Canzoneri and Minford (Turnovsky and d'Orey).

(3) The various trading patterns provide a way to analyze the effects of asymmetry in policy co-ordination. With asymmetry in economic structure induced by asymmetric trading patterns, for example pattern VI where the foreign country is assumed to trade with the ROW only the price-inelastic goods, the Stackelberg leader-follower solution may be feasible. This implies "*Hegemonic Stability*" in international co-ordination: for one country the followership is superior to the leadership, while the leadership dominates the followership for the other country. Also, the leader can gain (compared to the Cournot-Nash solution) more than the follower. This result contrasts with Eichengreen's finding that both countries prefer to be the follower because the follower gains more than the leader even with asymmetry.

In this chapter, we have considered no capital mobility case. Some degree of capital mobility is necessary to reflect the effects of international capital flows in policy co-ordination analysis. This will be incorporated into the analysis in the next chapter.

APPENDIX 3A

Derivation of the Model and Equilibria of the Game

In this section we describe the derivation of the equations of our model and of Nash, Stackelberg, and Pareto-efficient cooperative equilibria.

A. Model

The derivation of the equations given in section II is described here in detail. The variables denoted by upper case letters and the nominal interest rate i are in level form. The superscripts ^{L}, ^{S}, and ^ denote the long-run, short-run, and the deviation from the long-run equilibrium value. The variables are defined in table 3A.1 and the structural coefficients are defined in table 3A.2.

Table 3A.1 Definitions of Variables

Endogenous variables			Exogenous variables		
Y^s	=	real output	E	=	nominal exchange rate
Y^d	=	real expenditure	M	=	nominal money supply
N	=	number of employees	G	=	real government
S	=	nominal product price			expenditure
W	=	nominal wage rate	W^f	=	nominal wage rate at full
i	=	nominal interest rate	c_1	=	employment level
P	=	consumer price index level			expected inflation rate
I	=	real investment			
X	=	real exports			
x	=	real exports in log form			
IM	=	real imports			
im	=	real imports in log form			
T	=	real balance of trade			
t	=	real balance of trade divided by long-run real exports			

Table 3A.2 Definitions of Structural Coefficients

Structural Coefficients		
α_1	=	labor elasticity of real output
θ_1	=	inverse of the real wage elasticity of labor demand
π_2	=	nominal interest rate semi-elasticity of money demand
π_1	=	income elasticity of money demand
a_1	=	price elasticity of home exports to the foreign country
a_3	=	price elasticity of home exports to the ROW
b_1	=	price elasticity of foreign exports to the home country
b_3	=	price elasticity of the ROW exports to the home country
a_2	=	income elasticity of home exports to the foreign country
a_4	=	income elasticity of home exports to the ROW
b_2	=	income elasticity of foreign exports to the home country
b_4	=	income elasticity of the ROW exports to the home country
γ_1	=	real interest rate semi-elasticity of real investment
β_1	=	proportion of consumption on home goods
β_2	=	proportion of consumption on foreign goods
β_3	=	proportion of consumption on the ROW goods

Note: a_2, a_4, b_2, and b_4 are assumed to be equal.

1. Aggregate Supply

$$Y^s = \alpha_o N^{\alpha 1} K^{\alpha 2} = f(N, K)$$

$$y^s = \ln\alpha_o + \alpha_1 n + \alpha_2 k \qquad 0 < \alpha_1 < 1 \text{ and } 0 < \alpha_2 < 1$$

(1) $\hat{y}^s = \alpha_1\hat{n} + \alpha_2\hat{k} = \alpha_1\hat{n}$ assuming $\hat{k} = 0$ in the short-run

2. Labour Demand

$$W = S\, f_N(N, K), \quad \text{where } f_N(N, K) = (\alpha_1/N)\, f(N, K)$$

$$w - s = (\ln\alpha_o + \ln\alpha_1) - (1 - \alpha_1)n = \theta_o - \theta_1 n$$

(2) $\hat{w} - \hat{s} = -\theta_1\hat{n}$

3. Labour Supply

$$W = W^f$$

$$w = w^f$$

(3) $\hat{w} = 0$

4. Money Market

$$M/P = Y^{d\,\pi_1} \exp^{-\pi_2 i}$$

$$m - p = \pi_1 y^d - \pi_2 i$$

(4) $\hat{m} - \hat{p} = \pi_1 \hat{y}^d - \pi_2 \hat{i}$

5. Balance of Trade

$$T = X - IM$$

Assuming $T^L = 0$,

$$\Delta T = T^S - T^L = T^S$$

$$\Delta X/X^L = (X^S - X^L)/X^L = \hat{x}$$

$$\Delta IM/IM^L = (IM^S - IM^L)/IM^L = \hat{im}$$

Since $X^L = IM^L$,

$$\hat{t} = \Delta T/X^L = (T^S - T^L)/X^L = \Delta X/X^L - \Delta IM/IM^L = \hat{x} - \hat{im}$$

where, t is defined as the short-run real BOT divided by long-run real exports, i.e. $t = T^S/X^L$.

$$X = (ES^*/E^*S)^{a_1} Y^{d*\,a_2} (ES^{RW}/E^{RW}S)^{a_3} Y^{dRW\,a_4}$$

$$IM = (E^*S/ES^*)^{b_1} Y^{d\,b_2} (E^{RW}S/ES^{RW})^{b_3} Y^{d\,b_4}$$

$$x = [- a_1(s - e - s^* + e^*) + a_2 y^{d*} - a_3(s - e - s^{RW} + e^{RW}) + a_4 y^{dRW}]$$

$$im = [- b_1(s^* - e^* - s + e) + b_2 y^d - b_3(s^{RW} - e^{RW} - s + e) + b_4 y^d]$$

(5) $\hat{t} = \hat{x} - \hat{im}$

$$= [(a_1 + a_3 + b_1 + b_3)\hat{e} - (a_1 + b_1)\hat{e}^* - (a_3 + b_3)\hat{e}^{RW} - (a_1 + a_3 + b_1 + b_3)\hat{s}$$
$$+ (a_1 + b_1)\hat{s}^* + (a_3 + b_3)\hat{s}^{RW} - (b_2 + b_4)\hat{y}^d + a_2\hat{y}^{d*} + a_4\hat{y}^{dRW}]$$

6. Aggregate Demand

$$Y^d = C(Y^d) + I(i - c_1) + G + X - IM$$

$$\Delta Y^d = [I_i(\Delta i - \Delta c_1) + \Delta G + \Delta X - \Delta IM]/(1 - C_y)$$

Let $\hat{y}^d = \Delta Y^d/Y^{dL}$

$$= [(I_i/Y^{dL})(\hat{i} - \hat{c}_1) + (G^L/Y^{dL})\hat{g} + (X^L/Y^{dL})(\hat{x} - \hat{im})]/(1 - C_y)$$

Note: Since i and c_1 are in percentage form, $\Delta i - \Delta c_1 = \hat{i} - \hat{c}_1$.

Assuming $1 - C_y = X^L/Y^{dL}$,

(6) $\hat{y}^d = - \gamma_1(\hat{i} - \hat{c}_1) + \hat{t}$

where C_y represents the marginal propensity to consume out of income, $\gamma_1 = - I_i/(1 - C_y)Y^{dL}$, and $\hat{g}$ is assumed to be zero. Note that X^L/Y^{dL} reflects the export-dependency of the domestic economy. If we relax the assumption that X^L/Y^{dL} equals $(1 - C_y)$, the coefficient of $\hat{t}$ in equation (6) is no longer unity. This coefficient measures the degree of openness of the economy, and it can be used to impose asymmetry between countries.

7. Market Clearing Condition

(7) $\hat{y}^d = \hat{y}^s$

8. Consumer Price Index (CPI)

$$p = \beta_1 s + \beta_2(e + s^* - e^*) + \beta_3(e + s^{RW} - e^{RW}), \text{ where } \beta_1 + \beta_2 + \beta_3 = 1$$

(8) $\hat{p} = \beta_1\hat{s} + \beta_2(\hat{e} + \hat{s}^* - \hat{e}^*) + \beta_3(\hat{e} + \hat{s}^{RW} - \hat{e}^{RW})$

Substituting (4),(5) and (8) into (6) yields,

(9) $\hat{y}^d = [\gamma_1\hat{m} - (A\pi_2 + \beta_1\gamma_1)\hat{s} + D\hat{e} + E\hat{s}^* - E\hat{e}^* + \pi_2 a_2\hat{y}^{d*} + \pi_2\gamma_1\hat{c}_1]/B$

From (1), (2), (3) we obtain;

(10) $\hat{y}^s = \alpha_1/\theta_1\hat{s}$

From (7), (9), and (10), we can solve $\hat{s}$ as a function of the exogenous variables and foreign variables;

(11) $\hat{s} = \theta_1 [\gamma_1\hat{m} + D\hat{e} + E\hat{s}^* - E\hat{e}^* + \pi_2 a_2 \hat{y}^{d*} + \pi_2\gamma_1\hat{c}_1]/C$

From (10), (11), and corresponding equations for the foreign country, $\hat{s}$ can be solved in reduced form;

(12) $\hat{s} = \theta_1 [C^*\gamma_1\hat{m} + \gamma_1^* Z\hat{m}^* + C^*\pi_2\gamma_1\hat{c}_1 + Z\pi_2^*\gamma_1^*\hat{c}_1^*$

$+ (C^*D - E^*Z)\hat{e} - (C^*E - D^*Z)\hat{e}^*]/(CC^* - ZZ^*)$

Note that we obtain symmetric equations for the foreign country in similar way.

where

$$
\begin{array}{lcl lcl}
A & = & (a_1 + b_1 + a_3 + b_3), & A^* & = & (a_1^* + b_1^* + a_3^* + b_3^*) \\
B & = & (1 + b_2 + b_4)\pi_2 + \gamma_1\pi_1, & B^* & = & (1 + b_2^* + b_4^*)\pi_2^* + \gamma_1^*\pi_1^* \\
C & = & \alpha_1 B + \theta_1(A\pi_2 + \beta_1\gamma_1), & C^* & = & \alpha_1^* B^* + \theta_1^*(A^*\pi_2^* + \beta_1^*\gamma_1^*) \\
D & = & A\pi_2 - (1 - \beta_1)\gamma_1, & D^* & = & A^*\pi_2^* - (1 - \beta_1^*)\gamma_1^* \\
E & = & (a_1 + b_1)\pi_2 - \beta_2\gamma_1, & E^* & = & (a_1^* + b_1^*)\pi_2^* - \beta_2^*\gamma_1^* \\
Z & = & E\theta_1^* + \pi_2 a_2\alpha_1^*, & Z^* & = & E^*\theta_1 + \pi_2^* a_2^*\alpha_1
\end{array}
$$

Also, from equations (3.10), (3.11), and (3.12), the effects of exchange rate policy and the money demand shock on the target variables are:

$$
\begin{aligned}
x_1 &= \beta_1\theta_1(C^*D - E^*Z)/(CC^* - ZZ^*) - \beta_2\theta_1^*(CE^* - DZ^*)/(CC^* - ZZ^*) + (1 - \beta_1) \\
x_2 &= A - \{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(CE^* - DZ^*)/(CC^* - ZZ^*) \\
&\quad - \{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*D - E^*Z)/(CC^* - ZZ^*) \\
x_3 &= (C^*D - E^*Z)/(CC^* - ZZ^*)
\end{aligned}
$$

$$
\begin{aligned}
y_1 &= \beta_1\theta_1(C^*E - D^*Z)/(CC^* - ZZ^*) - \beta_2\theta_1^*(CD^* - EZ^*)/(CC^* - ZZ^*) + \beta_2 \\
y_2 &= (a_1 + b_1) - \{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(CD^* - EZ^*)/(CC^* - ZZ^*) \\
&\quad - \{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*E - D^*Z)/(CC^* - ZZ^*) \\
y_3 &= (C^*E - D^*Z)/(CC^* - ZZ^*)
\end{aligned}
$$

$$
\begin{aligned}
q_1 &= \{\beta_1\theta_1 C^*\gamma_1 + \beta_2\theta_1^*\gamma_1 Z^*\}/(CC^* - ZZ^*) \\
q_2 &= [C^*\gamma_1\{A\theta_1 + (b_2 + b_4)\alpha_1\} - Z^*\gamma_1\{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}]/(CC^* - ZZ^*) \\
q_3 &= C^*\gamma_1/(CC^* - ZZ^*)
\end{aligned}
$$

$$
\begin{aligned}
t_1 &= \{\beta_1\theta_1\gamma_1^* Z + \beta_2\theta_1^* C\gamma_1^*\}/(CC^* - ZZ^*) \\
t_2 &= [C\gamma_1^*\{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\} - Z\gamma_1^*\{A\theta_1 + (b_2 + b_4)\alpha_1\}]/(CC^* - ZZ^*) \\
t_3 &= Z\gamma_1^*/(CC^* - ZZ^*)
\end{aligned}
$$

Notes:

1. x_2 reflects the three effects of the home country's depreciation on the home country's balance of trade.

a. A: balance-improving effect via overall trade due to relative price change (direct effect).

b. $-\{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(CE^* - DZ^*)/(CC^* - ZZ^*)$: balance-deteriorating effect via two-country trade due to the decreased price and income of the foreign country following home country's depreciation (indirect effect).

c. $-\{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*D - E^*Z)/(CC^* - ZZ^*)$: balance-deteriorating effect via overall trade due to the increased price and income of the home country (indirect effect).

2. y_2 reflects the three effects of the foreign country's depreciation on the home country's balance of trade.

a. $(a_1 + b_1)$: balance-deteriorating effect via two-country trade due to relative price change between two small countries (direct effect).

b. $-\{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(CD^* - EZ^*)/(CC^* - ZZ^*)$: balance-improving effect via two-country trade due to the increased price and income of the foreign country following foreign country's depreciation (indirect effect).

c. $-\{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*E - D^*Z)/(CC^* - ZZ^*)$: balance-improving effect via overall trade due to the decreased price and income of the home country (indirect effect).

3. In both x_2 and y_2, the direct effect is assumed to dominate the indirect effects, i.e. x_2 and y_2 are positive (see the next section).

B. **Algebraic Analysis of Reduced Form Multipliers**

Here we proove that the x_i's, y_i's, q_i's, and t_i's are all positive, and $x_i > y_i$ and $q_i > t_i$ for i = 1, 2, 3; i.e. the signs in the reduced form equations (3.10), (3.11), and (3.12) are correct, and the slope of the reaction function (3.14), Ψ_1/Ψ_7, is less than 1. Since the two small countries are assumed to be symmetric in pattern I, we ignore the notation for the foreign country, *, below.

Assumption 1: In structural equation (9), the own-policy effect is positive and the foreign-policy effect is negative on domestic output, and the own-country effect is stronger than the cross-country effect; i.e. $D > E > 0$. ($Z > 0$ if $E > 0$.)

Assumption 2: In structural equation (3.8), the proportion of consumption on home goods (β_1) is larger than the proportion of consumption on foreign goods (β_2).

Assumption 3: Income elasticity of goods demand between countries are the same; i.e. $a_2 = a_4 = b_2 = b_4$.

Assumption 4: In reduced form equation (3.12), the transmission effect is negative; i.e. $y_3 = (CE - DZ)/(C^2 - Z^2) > 0$. Since $C > Z > 0$ from Assumption 1, $(CE - DZ) > 0$.

Assumption 5: $1/a_2 > (a_3 + b_3)/(a_1 + b_1) - 1$. This assumption is to provide a sufficient condition for proposition 6, $y_2 > 0$. But it is not a necessary condition. At our parameter values, $1/a_2 = 1$ and $(a_3 + b_3)/(a_1 + b_1) - 1 = 0.1$.

Proposition 1: t_2 is positive.

Proof: $(a_1 + b_1)\theta_1 + a_2\alpha_1 = (Z + \beta_2\gamma_1\theta_1)/\pi_2$ and

$$A\theta_1 + (b_2 + b_4)\alpha_1 = (C - \alpha_1\pi_2 - \alpha_1\gamma_1\pi_1 - \beta_1\gamma_1\theta_1)/\pi_2$$

Hence,

$$t_2 = [C\gamma_1(Z + \beta_2\gamma_1\theta_1)/\pi_2 - Z\gamma_1(C - \alpha_1\pi_2 - \alpha_1\gamma_1\pi_1 - \beta_1\gamma_1\theta_1)/\pi_2]/(C^2 - Z^2)$$

$$= [C\gamma_1\beta_2\gamma_1\theta_1)/\pi_2 + Z\gamma_1(\alpha_1\pi_2 + \alpha_1\gamma_1\pi_1 + \beta_1\gamma_1\theta_1)/\pi_2]/(C^2 - Z^2)$$

$$> 0,$$

since the last expression includes only positive terms.

<u>Proposition 2</u>: q_1, q_2, q_3, t_1, and t_3 are positive and $q_i > t_i$ for i = 1, 2, 3.

Proof: Since C > Z > 0, we can simply proove this statement.

<u>Proposition 3</u>: x_3 is positive and $x_3 > y_3$.

Proof: Since D > E from assumption 1 and $y_3 = (CE - DZ)/(C^2 - Z^2) > 0$ from assumption 4, $x_3 = (CD - EZ)/(C^2 - Z^2) > 0$ and $x_3 > y_3$.

<u>Proposition 4</u>: y_1 is positive.

Proof: $C = \alpha_1(1 + b_2 + b_4)\pi_2 + (\pi_1\alpha_1 + \theta_1)\gamma_1 + \theta_1 D$, $Z = E\theta_1 + \pi_2 a_2\alpha_1$, $C > Z$,

$\{(1 - \beta_1) \equiv (\beta_2 + \beta_3)\} > \beta_2$, and $a_2 = b_2 = b_4$ from assumption 3.

Hence,

$$y_1(C^2 - Z^2) = \beta_2(C^2 - Z^2) - \beta_2(CD\theta_1 - ZE\theta_1) + \beta_1\theta_1(CE - DZ)$$

$$= \beta_2[C\{\alpha_1(1 + b_2 + b_4)\pi_2 + (\pi_1\alpha_1 + \theta_1)\gamma_1 + \theta_1 D\} - Z(E\theta_1 + \pi_2 a_2\alpha_1)]$$

$$- \beta_2(C\theta_1 D - ZE\theta_1) + \beta_1\theta_1(CE - DZ)$$

$$= \beta_2\{C\alpha_1(1 + 2a_2)\pi_2 - Z\pi_2 a_2\alpha_1 + C(\pi_1\alpha_1 + \theta_1)\gamma_1\} + \beta_1\theta_1(CE - DZ)$$

> 0, and thus $y_1 > 0$.

<u>Proposition 5</u>: x_1 is positive and $x_1 > y_1$.

Proof: $(CD - EZ)/(C^2 - Z^2) > (CE - DZ)/(C^2 - Z^2)$ from proposition 3, and

$\{(1 - \beta_1) \equiv (\beta_2 + \beta_3)\} > \beta_2$. Also, $y_1 > 0$ from proposition 4.

Thus, $x_1 > y_1 > 0$.

Proposition 6: y_2 is positive.

Proof: Let $Y_2 = y_2(C^2 - Z^2)$.

$$
\begin{aligned}
Y_2 = {} & (a_1 + b_1)C^2 - (a_1 + b_1)Z^2 - (a_1 + b_1)\theta_1 CD - a_2\alpha_1 CD + (a_1 + b_1)\theta_1 EZ \\
& + a_2\alpha_1 EZ - A\theta_1 CE - (b_2 + b_4)\alpha_1 CE + A\theta_1 DZ + (b_2 + b_4)\alpha_1 DZ \\
= {} & (a_1 + b_1)C\{\alpha_1(1 + b_2 + b_4)\pi_2 + (\alpha_1\pi_1 + \theta_1)\gamma_1 + D\theta_1\} \\
& - (a_1 + b_1)Z(E\theta_1 + \pi_2 a_2\alpha_1) - (a_1 + b_1)\theta_1 DC \\
& - a_2\alpha_1 D\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1 + A\pi_2\theta_1 + \beta_1\gamma_1\theta_1\} \\
& + (a_1 + b_1)\theta_1 EZ + a_2\alpha_1 Z\{(a_1 + b_1)\pi_2 - \beta_2\gamma_1\} \\
& - A\theta_1 E\{\alpha_1(1 + b_2 + b_4)\pi_2 + (\alpha_1\pi_1 + \theta_1)\gamma_1 + D\theta_1\} \\
& - (b_2 + b_4)\alpha_1 C\{(a_1 + b_1)\pi_2 - \beta_2\gamma_1\} + A\theta_1 D(E\theta_1 + \pi_2 a_2\alpha_1) + (b_2 + b_4)\alpha_1 DZ \\
= {} & (a_1 + b_1)C\{\alpha_1\pi_2 + (\alpha_1\pi_1 + \theta_1)\gamma_1\} \\
& - a_2\alpha_1 D\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1 + \beta_1\theta_1\gamma_1\} - a_2\alpha_1\beta_2\gamma_1(E\theta_1 + \pi_2 a_2\alpha_1) \\
& - A\theta_1 E\{\alpha_1(1 + b_2 + b_4)\pi_2 + (\alpha_1\pi_1 + \theta_1)\gamma_1\} + (b_2 + b_4)\alpha_1 C\beta_2\gamma_1 \\
& + (b_2 + b_4)\alpha_1 D(E\theta_1 + \pi_2 a_2\alpha_1) \\
= {} & (a_1 + b_1)\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1 + \theta_1\gamma_1\}\alpha_1\pi_2 \\
& + (a_1 + b_1)\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1 + \theta_1\gamma_1\}\pi_1\alpha_1\gamma_1 \\
& + (a_1 + b_1)\alpha_1\beta_1\gamma_1^2\pi_1\theta_1) + (a_1 + b_1)\beta_1\gamma_1^2\theta_1^2 \\
& - Aa_2\alpha_1^2\pi_2^2 - Aa_2\alpha_1\pi_2\gamma_1(\pi_1\alpha_1 + \beta_1\theta_1) \\
& + (1 - \beta_1)\gamma_1\alpha_1^2\pi_2 a_2 + (1 - \beta_1)\gamma_1^2(\alpha_1\pi_1 + \beta_1\theta_1)a_2\alpha_1 \\
& + a_2\alpha_1\beta_2^2\gamma_1^2\theta_1 + A(\alpha_1\pi_1 + \theta_1)\beta_2\gamma_1^2\theta_1 \\
& + [(b_2 + b_4)\alpha_1\beta_2\gamma_1\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1\} - a_2^2\alpha_1^2\beta_2\gamma_1\pi_2] \\
& + [A(1 + b_2 + b_4)\alpha_1\beta_2\gamma_1\pi_2\theta_1 - (a_1 + b_1)a_2\alpha_1\beta_2\gamma_1\pi_2\theta_1] \\
& + (b_2 + b_4)\alpha_1\beta_2\gamma_1^2\theta_1 + (a_1 + b_1)(1 + b_2 + b_4)\alpha_1\beta_1\gamma_1\pi_2\theta_1
\end{aligned}
$$

Now, we still have two negative terms:

$- Aa_2\alpha_1^2\pi_2^2, \ - Aa_2\alpha_1\pi_2\gamma_1(\pi_1\alpha_1 + \beta_1\theta_1)$

But from proposition 3, (CD - EZ) > (CE - DZ), yielding

$[(a_1 + b_1)\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1 + \theta_1\gamma_1\}\alpha_1\pi_2 + (1 - \beta_1)\gamma_1\alpha_1^2\pi_2 a_2]$

$> Aa_2\alpha_1^2\pi_2^2$

Thus, the only negative term in Y_2 which is not eliminated algebraically is

$- Aa_2\alpha_1\pi_2\gamma_1(\pi_1\alpha_1 + \beta_1\theta_1)$.

By comparing

$(a_1 + b_1)\{\alpha_1(1 + b_2 + b_4)\pi_2 + \alpha_1\pi_1\gamma_1 + \theta_1\gamma_1\}\pi_1\alpha_1\gamma_1, \ - Aa_2\alpha_1\pi_2\gamma_1\pi_1\alpha_1,$

$(a_1 + b_1)(1 + b_2 + b_4)\alpha_1\beta_1\gamma_1\pi_2\theta_1, \ - Aa_2\alpha_1\pi_2\gamma_1\beta_1\theta_1$

since **$(1 + b_2 + b_4)/a_2 > A/(a_1 + b_1)$** from assumption 5 where $b_2 = b_4 = a_2$, $Y_2 > 0$ and thus y_2 is positive.

Proposition 7: x_2 is positive.

Proof: Since y_2 is positive from proposition 6, if $x_2 > y_2$ then x_2 is positive.

$$(x_2 - y_2) = (A - a_1 - b_1) - \{(A - a_1 - b_1)\theta_1 + (b_2 + b_4 - a_2)\alpha_1\}\{(CD - EZ) - (CE - DZ)\}/(C^2 - Z^2)$$

$$= (A - a_1 - b_1) - \{(A - a_1 - b_1)\theta_1 + (b_2 + b_4 - a_2)\alpha_1\}(D - E)/(C - Z)$$

where $(C - Z) = (D - E)\theta_1 + (1 + b_2 + b_4 - a_2)\alpha_1\pi_2 + \alpha_1\pi_1\gamma_1 + \theta_1\gamma_1$.

$$(A - a_1 - b_1)(C - Z) - \{(A - a_1 - b_1)\theta_1(D - E) + (b_2 + b_4 - a_2)\alpha_1(D - E)\}$$

$$= (A - a_1 - b_1)\{(1 + b_2 + b_4 - a_2)\alpha_1\pi_2 + \alpha_1\pi_1\gamma_1 + \theta_1\gamma_1\} - (b_2 + b_4 - a_2)\alpha_1\{(A - a_1 - b_1)\pi_2 - \beta_3\gamma_1\}$$

$$= (a_3 + b_3)\alpha_1\pi_2 + (a_3 + b_3)(\alpha_1\pi_1\gamma_1 + \theta_1\gamma_1) + a_2\alpha_1\beta_3\gamma_1$$

$$> 0.$$

Hence $x_2 > y_2 > 0$. Note that $x_1 > y_1$ and $x_3 > y_3$ from propositions 3 and 5, and thus the slope of the reaction function (3.14), $\Psi_1/\Psi_7 = \sum z_i x_i y_i/\sum z_i x_i^2$, is less than 1.

C. Sensitivity of Welfare Gains to Welfare Weights

The following table reports the sensitivity of the size of gains from co-ordination to alternative welfare weights. It is noted that the size of gains become smaller with higher weight for the balance of trade target.

Table 3A.3 Sensitivity of Welfare Gains from Co-ordination to Welfare Weights

Values of Welfare Weights (z_1,z_2,z_3)	Inflation Rate (%)	Balance of Trade (ratio, %)	Employ-ment Rate (% change)	Welfare Gains (%) $(-U_N)^{1/4}-(-U_C)^{1/4}$	Welfare Gains (ratio) $(-U_N)^{1/4}/(-U_C)^{1/4}$
(0.98,0.01,0.01)	0.4698	6.2923	0.7089	0.0001940 (0.0013580)*	1.0003239
(0.01,0.98,0.01)	0.7465	9.9981	1.1264	0.0000000 (0.0000000)	1.0000000
(0.01,0.01,0.98)	0.3405	4.5606	0.5138	0.0001990 (0.0001407)	1.0002670
(0.80,0.10,0.10)	0.7049	9.4409	1.0636	0.0000215 (0.0000476)	1.0000292
(0.10,0.80,0.10)	0.7450	9.9776	1.1240	0.0000001 (0.0000002)	1.0000000
(0.10,0.10,0.80)	0.6770	9.0681	1.0268	0.0000709 (0.0000556)	1.0000720
(0.49,0.01,0.49)	0.3967	5.3135	0.5986	0.0000185 (0.0000185)	1.0000269
(0.45,0.10,0.45)	0.6907	9.2507	1.0422	0.0000063 (0.0000066)	1.0000072
(0.35,0.30,0.35)	0.7313	9.7943	1.1034	0.0000018 (0.0000021)	1.0000022
(0.30,0.40,0.30)	0.7367	9.8668	1.1116	0.0000010 (0.0000013)	1.0000013

Note: * The welfare gains in the parentheses are measured in GNP equialent units using the formula, $\hat{y} = 0.7\ (1/z_3)^{1/4}\ [(-U_N)^{1/4}-(-U_C)^{1/4}]$.

D. **Equilibria of the Game**

1. Nash Equilibrium

We need to define some short notations to simplify the expressions as below.

$$\Psi_1 = z_1x_1y_1 + z_2x_2y_2 + z_3x_3y_3 \quad , \quad \Psi_1^* = z_1^*x_1^*y_1^* + z_2^*x_2^*y_2^* + z_3^*x_3^*y_3^*$$

$$\Psi_2 = z_2x_2q_2 - z_1x_1q_1 - z_3x_3q_3 \quad , \quad \Psi_2^* = z_2^*x_2^*q_2^* - z_1^*x_1^*q_1^* - z_3^*x_3^*q_3^*$$

$$\Psi_3 = z_1x_1t_1 + z_2x_2t_2 + z_3x_3t_3 \quad , \quad \Psi_3^* = z_1^*x_1^*t_1^* + z_2^*x_2^*t_2^* + z_3^*x_3^*t_3^*$$

$$\Psi_4 = z_1x_1 \quad , \quad \Psi_4^* = z_1^*x_1^*$$

$$\Psi_5 = z_2x_2 \quad , \quad \Psi_{5*} = z_2^*x_2^*$$

$$\Psi_6 = z_3x_3 \quad , \quad \Psi_6^* = z_3^*x_3^*$$

$$\Psi_7 = z_1x_{12} + z_2x_{22} + z_3x_{32} \quad , \quad \Psi_7^* = z_1^*x_1^{*2} + z_2^*x_2^{*2} + z_3^*x_3^{*2}$$

$$C_{\hat{e}*} = \Psi_1/\Psi_7 \quad , \quad C_{\hat{e}}^* = \Psi_1^*/\Psi_7^*$$

$$C_{\hat{m}} = \Psi_2/\Psi_7 \quad , \quad C_{\hat{m}*}^* = \Psi_2^*/\Psi_7^*$$

$$C_{\hat{m}*} = -\Psi_3/\Psi_7 \quad , \quad C_{\hat{m}}^* = -\Psi_3^*/\Psi_7^*$$

$$C_{\hat{c}} = \Psi_2/\Psi_7 \quad , \quad C_{\hat{c}*}^* = \Psi_2^*/\Psi_7^*$$

$$C_{\hat{c}*} = -\Psi_3/\Psi_7 \quad , \quad C_{\hat{c}}^* = -\Psi_3^*/\Psi_7^*$$

$$C_{\hat{p}t} = \Psi_4/\Psi_7 \quad , \quad C_{\hat{p}t}^* = \Psi_4^*/\Psi_7^*$$

$$C_{\hat{t}t} = \Psi_5/\Psi_7 \quad , \quad C_{\hat{t}t}^* = \Psi_5^*/\Psi_7^*$$

$$C_{\hat{n}t} = \Psi_6/\Psi_7 \quad , \quad C_{\hat{n}t}^* = \Psi_6^*/\Psi_7^*$$

We can rewrite the reaction functions as

$$\hat{e} = E(\hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$= C_{\hat{e}*}\,\hat{e}^* + C_{\hat{m}}\,\hat{m} + C_{\hat{m}*}\,\hat{m}^* + C_{\hat{c}}\,\pi_2\hat{c}_1 + C_{\hat{c}*}\,\pi_2^*\hat{c}_1^* + C_{\hat{p}t}\,\hat{p}^t + C_{\hat{t}t}\,\hat{t}^t + C_{\hat{n}t}\,\hat{n}^t$$

$$\hat{e}^* = E^*(\hat{e}, \hat{m}^*, \hat{m}, \hat{c}_1^*, \hat{c}_1, \hat{p}^{t*}, \hat{t}^{t*}, \hat{n}^{t*})$$

$$= C_{\hat{e}}^*\,\hat{e} + C_{\hat{m}*}^*\,\hat{m}^* + C_{\hat{m}}^*\,\hat{m} + C_{\hat{c}*}^*\,\pi_2^*\hat{c}_1^* + C_{\hat{c}}^*\,\pi_2\hat{c}_1 + C_{\hat{p}t}^*\,\hat{p}^{t*} + C_{\hat{t}t}^*\,\hat{t}^{t*} + C_{\hat{n}t}^*\,\hat{n}^{t*}$$

Solving for $\hat{e}$ and $\hat{e}^*$ yields the Nash equilibrium as;

$$\hat{e}_N = [(C_{\hat{e}*}C_{\hat{m}}^* + C_{\hat{m}})\,\hat{m} + (C_{\hat{e}*}C_{\hat{m}*}^* + C_{\hat{m}*})\,\hat{m}^* + (C_{\hat{e}*}C_{\hat{m}}^* + C_{\hat{m}})\,\pi_2\hat{c}_1$$

$$+ (C_{\hat{e}*}C_{\hat{m}*}^* + C_{\hat{m}*})\,\pi_2^*\hat{c}_1^* + C_{\hat{e}*}C_{\hat{p}t}^*\,\hat{p}^{t*} + C_{\hat{e}*}C_{\hat{t}t}^*\,\hat{t}^{t*} + C_{\hat{e}*}C_{\hat{n}t}^*\,\hat{n}^{t*}$$

$$+ C_{\hat{p}t}\,\hat{p}^t + C_{\hat{t}t}\,\hat{t}^t + C_{\hat{n}t}\,\hat{n}^t] / (1 - C_{\hat{e}*}C_{\hat{e}}^*)$$

$$\hat{e}_N^* = [(C_{\hat{e}}^*C_{\hat{m}*} + C_{\hat{m}*}^*)\,\hat{m}^* + (C_{\hat{e}}^*C_{\hat{m}} + C_{\hat{m}}^*)\,\hat{m} + (C_{\hat{e}}^*C_{\hat{m}*} + C_{\hat{m}*}^*)\,\pi_2^*\hat{c}_1^*$$

$$+ (C_{\hat{e}}^*C_{\hat{m}} + C_{\hat{m}}^*)\,\pi_2\hat{c}_1 + C_{\hat{e}}^*C_{\hat{p}t}\,\hat{p}^t + C_{\hat{e}}^*C_{\hat{t}t}\,\hat{t}^t + C_{\hat{e}}^*C_{\hat{n}t}\,\hat{n}^t$$

$$+ C_{\hat{p}t}^*\,\hat{p}^{t*} + C_{\hat{t}t}^*\,\hat{t}^{t*} + C_{\hat{n}t}^*\,\hat{n}^{t*}] / (1 - C_{\hat{e}*}C_{\hat{e}}^*)$$

2. Stackelberg Equilibrium

If the home country takes the leadership of the game and the foreign country follows, the Stackelberg equilibrium exists at the tangency point between the home indifference curve and the foreign reaction function.

Thus, from the first order condition and the foreign reaction function

$$MRS_{\hat{e},\hat{e}*} = - U_{\hat{e}}/U_{\hat{e}*} = C_{\hat{e}}^*$$

Solving this equation yields the Stackelberg equilibrium as follows;

$$\hat{e}_L = [\{(\Psi_2 - C_{\hat{e}}^*\psi_2) + C_{\hat{m}}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\}\,\hat{m} - \{(\Psi_3 - C_{\hat{e}}^*\psi_3) - C_{\hat{m}*}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\}\,\hat{m}^*$$

$$+ \{(\Psi_2 - C_{\hat{e}}^*\psi_2) + C_{\hat{m}}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\}\,\pi_2\hat{c}_1 - \{(\Psi_3 - C_{\hat{e}}^*\psi_3) - C_{\hat{m}*}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\}\,\pi_2^*\hat{c}_1^*$$

$$+ (\Psi_4 - C_{\hat{e}}^*\psi_4)\,\hat{p}^t + (\Psi_5 - C_{\hat{e}}^*\psi_5)\,\hat{t}^t + (\Psi_6 - C_{\hat{e}}^*\psi_6)\,\hat{n}^t$$

$$+ C_{\hat{p}t}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\,\hat{p}^{t*} + C_{\hat{t}t}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\,\hat{t}^{t*} + C_{\hat{n}t}^*(\Psi_1 - C_{\hat{e}}^*\psi_1)\,\hat{n}^{t*}]$$

$$/(\Psi_7 - C_{\hat{e}}^*\psi_7 - C_{\hat{e}}^*\Psi_1 + C_{\hat{e}}^{*2}\psi_1)$$

$$\hat{e}_F^* = [\{C_{\hat{e}}^*(\Psi_2 - C_{\hat{e}}^*\psi_2) + C_{\hat{m}}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\}\,\hat{m} - \{C_{\hat{e}}^*(\Psi_3 - C_{\hat{e}}^*\psi_3) - C_{\hat{m}*}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\}\,\hat{m}^*$$

$$+ \{C_{\hat{e}}^*(\Psi_2 - C_{\hat{e}}^*\psi_2) + C_{\hat{m}}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\}\,\pi_2\hat{c}_1 - \{C_{\hat{e}}^*(\Psi_3 - C_{\hat{e}}^*\psi_3) - C_{\hat{m}*}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\}\,\pi_2^*\hat{c}_1^*$$

$$+ C_{\hat{e}}^*(\Psi_4 - C_{\hat{e}}^*\psi_4)\,\hat{p}^t + C_{\hat{e}}^*(\Psi_5 - C_{\hat{e}}^*\psi_5)\,\hat{t}^t + C_{\hat{e}}^*(\Psi_6 - C_{\hat{e}}^*\psi_6)\,\hat{n}^t$$

$$+ C_{\hat{p}t}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\,\hat{p}^{t*} + C_{\hat{t}t}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\,\hat{t}^{t*} + C_{\hat{n}t}^*(\Psi_7 - C_{\hat{e}}^*\psi_7)\,\hat{n}^{t*}]$$

$$/(\Psi_7 - C_{\hat{e}}^*\psi_7 - C_{\hat{e}}^*\Psi_1 + C_{\hat{e}}^{*2}\psi_1)$$

where

$$\psi_1 = z_1y_{12} + z_2y_{22} + z_3y_{32} \quad , \psi_1^* = z_1^*y_{1*}^{*2} + z_2^*y_{2*}^{*2} + z_3^*y_{3*}^{*2}$$

$$\psi_2 = z_2y_2q_2 - z_1y_1q_1 - z_3y_3q_3 \quad , \psi_2^* = z_2^*y_2^*q_2^* - z_1^*y_1^*q_1^* - z_3^*y_3^*q_3^*$$

$$\psi_3 = z_1y_1t_1 + z_2y_2t_2 + z_3y_3t_3 \quad , \psi_3^* = z_1^*y_1^*t_1^* + z_2^*y_2^*t_2^* + z_3^*y_3^*t_3^*$$

$$\psi_4 = z_1y_1 \quad , \psi_4^* = z_1^*y_1^*$$

$$\psi_5 = z_2y_2 \quad , \psi_5^* = z_2^*y_2^*$$

$$\psi_6 = z_3y_3 \quad , \psi_6^* = z_3^*y_3^*$$

$$\psi_7 = \Psi_1 = z_1x_1y_1 + z_2x_2y_2 + z_3x_3y_3, \ \psi_7^* = \Psi_1^* = z_1^*x_1^*y_1^* + z_2^*x_2^*y_2^* + z_3^*x_3^*y_3^*$$

3. Cooperative Equilibrium

Suppose the policy authorities of two countries agree to maximize the joint utility function $V = (U + U^*)/2$ instead of each country's utility function with respect to $\hat{e}$ and $\hat{e}^*$. Then we will find a cooperative equilibrium on the Pareto-efficient contract curve as below.

Solving the first order conditions as

$$V_{\hat{e}} = 1/2\ U_{\hat{e}} + 1/2\ U_{\hat{e}}^* = 0 \text{ and } V_{\hat{e}*}^* = 1/2\ U_{\hat{e}*} + 1/2\ U_{\hat{e}*}^* = 0$$

We can rewrite the reaction functions as

$$\hat{e} = E(\hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t, \hat{p}^{t*}, \hat{t}^{t*}, \hat{n}^{t*})$$

$$= D_{\hat{e}*}\ \hat{e}^* + D_{\hat{m}}\ \hat{m} + D_{\hat{m}*}\ \hat{m}^* + D_{\hat{c}}\ \pi_2\hat{c}_1 + D_{\hat{c}*}\ \pi_2^*\hat{c}_1^*$$

$$+ D_{\hat{p}t}\ \hat{p}^t + D_{\hat{t}t}\ \hat{t}^t + D_{\hat{n}t}\ \hat{n}^t + D_{\hat{p}t*}\ \hat{p}^{t*} + D_{\hat{t}t*}\ \hat{t}^{t*} + D_{\hat{n}t*}\ \hat{n}^{t*}$$

$$\hat{e}^* = E^*(\hat{e}, \hat{m}^*, \hat{m}, \hat{c}_1^*, \hat{c}_1, \hat{p}^{t*}, \hat{t}^{t*}, \hat{n}^{t*}, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$= D_{\hat{e}}\ \hat{e} + D_{\hat{m}*}^*\ \hat{m}^* + D_{\hat{m}}^*\ \hat{m} + D_{\hat{c}*}^*\ \pi_2^*\hat{c}_1^* + D_{\hat{c}}\ \pi_2\hat{c}_1$$

$$+ D_{\hat{p}t*}\ \hat{p}^{t*} + D_{\hat{t}t*}^*\ \hat{t}^{t*} + D_{\hat{n}t*}^*\ \hat{n}^{t*} + D_{\hat{p}t}^*\ \hat{p}^t + D_{\hat{t}t}^*\ \hat{t}^t + D_{\hat{n}t}^*\ \hat{n}^t$$

Thus, similarly with Nash equilibrium, the cooperative equilibrium is:

$$\hat{e}_C = [(D_{\hat{e}*}D_{\hat{m}}^* + D_{\hat{m}})\,\hat{m} + (D_{\hat{e}*}D_{\hat{m}*}^* + D_{\hat{m}*})\,\hat{m}^* + (D_{\hat{e}*}D_{\hat{m}}^* + D_{\hat{m}})\,\pi_2\hat{c}_1$$

$$+ (D_{\hat{e}*}D_{\hat{m}*}^* + D_{\hat{m}*})\,\pi_2^*\hat{c}_1^* + (D_{\hat{e}*}D_{\hat{p}t}^* + D_{\hat{p}t})\,\hat{p}^t + (D_{\hat{e}*}D_{\hat{t}t}^* + D_{\hat{t}t})\,\hat{t}^t$$

$$+ (D_{\hat{e}*}D_{\hat{n}t}^* + D_{\hat{n}t})\,\hat{n}^t + (D_{\hat{e}*}D_{\hat{p}t*}^* + D_{\hat{p}t*})\,\hat{p}^{t*} + (D_{\hat{e}*}D_{\hat{t}t*}^* + D_{\hat{t}t*})\,\hat{t}^{t*}$$

$$+ (D_{\hat{e}*}D_{\hat{n}t*}^* + D_{\hat{n}t*})\,\hat{n}^{t*}]/\,(1 - D_{\hat{e}*}D_{\hat{e}}^*)$$

$$\hat{e}_C^* = [(D_{\hat{e}}^*D_{\hat{m}*} + D_{\hat{m}*}^*)\,\hat{m}^* + (D_{\hat{e}}^*D_{\hat{m}} + D_{\hat{m}}^*)\,\hat{m} + (D_{\hat{e}}^*D_{\hat{m}*} + D_{\hat{m}*}^*)\,\pi_2^*\hat{c}_1^*$$

$$+ (D_{\hat{e}}^*D_{\hat{m}} + D_{\hat{m}}^*)\,\pi_2\hat{c}_1 + (D_{\hat{e}}^*D_{\hat{p}t*} + D_{\hat{p}t*}^*)\,\hat{p}^{t*} + (D_{\hat{e}}^*D_{\hat{t}t*} + D_{\hat{t}t*}^*)\,\hat{t}^{t*}$$

$$+ (D_{\hat{e}}^*D_{\hat{n}t*} + D_{\hat{n}t*}^*)\,\hat{n}^{t*} + (D_{\hat{e}}^*D_{\hat{p}t} + D_{\hat{p}t}^*)\,\hat{p}^t + (D_{\hat{e}}^*D_{\hat{t}t} + D_{\hat{t}t}^*)\,\hat{t}^t$$

$$+ (D_{\hat{e}}^*D_{\hat{n}t} + D_{\hat{n}t}^*)\,\hat{n}^t]/\,(1 - D_{\hat{e}*}D_{\hat{e}}^*)$$

where

$$
\begin{array}{llll}
D_{\hat{e}*} = (\Psi_1 + \psi_7^*)/(\Psi_7 + \psi_1^*) & , & D_{\hat{e}}^* = (\Psi_1^* + \psi_7)/(\Psi_7^* + \psi_1) \\
D_{\hat{m}} = (\Psi_2 + \psi_3^*)/(\Psi_7 + \psi_1^*) & , & D_{\hat{m}*}^* = (\Psi_2^* + \psi_3)/(\Psi_7^* + \psi_1) \\
D_{\hat{m}*} = -(\Psi_3 + \psi_2^*)/(\Psi_7 + \psi_1^*) & , & D_{\hat{m}}^* = -(\Psi_3^* + \psi_2)/(\Psi_7^* + \psi_1) \\
D_{\hat{c}} = (\Psi_2 + \psi_3^*)/(\Psi_7 + \psi_1^*) & , & D_{\hat{c}*}^* = (\Psi_2^* + \psi_3)/(\Psi_7^* + \psi_1) \\
D_{\hat{c}*} = -(\Psi_3 + \psi_2^*)/(\Psi_7 + \psi_1^*) & , & D_{\hat{c}}^* = -(\Psi_3^* + \psi_2)/(\Psi_7^* + \psi_1) \\
D_{\hat{p}t} = \Psi_4/(\Psi_7 + \psi_1^*) & , & D_{\hat{p}t*}^* = \Psi_4^*/(\Psi_7^* + \psi_1) \\
D_{\hat{t}t} = \Psi_5/(\Psi_7 + \psi_1^*) & , & D_{\hat{t}t*}^* = \Psi_5^*/(\Psi_7^* + \psi_1) \\
D_{\hat{n}t} = \Psi_6/(\Psi_7 + \psi_1^*) & , & D_{\hat{n}t*}^* = \Psi_6^*/(\Psi_7^* + \psi_1) \\
D_{\hat{p}t*} = -\psi_4^*/(\Psi_7 + \psi_1^*) & , & D_{\hat{p}t}^* = -\psi_4/(\Psi_7^* + \psi_1) \\
D_{\hat{t}t*} = -\psi_5^*/(\Psi_7 + \psi_1^*) & , & D_{\hat{t}t}^* = -\psi_5/(\Psi_7^* + \psi_1) \\
D_{\hat{n}t*} = -\psi_6^*/(\Psi_7 + \psi_1^*) & , & D_{\hat{n}t}^* \quad -\psi_6/(\Psi_7^* + \psi_1)
\end{array}
$$

APPENDIX 3B

Effects of Shocks on the Equilibrium Equations and the Reaction Function

In this section, we describe the effects of various shocks on three equilibrium equations and the reaction function. The simplifying notations are defined in Appendix 3A for A, B, C, D, E, and Z, x_i's, y_i's, q_i's, and t_i's. For convenience, only the additional shocks are attached to the basic reduced form of each equation in section II.

A. **Supply-Side Shock**

When a productivity change is defined by $\hat{v}$, the resulting aggregate supply equation is $\hat{y}^s = \alpha_1\hat{n} + \hat{v}$.

1. CPI Equilibrium

$$\hat{p} = P(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) - (v_1\,\hat{v} + fv_1\,\hat{v}^*) = 0$$

2. Balance of Trade Equilibrium

$$\hat{t} = T(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + (v_2\,\hat{v} - fv_2\,\hat{v}^*) = 0$$

3. Employment Equilibrium

$$\hat{n} = N(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) - (v_3\,\hat{v} + fv_3\,\hat{v}^*) = 0$$

4. Reaction Function

$$\hat{e} = E(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$- [(z_2x_2v_2 - z_1x_1v_1 - z_3x_3v_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)]\,\hat{v}$$

$$+ [(z_1x_1fv_1 + z_2x_2fv_2 + z_3x_3fv_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)]\,\hat{v}^*$$

where,

$v_1 = \{\beta_1\theta_1(C^*B - Z\pi_2^*a_2^*) + \beta_2\theta_1^*(Z^*B - C\pi_2^*a_2^*)\}/(CC^* - ZZ^*)$

$v_2 = \{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*B - Z\pi_2^*a_2^*)/(CC^* - ZZ^*) - (b_2 + b_4)$

$\quad - \{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(Z^*B - C\pi_2^*a_2^*)/(CC^* - ZZ^*)$

$v_3 = (C^*B - Z\pi_2^*a_2^*)/(CC^* - ZZ^*)$

$fv_1 = \{\beta_1\theta_1(ZB^* - C^*\pi_2a_2) + \beta_2\theta_1^*(CB^* - Z^*\pi_2a_2)\}/(CC^* - ZZ^*)$

$fv_2 = \{(a_1 + b_1)\theta_{1*} + a_2\alpha_1^*\}(CB^* - Z^*\pi_2a_2)/(CC^* - ZZ^*) - a_2$

$\quad - \{A\theta_1 + (b_2 + b_4)\alpha_1\}(ZB^* - C^*\pi_2a_2)/(CC^* - ZZ^*)$

$fv_3 = (ZB^* - C^*\pi_2a_2)/(CC^* - ZZ^*)$

B. **Demand-Side Shock**

When a change in the aggregate demand is defined by $\hat{u}$, the resulting aggregate demand equation is $\hat{y}^d = - \gamma_1(\hat{i} - \hat{c}_1) + \hat{t} + \hat{u}$.

1. C.P.I. Equilibrium

$\hat{p} = P(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + [q_1 (\pi_2/\gamma_1)\hat{u} + t_1 (\pi_2^*/\gamma_1^*)\hat{u}^*] = 0$

2. Balance of Trade Equilibrium

$\hat{t} = T(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) - [q_2 (\pi_2/\gamma_1)\hat{u} - t_2 (\pi_2^*/\gamma_1^*)\hat{u}^*] = 0$

3. Employment Equilibrium

$\hat{n} = N(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + [q_3 (\pi_2/\gamma_1)\hat{u} + t_3 (\pi_2^*/\gamma_1^*)\hat{u}^*] = 0$

4. Reaction Function

$\hat{e} = E(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$

$\quad + [(z_2x_2q_2 - z_1x_1q_1 - z_3x_3q_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)] (\pi_2/\gamma_1)\hat{u}$

$\quad - [(z_1x_1t_1 + z_2x_2t_2 + z_3x_3t_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)] (\pi_2^*/\gamma_1^*)\hat{u}^*$

C. **ROW Depreciation**: $\hat{e}^{RW} > 0$

1. CPI Equilibrium

$$\hat{p} = P(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) - u_1 \hat{e}^{RW} = 0$$

2. Balance of Trade Equilibrium

$$\hat{t} = T(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) - u_2 \hat{e}^{RW} = 0$$

3. Employment Equilibrium

$$\hat{n} = N(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) - u_3 \hat{e}^{RW} = 0$$

4. Reaction Function

$$\hat{e} = E(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$+ [(z_1x_1u_1 + z_2x_2u_2 + z_3x_3u_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)] \hat{e}^{RW}$$

where,

$$F = (a_3 + b_3)\pi_2 - \beta_3\gamma_1, \; F^* = (a_3^* + b_3^*)\pi_2^* - \beta_3^*\gamma_1^*$$

$$u_1 = \beta_3 + \beta_1\theta_1(C^*F + F^*Z)/(CC^* - ZZ^*) + \beta_2\theta_1^*(CF^* + FZ^*)/(CC^* - ZZ^*)$$

$$u_2 = (a_3 + b_3) + \{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(CF^* + FZ^*)/(CC^* - ZZ^*)$$

$$- \{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*F + F^*Z)/(CC^* - ZZ^*)$$

$$u_3 = (C^*F + F^*Z)/(CC^* - ZZ^*)$$

D. **ROW Product Price Change**: $\hat{s}^{RW} > 0$

1. CPI Equilibrium

$$\hat{p} = P(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + u_1 \hat{s}^{RW} = 0$$

2. Balance of Trade Equilibrium

$$\hat{t} = T(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + u_2 \hat{s}^{RW} = 0$$

3. Employment Equilibrium

$$\hat{n} = N(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + u_3\, \hat{s}^{RW} = 0$$

4. Reaction Function

$$\hat{e} = E(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$- [(z_1x_1u_1 + z_2x_2u_2 + z_3x_3u_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)]\, \hat{s}^{RW}$$

E. **ROW GNP Change**: $\hat{y}^{dRW} > 0$

1. CPI Equilibrium

$$\hat{p} = P(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + s_1\, \hat{y}^{dRW} = 0$$

2. Balance of Trade Equilibrium

$$\hat{t} = T(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + s_2\, \hat{y}^{dRW} = 0$$

3. Employment Equilibrium

$$\hat{n} = N(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*) + s_3\, \hat{y}^{dRW} = 0$$

4. Reaction Function

$$\hat{e} = E(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{p}^t, \hat{t}^t, \hat{n}^t)$$

$$- [(z_1x_1s_1 + z_2x_2s_2 + z_3x_3s_3)/(z_1x_1^2 + z_2x_2^2 + z_3x_3^2)]\, \hat{y}^{dRW}$$

where,

$$s_1 = \beta_3 + \beta_1\theta_1(C^*\pi_2a_4 + \pi_2^*a_4^*Z)/(CC^* - ZZ^*) + \beta_2\theta_1^*(C\pi_2^*a_4^* + \pi_2a_4Z^*)/(CC^* - ZZ^*)$$

$$s_2 = a_4 + \{(a_1 + b_1)\theta_1^* + a_2\alpha_1^*\}(C\pi_2^*a_4^* + \pi_2a_4Z^*)/(CC^* - ZZ^*)$$

$$- \{A\theta_1 + (b_2 + b_4)\alpha_1\}(C^*\pi_2a_4 + \pi_2^*a_4^*Z)/(CC^* - ZZ^*)$$

$$s_3 = (C^*\pi_2a_4 + \pi_2^*a_4^*Z)/(CC^* - ZZ^*)$$

F. **Pot-pourri of Shocks**: With all shocks considered, the reaction func-tions are as in table 3B given the parameter values shown in table 3.5.

Table 3B Reaction Functions in Alternative Trading Patterns

Pattern I (symmetric)

$$\begin{aligned}\hat{e} = {} & 0.3774\,\hat{e}^* + 0.3328\,\hat{m} - 0.1628\,\hat{m}^* + 0.1664\,\hat{c}_1 - 0.0814\,\hat{c}_1^* + 0.0555\,\hat{u} \\ & - 0.0271\,\hat{u}^* - 0.1108\,\hat{v} + 0.0920\,\hat{v}^* + 0.6226\,\hat{e}^{RW} - 0.6226\,\hat{s}^{RW} \\ & - 0.6665\,\hat{y}^{RW} + 0.0270\end{aligned}$$

Pattern II (asymmetric)

$$\begin{aligned}\hat{e} = {} & 0.3611\,\hat{e}^* + 0.3277\,\hat{m} - 0.1556\,\hat{m}^* + 0.1638\,\hat{c}_1 - 0.0778\,\hat{c}_1^* + 0.0546\,\hat{u} \\ & - 0.0259\,\hat{u}^* - 0.1177\,\hat{v} + 0.0881\,\hat{v}^* + 0.6389\,\hat{e}^{RW} - 0.6389\,\hat{s}^{RW} \\ & - 0.6997\,\hat{y}^{RW} + 0.0130\end{aligned}$$

$$\begin{aligned}\hat{e}^* = {} & 0.3704\,\hat{e} + 0.3329\,\hat{m}^* - 0.1612\,\hat{m} + 0.1665\,\hat{c}_1^* - 0.0806\,\hat{c}_1 + 0.0555\,\hat{u}^* \\ & - 0.0269\,\hat{u} - 0.1108\,\hat{v}^* + 0.0896\,\hat{v} + 0.6296\,\hat{e}^{RW} - 0.6296\,\hat{s}^{RW} \\ & - 0.6659\,\hat{y}^{RW} + 0.0141\end{aligned}$$

Pattern IV (symmetric)

$$\begin{aligned}\hat{e} = {} & 0.3954\,\hat{e}^* + 0.3282\,\hat{m} - 0.1641\,\hat{m}^* + 0.1641\,\hat{c}_1 - 0.0821\,\hat{c}_1^* + 0.0547\,\hat{u} \\ & - 0.0274\,\hat{u}^* - 0.1162\,\hat{v} + 0.0991\,\hat{v}^* + 0.6046\,\hat{e}^{RW} - 0.6046\,\hat{s}^{RW} \\ & - 0.6470\,\hat{y}^{RW} + 0.0262\end{aligned}$$

Pattern V (asymmetric)

$$\begin{aligned}\hat{e} = {} & 0.3883\,\hat{e}^* + 0.3282\,\hat{m} - 0.1625\,\hat{m}^* + 0.1641\,\hat{c}_1 - 0.0813\,\hat{c}_1^* + 0.0547\,\hat{u} \\ & - 0.0271\,\hat{u}^* - 0.1163\,\hat{v} + 0.0968\,\hat{v}^* + 0.6117\,\hat{e}^{RW} - 0.6117\,\hat{s}^{RW} \\ & - 0.6464\,\hat{y}^{RW} + 0.0262\end{aligned}$$

$$\begin{aligned}\hat{e}^* = {} & 0.3788\,\hat{e} + 0.3236\,\hat{m}^* - 0.1570\,\hat{m} + 0.1618\,\hat{c}_1^* - 0.0785\,\hat{c}_1 + 0.0539\,\hat{u}^* \\ & - 0.0262\,\hat{u} - 0.1227\,\hat{v}^* + 0.0951\,\hat{v} + 0.6212\,\hat{e}^{RW} - 0.6212\,\hat{s}^{RW} \\ & - 0.6804\,\hat{y}^{RW} + 0.0256\end{aligned}$$

Pattern VI (asymmetric)

$$\begin{aligned}\hat{e} = {} & 0.4655\,\hat{e}^* + 0.3317\,\hat{m} - 0.1831\,\hat{m}^* + 0.1658\,\hat{c}_1 - 0.0916\,\hat{c}_1^* + 0.0553\,\hat{u} \\ & - 0.0305\,\hat{u}^* - 0.1105\,\hat{v} + 0.1211\,\hat{v}^* + 0.5345\,\hat{e}^{RW} - 0.5345\,\hat{s}^{RW} \\ & - 0.6735\,\hat{y}^{RW} + 0.0262\end{aligned}$$

$$\begin{aligned}\hat{e}^* = {} & 0.7710\,\hat{e} + 0.4789\,\hat{m}^* - 0.3362\,\hat{m} + 0.2395\,\hat{c}_1^* - 0.1681\,\hat{c}_1 + 0.0798\,\hat{u}^* \\ & - 0.0560\,\hat{u} + 0.0211\,\hat{v}^* + 0.1863\,\hat{v} + 0.2290\,\hat{e}^{RW} - 0.2290\,\hat{s}^{RW} \\ & + 0.0025\,\hat{y}^{RW} + 0.0421\end{aligned}$$

Note: 1. First (second) equations are the reaction functions of the Home (Foreign) country.
2. Pattern III is the mirror image of pattern II.

APPENDIX 3C

Tables for the Numerical Results

TABLE I Description of Equilibria with A Balance of Trade Target Shock (10%) in Pattern I

	Home	Country					
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{t}$	$\hat{n}$	$\hat{i}$	U
NE	3.3370	3.3370	0.6907	9.2507	1.0422	2.8404	-0.759560E-4
SE_L	3.3362	3.3367	0.6905	9.2479	1.0419	2.8395	-0.759559E-4
SE_F	3.3367	3.3362	0.6907	9.2507	1.0422	2.8404	-0.759555E-4
CE	3.3333	3.3333	0.6899	9.2405	1.0410	2.8372	-0.759549E-4
BP	-4.3386	-17.0000	0.9324	9.3029	0.7569	2.9244	-0.697572E-4
SRF = 0.377419,			INT = 0.020775				

Notes: 1. A shift in the balance of trade target from zero to 0.1 is referred to as a target shock.

2. The exchange rate ($\hat{e}$) and the employment rate ($\hat{n}$) are percentage changes from the long-run rates; the inflation rate ($\hat{p}$), the interest rate ($\hat{i}$), and the balance of trade ($\hat{t}$) are the percentage point deviations from the long-run levels, where $\hat{t}$ is BOT/(long-run exports) ratio.

3. NE - Nash equilibrium, SE_L (SE_F) - Stackelberg equilibrium as a leader (follower), CE - cooperative equilibrium, BP - bliss point, SRF - slope of the reaction function, INT - Intercept of the reaction function.

TABLE II Description of Equilibria with A Balance of Trade Target Shock (10%) in Pattern II

	Home		Country				
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{t}$	$\hat{n}$	$\hat{i}$	U
NE	3.1737	3.2521	0.6667	9.2414	1.0697	2.8309	-0.772445E-4
SE_L	3.1727	3.2518	0.6664	9.2378	1.0693	2.8298	-0.772444E-4
SE_F	3.1734	3.2514	0.6667	9.2414	1.0697	2.8309	-0.772439E-4
CE	3.1697	3.2477	0.6659	9.2304	1.0684	2.8275	-0.772421E-4
BP	-3.0562	-14.0000	0.9252	9.3013	0.7654	2.9218	-0.697592E-4
SRF = 0.361109,			INT = 0.019993				

	Foreign		Country				
	$\hat{e}^*$	$\hat{e}$	$\hat{p}^*$	$\hat{t}^*$	$\hat{n}^*$	$\hat{i}^*$	U^*
NE^*	3.2521	3.1737	0.6909	9.2507	1.0419	2.8405	-0.759466E-4
SE_L^*	3.2514	3.1734	0.6907	9.2480	1.0416	2.8396	-0.759465E-4
SE_F^*	3.2518	3.1727	0.6909	9.2507	1.0419	2.8405	-0.759460E-4
CE^*	3.2477	3.1697	0.6899	9.2378	1.0405	2.8365	-0.759459E-4
BP^*	-3.8491	-16.0000	0.9290	9.3022	0.7609	2.9232	-0.697568E-4
SRF^*= 0.370364,			INT^*= 0.020767				

Notes: 1. See notes in table I.
2. Pattern III is the mirror image of pattern II. Thus Table III is not reported here.

TABLE IV Description of Equilibria with A Balance of Trade Target Shock (10%) in Pattern IV

	Home		Country				
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{t}$	$\hat{n}$	$\hat{i}$	U
NE	3.3358	3.3358	0.6904	9.2474	1.0418	2.8394	-0.759554E-4
SE_L	3.3352	3.3356	0.6903	9.2454	1.0416	2.8388	-0.759553E-4
SE_F	3.3356	3.3352	0.6904	9.2474	1.0418	2.8394	-0.759552E-4
CE	3.3333	3.3333	0.6899	9.2405	1.0410	2.8372	-0.759549E-4
BP	-8.2636	-26.0000	0.9261	9.3015	0.7642	2.9222	-0.697583E-4
SRF = 0.395398,			INT = 0.020168				

Note: See notes in table I.

TABLE V Description of Equilibria with A Balance of Trade Target Shock (10%) in Pattern V

	Home		Country				
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{t}$	$\hat{n}$	$\hat{i}$	U
NE	3.2486	3.1746	0.6899	9.2472	1.0424	2.8392	-0.759815E-4
SE_L	3.2481	3.1744	0.6898	9.2453	1.0422	2.8386	-0.759814E-4
SE_F	3.2484	3.1739	0.6899	9.2472	1.0424	2.8392	-0.759812E-4
CE	3.2454	3.1718	0.6892	9.2378	1.0413	2.8363	-0.759812E-4
BP	-7.6920	-25.0000	0.9316	9.3028	0.7578	2.9241	-0.697569E-4
SRF = 0.388314,			INT = 0.020159				

	Foreign		Country				
	$\hat{e}^*$	$\hat{e}$	$\hat{p}^*$	$\hat{t}^*$	$\hat{n}^*$	$\hat{i}^*$	U^*
NE^*	3.1746	3.2486	0.6671	9.2382	1.0685	2.8301	-0.772058E-4
SE_L^*	3.1739	3.2484	0.6669	9.2354	1.0682	2.8292	-0.772057E-4
SE_F^*	3.1744	3.2481	0.6671	9.2382	1.0685	2.8301	-0.772055E-4
CE^*	3.1718	3.2454	0.6665	9.2304	1.0676	2.8277	-0.772044E-4
BP^*	-5.8139	-20.4785	0.9321	9.3029	0.7573	2.9243	-0.697570E-4
SRF^*= 0.378831,			INT^*= 0.019439				

Notes: See notes in table I.

TABLE VI Description of Equilibria with A Balance of Trade Target Shock (10%) in Pattern VI

	Home		Country				
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{t}$	$\hat{n}$	$\hat{i}$	U
NE	6.1455	8.7158	0.6857	9.2498	1.0481	2.8387	-0.762163E-4
SE_L	6.1443	8.7149	0.6855	9.2464	1.0477	2.8377	-0.762162E-4
SE_F	6.1106	8.6409	0.6861	9.2499	1.0476	2.8389	-0.761957E-4
CE	6.0628	8.6006	0.6761	9.1209	1.0335	2.7992	-0.763644E-4
BP	-15.6022	-38.0000	0.9292	9.3022	0.7607	2.9233	-0.697567E-4
SRF = 0.465531,			INT = 0.020880				
	Foreign		Country				
	$\hat{e}^*$	$\hat{e}$	$\hat{p}^*$	$\hat{t}^*$	$\hat{n}^*$	$\hat{i}^*$	U^*
NE^*	8.7158	6.1455	1.4682	9.2028	0.0804	3.0489	-1.036415E-4
SE_L^*	8.409	6.1106	1.4529	9.0912	0.0764	3.0126	-1.035057E-4
SE_F^*	8.7149	6.1443	1.4681	9.2028	0.0805	3.0488	-1.036320E-4
CE^*	8.6006	6.0628	1.4490	9.0839	0.0796	3.0094	-1.031554E-4
BP^*	1.6646	-3.0000	0.9028	9.3075	0.7940	2.9172	-0.698439E-4
SRF^*= 0.770996,			INT^*= 0.039776				

Notes: See notes in table I.

Footnotes

[1] Either of the balance of payments, the balance of trade, or the foreign reserve stock is used as the external target variable in Hamada (1974, 1976), Jones (1983), Oudiz and Sachs (1984), Oudiz (1985), Eichengreen (1985), Hughes Hallett (1985, 1987), Frankel (1988), and Frankel and Rockett (1988).

[2] Three targets (two internal targets and one external target) have been considered in Oudiz and Sachs (1984), Oudiz (1985), Hughes Hallett (1985, 1987), and Frankel and Rockett (1988), who used large multicountry econometric models with two policy instruments.

[3] It is assumed that the large country (ROW) does not participate in the policy game which is played by the two small countries, and stays in the long-run equilibrium level throughout the game.

[4] See Oudiz and Sachs (1984), Hughes Hallett (1985, 1987), Frankel (1988), and Frankel and Rockett (1988). They used a current account surplus (e.g. 2% of GNP) as the external target, which initiated their game. Eichengreen (1985) also used the external target (i.e. more than a half of the world gold stock) as the target shock.

[5] A transmission effect is generally defined as the effect of one country's policy on the other country's output. Since we use the employment rate as a target variable instesd of output, we define a transmission effect as the foreign policy effect on the domestic employment rate. A negative transmission effect has been suggested in a traditional Mundell-Fleming model. But a positive transmission effect of money supply policy is also found in Eichengreen (1985), Hamada (1985), and Taylor (1985) in a different context.

[6] See footnote 7 in chapter one.

[7] Since the short-run expected inflation rate $c_1^S \equiv \hat{p}^{SE} = p^{SE} - p^L = \ln(P^{SE}/P^L)$ and the long-run expected inflation rate $c_1^L \equiv \hat{p}^{LE} = 0$, the absolute deviation between them $\hat{c}_1 = c_1^S - c_1^L = c_1^S$; the p, t, S, L, and E denote the logarithmic form of P (CPI level), target, short-run, long-run, and expectation respectively. Given the long-run equilibrium CPI level (P^L) and the short-run target CPI level (P^{St}), the short-run target inflation rate ($\hat{p}^t = \ln(P^{St}/P^L)$) can be computed. Therefore, the short-run expected inflation rate ($c_1^S \equiv \hat{p}^{SE}$) can also be computed from P^L and the short-run expected CPI level (P^{SE}) which is determined by the short-run target CPI level (P^{St}). That is, the short-run expected inflation rate (c_1^S) is derived from the short-run target inflation rate ($\hat{p}^t$) which is exogenous. Alternatively, we may simply assume static expectation as in Oudiz and Sachs (1984) and Oudiz (1985).

[8] In much of the literature, the price competitiveness of a country is incorporated in the Dornbusch (1976) type aggregate demand equation as

$$\hat{y} = -\lambda_1 (\hat{i} - \hat{c}_1) + \lambda_2 (\hat{e} - \hat{s} - \hat{e}^* + \hat{s}^*) + \lambda_3 \hat{y}^{d*}$$

using our notation. Thus, the balance of trade is not explicitly defined and used as a target variable in the objective function of the policy authority. Equation (3.6) can be rewritten as

$$\hat{y} = [1/(1 + b_2 + b_4)][-\gamma_1 (\hat{i} - \hat{c}_1) + (a_1+b_1)(\hat{e} - \hat{s} - \hat{e}^* + \hat{s}^*) + (a_3 + b_3)(\hat{e} - \hat{s} - \hat{e}^{RW} + \hat{s}^{RW}) + a_2 \hat{y}^{d*} + a_4 \hat{y}^{RW}]$$

to be comparable with the above equation.

[9] See Basar and Olsder (1982) for a discussion of the Stackelberg equilibrium concept.

[10] See Hamada (1985), Turnovsky and d'Orey (1986), Laskar (1986), and Oudiz and Sachs(1985) for the definition of cooperative equilibrium.

[11] See footnote 6 in chapter one for description of the "*focal-point*" theory.

[12] These assumptions imply that the goods are imperfect substitutes, and that for a large country the share of traded goods is small (less openness) compared to the non-traded home goods which are highly substitutable for the imports.

[13] Zero inflation, full employment, and 2% for the current account ratio (current account/GNP) were used as target values in Oudiz and Sachs (1984). If the (long-run exports)/(long-run GNP) ratio is assumed to be 20%, then our 10% for the (current account)/(long-run exports) ratio gives this value of 2% for (current account)/(long-run GNP).

[14] An initial condition (inherited inflation) in Canzoneri and Minford (1986), Oudiz and Sachs (1985), and Miller and Salmon (1985), or a competitive struggle for gold in Eichengreen (1985), starts the game as a target shock; a supply shock or a demand shock is used by others, e.g. Turnovsky and d'Orey (1986). See also footnote 4.

[15] Selecting welfare weights is a subjective problem. Aggregation of varying preferences of individual actors deepens the problem. Frankel and Rockett (1988) point out the arbitrariness in choosing welfare weights: "*The choice of welfare weights is necessarily more arbitrary, even, than the choice of target optima.....*" With no better objective criteria, recent numerical studies including Frankel and Rockett adopt Oudiz-Sachs (1984) method in selecting the welfare weights. However, the Oudiz-Sachs method depends on the economic situation at the baseline which varies along different time periods. Also, it is based on the assumption that the governments have the correct objective function and they can maximize it successfully at the

baseline, which is assumed to be a Nash equilibrium.

[16] When we consider the marginal utilities of all target variables at Nash and cooperative equilibria in converting the welfare cost into GNP equivalent units, almost the same result is obtained; i.e. 1% of welfare cost is equivalent to 1.08% change in GNP.

CHAPTER FOUR

EXCHANGE RATE CO-ORDINATION UNDER CAPITAL MOBILITY

I. Introduction

In chapter three, we found several results. First, the size of gains from co-ordination is small; second, a higher degree of interdependence between countries (as measured by the ratio of transmission effects to own effects of exchange rate policy) generally induces larger welfare gains from co-ordination; and third, with asymmetry in economic structure, "*Hegemonic Stability*" may be feasible. It is our main interest in this chapter to examine how the incorporation of capital mobility may affect these results.

As discussed in chapter two, many economists have noted that the integration of world capital markets constrains independent national policy-making and that it creates repercussions on other countries from national policy action (see Artis and Ostry (1986), Carlozzi and Taylor (1985), and Tobin (1978)). Tobin (1978) suggested that we should make the international capital market less efficient by levying a tax on all inter-currency transactions for national macroeconomic performance to be more efficient; this idea has been supported by Dornbusch (1988). To examine this issue, we will measure how the welfare costs caused by shocks from the rest of the world vary with the degree of capital mobility. Also, we raise a question which relates Tobin's proposal to the policy co-ordination issue: Could a less efficient capital market increase the welfare gains from policy co-ordination?

To investigate this issue, we incorporate varying degrees of capital mobility into the previous model, based on the assumption of imperfect substitutability in financial assets. This assumption is necessary for capital mobility to be consistent with our assumption of the positive balance of payments target, and for short-run sterilized intervention to be effective. (Note that sterilized intervention may be assumed to justify the lack of a channel between the balance of payments and the money supply in our model.) This also allows us to assess the effects of asymmetric capital flows, for example, different degrees of capital mobility across capital markets due to differences in adjustment speed of capital flows or in substitutability between assets.

In most of the previous studies, however, perfect capital mobility has been assumed. Only a few exceptions are found: Corden (1985), Hamada (1974, 1976), and Hamada and Sakurai (1978) have considered no capital mobility. Oudiz and Sachs (1984) have qualitatively analyzed the impact of varying degrees of capital mobility on policy effects, assuming imperfect asset substitutability and using a portfolio-balance equation. After all, imperfect capital mobility seems to be more realistic for the less developed countries or some Newly Industrialized Countries, where capital markets are in their infancy.

Section II extends the Keynesian three-country model in chapter three to incorporate capital mobility. We will analyze the effects of asymmetric patterns in capital markets in section III. The effects of capital flows on the national welfare level and on the welfare gains from co-ordination will be assessed by numerical simulation in section IV, with a review of Tobin's and Eichengreen's suggestions. Section V will conclude this chapter.

II. Model Specification

Capital mobility is included by adding the following balance of payments equations for the two small countries to the same model used in chapter three. The derivation of these equations are described in Appendix 4A.

$$(4.1)\quad \hat{r} = \hat{t} + \phi_1 \{\hat{i} - \hat{i}^* - \hat{c}_2 + \hat{c}_2^*\} + \phi_2 \{\hat{i} - \hat{i}^{RW} - \hat{c}_2 + \hat{c}_2^{RW}\}$$

$$(4.1)^*\quad \hat{r}^* = \hat{t}^* + \phi_1^*\{\hat{i}^* - \hat{i} - \hat{c}_2^* + \hat{c}_2\} + \phi_2^*\{\hat{i}^* - \hat{i}^{RW} - \hat{c}_2^* + \hat{c}_2^{RW}\}$$

The superscripts *, ^{RW}, and $\hat{}$ denote the foreign country, the third country, and the deviation from the long-run expected value respectively. The variables are defined in table 4.1.

The expected depreciation, $\hat{c}_2$, is assumed to be exogenous. With forward looking behavior of the private agents, the issue of time consistency (or credibility) of government policy has been raised in the dynamic analysis of others (Oudiz and Sachs, 1985; Miller and Salmon, 1985). However, given that we restrict our attention

Table 4.1 Definitions of Variables

Endogenous variables	Exogenous variables
r = nominal balance of payments divided by long-run nominal exports t = real balance of trade divided by long-run real exports i = nominal interest rate (in natural units)	c_2= expected depreciation or appreciation rate of home currency

Note: Initially, the real balance of trade and the nominal balance of trade have the same value, since we assume that the balance of trade is zero and the product price is one in the long-run equilibrium.

to the short-run (or impact period), we assume here static or exogenous expectations to gain focus and to simplify the analysis in an already complicated three-country model.

Equation (4.1) describes the balance of payments equation with varying degrees of capital mobility. As described in Appendix 4A, the balance of payments is the sum of the nominal balance of trade and the capital account which consists of two components in our model. The capital account is interpreted as net capital inflows from different countries. It increases with the positive net yield or interest rate differential (adjusted for expected exchange rate changes) for the domestic country's financial assets. It should be noted that equation (4.1) can be reduced to $\hat{r} = \hat{t}$ where $\hat{t}$ is defined in equation (3.5) in chapter three, where the capital mobility coefficients (the ϕ_i's) are assumed to be zero. The ϕ_i's (or Φ_i's/X^L as defined in Appendix 4A) are also interpreted as the scaled sensitivity of demand for assets with respect to the net interest rate differential between any two countries involved.

We permit no dynamic channel through which the money supply can adjust endogenously to the change in the balance of payments, to avoid the analytical complexity of dynamics in a three-country setting. This restriction stems from sterilization policy. That is, the central bank fixes the exchange rate by selling bonds to the banks to absorb foreign exchange reserves or vice versa in case of a deficit. Since we restrict our analysis to the short-run (or impact period) and imperfect capital mobility, sterilization policy can be effective.

The implications of different quantities of government bonds, and of foreign debt are often ignored in the traditional Keynesian models of the open economy. (See for example, the seminal paper of Dornbusch (1976).) Given this precedent, we ignore debt here, especially since we concentrate on the impact period. However, a longer-run model would have to address the issue: How are private agents' decisions affected by changes in government bonds and in foreign debt holdings?

Without any channel between the money supply and the balance of payments (assuming perfect sterilization), the model is block-recursive because other variables are not affected by equation (4.1). The product price of each small country can be solved in the same reduced form as equations (3.9) and (3.9)* in chapter three. However, the capital account affects the real sector by influencing the exchange rate adjustment through the policy authorities' optimizing procedure. Hence, the degree of capital mobility matters and we can analyze its effect on the results. This is different from the mechanism in the Mundell/Fleming fixed-exchange-rate model, where perfect capital mobility matters because the balance of payments affects the endogenous variables through the money stock adjustment.

A. Equilibrium Equations

From the reduced form equations (3.9) and (3.9)*, we obtain the same reduced form equations (3.10) and (3.12) for CPI equilibrium and employment equilibrium, and equation (4.2) for the balance of payments (BOP) equilibrium as follows.

$$
\begin{aligned}
(4.2)\ \hat{r} &= R(\hat{e}, \hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{i}^{RW}, \hat{c}_2, \hat{c}_2^*, \hat{c}_2^{RW}) \\
&= x_2' \hat{e} - y_2' \hat{e}^* - q_2' \hat{m} + t_2' \hat{m}^* - q_2' \pi_2 \hat{c}_1 + t_2' \pi_2^* \hat{c}_1^* \\
&\quad - \phi_2 \hat{i}^{RW} - (\phi_1 + \phi_2) \hat{c}_2 + \phi_1 \hat{c}_2^* + \phi_2 \hat{c}_2^{RW} \\
&= 0
\end{aligned}
$$

where the effects of domestic and foreign exchange rate policies and monetary shocks, x_2', y_2', q_2', and t_2' are defined in Appendix 4A, and the parametric constants C and Z in Appendix 3A.

Note that from these equilibrium equations (3.10), (3.12), and (4.2), the cross-country effects of a foreign monetary expansion on domestic target variables, t_i's ($i = 1, 2, 3$), can be proved to be positive and that the effects of a depreciation in foreign currency on domestic target variables, $-y_i$'s ($i = 1, 2, 3$), are negative at our parameter values (see Appendices 3A and 4A for algebraic detail).

Now with capital mobility, exchange rate policy and an unanticipated monetary shock have more than the standard effects on the balance of trade. They have additional effects on the capital flows through interest rate changes.

A depreciation of domestic currency has both direct and indirect effects on the interest rates, and thus on capital flows. For the home country, the CPI level increases due to own currency depreciation and it shifts the LM curve to the left, directly increasing the domestic interest rate. But for the foreign country, the CPI level decreases, lowering its interest rate. These are direct effects. The indirect effects are channeled through the changes in the balance of trade. For the home country, the BOT surplus shifts the IS curve to the right raising income, the product price, and the domestic interest rate. The increased product price raises both countries' CPI levels, shifting their LM curves to the left and increasing interest rates. However, the foreign country's income and product price decrease, inducing the opposite results.

B. Policy Reaction Function (RF)

From the maximization of the same quadratic objective function as in chapter three (except the change in notation for the balance of payments from $\hat{t}$ to $\hat{r}$) with respect to own exchange rate, the linear policy reaction function is derived as follows.

$$(4.3)\ \hat{e} = E(\hat{e}^*, \hat{m}, \hat{m}^*, \hat{c}_1, \hat{c}_1^*, \hat{i}^{RW}, \hat{c}_2, \hat{c}_2^*, \hat{c}_2^{RW}, \hat{p}^t, \hat{r}^t, \hat{n}^t)$$

$$= (\Omega_1/\Omega_{10})\ \hat{e}^* + (\Omega_2/\Omega_{10})\ \hat{m} - (\Omega_3/\Omega_{10})\ \hat{m}^* + (\Omega_2/\Omega_{10})\ \pi_2\hat{c}_1$$

$$- (\Omega_3/\Omega_{10})\ \pi_2^*\hat{c}_1^* + (\Omega_4/\Omega_{10})\ \hat{i}^{RW} + (\Omega_5/\Omega_{10})\ \hat{c}_2 - (\Omega_6/\Omega_{10})\ \hat{c}_2^*$$

$$- (\Omega_4/\Omega_{10})\ \hat{c}_2^{RW} + (\Omega_7/\Omega_{10})\ \hat{p}^t + (\Omega_8/\Omega_{10})\ \hat{r}^t + (\Omega_9/\Omega_{10})\ \hat{n}^t$$

The slope, $\Omega_1/\Omega_{10} = \Sigma z_i x_i y_i / \Sigma z_i x_i^2$, of equation (4.3) is less than one as in equation (3.14), since the own policy effects, the x_i's (i = 1, 2, 3), can be shown to be larger than the cross-country effects of foreign policy, the y_i's (i = 1, 2, 3) (see Appendices 3A and 4A for algebraic analyses). This is due to the fact that a domestic policy affects the home country's position in overall trade and capital transactions, but a foreign policy affects the home country through their bilateral relation.

In equation (4.1), an increase in the ROW interest rate or a change in expected depreciation of the home currency ($\hat{c}_2 > 0$) decreases the net interest rate differential for the home country. Hence, the net capital outflows increase, inducing the domestic authorities to depreciate in order to improve the balance of payments. A change in expected depreciation of the foreign country ($\hat{c}_2^* > 0$) or of the ROW ($\hat{c}_2^{RW} > 0$) has the opposite effects on the home country. Also, the size of the exchange rate response following these shocks becomes larger with higher capital mobility (ϕ_1, ϕ_2), because of the higher interest rate effects on the capital account.

Since the differences in the exchange rates and welfare levels in the alternative equilibria (Cournot-Nash, Stackelberg, and cooperative) are similar to those in chapter three as shown in figure 3-1, we will not discuss them in this chapter.

III. Patterns in Capital Markets and Asymmetry

In most of the existing studies, perfect capital mobility has been assumed. However, in our model, we assume varying degrees of capital mobility based on imperfect asset substitutability and on the size differences across capital markets.

In a two-country model, the sensitivity of one country's capital inflows with respect to the net interest rate differential is equal to the sensitivity of the other country's capital outflows with respect to it; e.g. $\phi_1 \equiv \phi_1^*$ between the small countries in figure 4-1. Hence, a change in these parameters results in symmetric effects on both countries' reaction functions. Analogously to the asymmetric trading patterns in chapter three, a possible way to impose asymmetry between two countries is by assigning different values for ϕ_2 and ϕ_2^*, the parameters between each small country and the rest of the world. Here, both the trading patterns (as in chapter three) and the capital market patterns reflect the strength of real and financial links between the three countries, and determine the effects of small countries' exchange rate policies. The capital flows among the three countries are described in figure 4-1, and the alternative capital market patterns are defined in table 4.2.

A. Symmetric Cases

Let us consider the following two cases where both (large) capital markets between either of the small countries and the ROW are symmetric.

1. Pattern A: $\phi_2 = \phi_2^* > \phi_1 \equiv \phi_1^*$.

In this pattern, the degree of capital mobility is lower between the small countries than between either of the small countries and the ROW. For reasonable parameter values which assure the negative transmission effect, the reaction functions

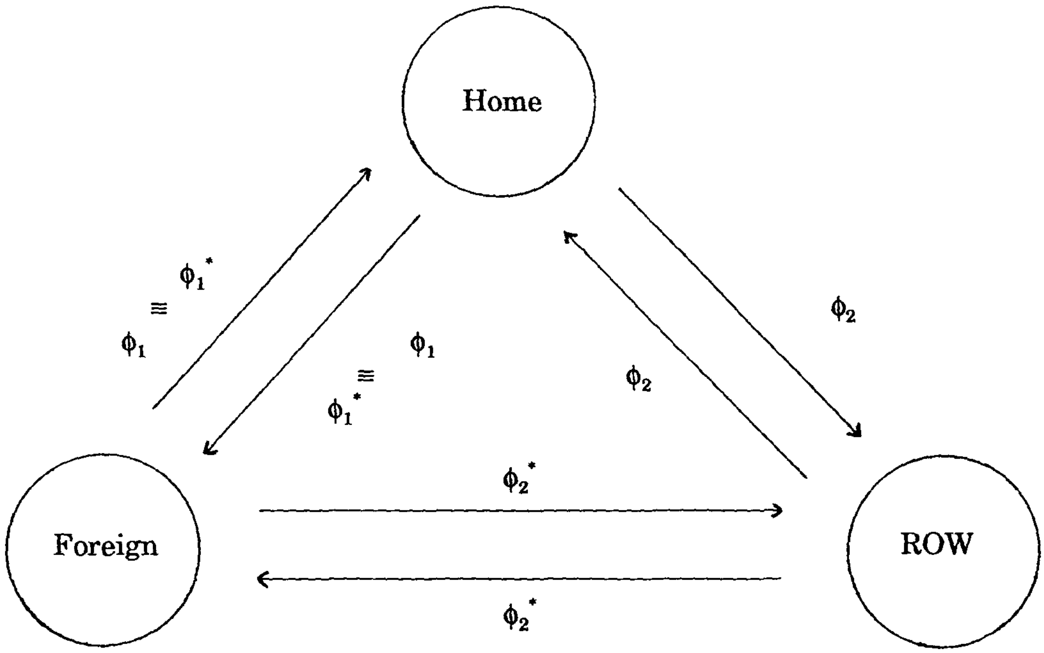

Figure 4-1 Capital Flows among Three Countries

Note: The arrows are implying the direction of the net capital flows, and the ϕ_i's denote the interest rate sensitivity of these flows.

Table 4.2 Interest Rate Sensitivity in Alternative Capital Market Patterns

Capital Market Patterns	Change from Pattern A	Order of Interest Rate Sensitivity
A		$\phi_2 = \phi_2^* > \phi_1 \equiv \phi_1^*$
B	ϕ_2 (+)	$\phi_2 > \phi_2^* > \phi_1 \equiv \phi_1^*$
C	ϕ_2^*(-)	$\phi_2 > \phi_1 \equiv \phi_1^* > \phi_2^* = 0$
D	ϕ_1 (-)	$\phi_2 = \phi_2^* > \phi_1 \equiv \phi_1^* = 0$

Notes: 1. $\phi_1 \equiv \phi_1^*$
2. (+) and (-) denote an increase and a decrease in the size of each interest-rate-sensitivity parameter from the corresponding value in pattern A.

and the indifference curves in this pattern are similar with those in figure 3-1 of chapter three.

2. Pattern D: $\phi_2 = \phi_2^* > \phi_1 \equiv \phi_1^* = 0$.

Here, the small countries have no interest-rate-sensitive capital transactions between them. The net interest rate sensitivity of capital flows between the small countries is zero.

B. Asymmetric Cases

We can consider the following two cases where both (large) capital markets between either of the small countries and the ROW are asymmetric.

1. Pattern B: $\phi_2 > \phi_2^* > \phi_1 \equiv \phi_1^*$.

Capital mobility is assumed to be higher between the Home country and the ROW than between the Foreign country and the ROW.

2. Pattern C: $\phi_2 > \phi_1 \equiv \phi_1^* > \phi_2^* = 0$.

Suppose that the Foreign country has no interest-rate-sensitive capital transaction with the ROW. The net interest rate sensitivity of capital flows between the Foreign country and the ROW is zero, and the Foreign country is almost totally dependent on the Home country for capital transaction.

IV. Simulation Test

The same base set of the values for structural parameters, targets, and weights that were used in chapter three is adopted here. We will refer to a positive balance of payments target as a "*target shock*" in the objective function of the policy authorities. Also, we will analyze an increase in GNP or the interest rate of the ROW as examples of an external shock, while assuming no "*target shock*". With this set of parameters of the model and of the objective function, and with newly defined parameters (ϕ_1, ϕ_2), we will examine following issues:

We will investigate Tobin's (1978) suggestion that a reduced level of efficiency in capital markets is beneficial, by comparing the size of welfare costs with or without the policy authorities' reaction to the shocks, and the size of gains from co-ordination, given various degrees of capital mobility. We will also examine the "*Hegemonic Stability*" issue discussed in Eichengreen (1985), by analyzing the effects of asymmetry in capital flows on the strategic interaction between small countries, and comparing their national welfare levels in Cournot-Nash and Stackelberg equilibria.

A. Values for Newly Defined Parameters

The values for newly defined parameters (ϕ_1, ϕ_2), which define the degree of capital mobility, are selected following the steps described below. In this section and the next section, we will consider a symmetric parametric change for both small countries. Hence, we will ignore the notation for foreign parameters, *, for simplicity of exposition, where $\phi_1 = \phi_1^*$ and $\phi_2 = \phi_2^*$ in figure 4-1.

1. Step 1: Assuming that the representative ratio of ϕ_1 to ϕ_2 is 1/5, a wide range of values from (ϕ_1, ϕ_2) = (0.000001, 0.000005) to (ϕ_1, ϕ_2) = (100, 500) are tried increasing by a factor of ten each time. When (ϕ_1, ϕ_2) equals (0.001, 0.005) or smaller there is almost no difference from no capital mobility. When (ϕ_1, ϕ_2) equals (100, 500), it is close to perfect capital mobility in the sense that the interest rate differential ($\hat{i}$ - $\hat{i}^{RW}$) is only 0.023% in table 4.3. Since we cannot have perfect capital mobility for sterilization policy to be effective, we do not consider higher values of (ϕ_1, ϕ_2) than (100, 500).

However, the ratio of ϕ_1 to ϕ_2 affects the analytical results as shown in tables 4.3 and 4.4, where the results of three different ratios of ϕ_1 to ϕ_2 are reported: When ϕ_1 increases (seen by moving from the first to the second lines in each three-line group in the tables) there is almost no change in target variables, but the welfare gain increases; when ϕ_2 decreases (seen by moving from the second to the third lines in each three-line group) the changes (in proportion) in both target variables and the welfare gain are substantial.

2. Step 2: $(\phi_1, \phi_2) = (1, 5)$ is chosen since it results in the maximum size of gains among the trial sets in step 1, as shown in table 4.4, and induces a reasonable interest rate discrepancy, i.e. $\hat{i} - \hat{i}^{RW} = 1.198\%$. The interest rate differential is used to define the moderate degrees of capital mobility which reflects Tobin's (1978) suggestion to reduce the efficiency in capital markets. The interest rate differentials corresponding to each set of values for ϕ_1 and ϕ_2 are reported in table 4.3. We will describe the values of ϕ_1 and ϕ_2 which lead to a higher (lower) interest rate differential than 1.198% as lower (higher) capital mobility values.

B. Size of Welfare Gains and Capital mobility

In existing studies, the welfare gain from co-ordination is defined as the difference in the welfare costs between a Cournot-Nash non-cooperative equilibrium and a cooperative equilibrium. However, we will also measure the gains from implementing exchange rate policy (whether cooperative or not) by the authorities compared with no policy. The size of welfare cost when the authorities undertake no policy, $(-U_o)^{1/2}$, can be used as a benchmark for interpreting the size of gains from co-ordination.

First, we will consider the case where there is a shift in the policy authorities' balance of payments target from zero to a 10% surplus (a "*target shock*"). We will measure the welfare gains both from co-ordination, $(-U_N)^{1/2} - (-U_C)^{1/2}$, and from non-cooperative reaction of the policy authorities, $(-U_o)^{1/2} - (-U_N)^{1/2}$. Since we assume 10% for the balance of payments target (BOP/exports ratio) and zero for other targets, if the authorities implement no policy inducing the target variables to be zero, then $(-U_o)^{1/2}$ is simply computed from the balance of payments target in the objective function; i.e. $(-U_o)^{1/2} = \{z_2 (\hat{r}^t)^2\}^{1/2}$. Thus, for the varying degrees of capital mobility, $(-U_o)^{1/2}$ is constant as shown in table 4.4. Also, as in chapter three, 1% of welfare gain is interpreted as equivalent to 1.04% change in GNP.

Second, we will consider the case of external shocks $(\hat{y}^{RW}, \hat{i}^{RW})$ from the ROW, while assuming zero for all three targets. An increase in ROW GNP is channeled through the current account and has positive cross-country effects on all three target variables. But, an increase in ROW interest rate is channeled through the capital account and has a negative cross-country effect only on the balance of payments. As above, we will measure both welfare gains; i.e. $(-U_N)^{1/2} - (-U_C)^{1/2}$ and $(-U_o)^{1/2} - (-U_N)^{1/2}$. But now, $(-U_o)^{1/2}$ is not caused by the BOP target, which is assumed zero this time. It is the welfare cost due to no reaction of the policy authorities to the external shocks which induce deviation of the target variables from their long-run equilibrium levels. Hence, the varying degrees of capital mobility affect the size of $(-U_o)^{1/2}$.

1. Welfare Gains with A "*Target Shock*" (positive BOP target)

As discussed in chapter three, the size of welfare gains from co-ordination is very small in our simulation compared to other studies (see Oudiz and Sachs, 1984; Oudiz, 1985; and Frankel and Rockett, 1988). For example, in table 4.4, the welfare gains measured in GNP equivalent units is around 0.00006% with moderate capital mobility, i.e. $(\phi_1, \phi_2) = (1, 5)$. This could be largely attributed to the lack of an adjustment channel between the balance of payments and the money stock in our model. If there were a channel, the balance of payments surplus would raise the money supply, reducing the interest rate and thus capital inflows, and increasing the aggregate demand and the product price and thus the employment rate. Then, we might have larger tradeoffs among the internal and the external targets. Also, the lowered net capital inflows due to the decreased interest rate might induce more depreciationary equilibria, increasing the level of welfare costs and thus the gains from co-ordination. Note that, in general, large welfare costs at the Cournot-Nash and cooperative solutions result in large difference between them, implying large absolute gains from co-ordination.

Although the size of gains from co-ordination is small, the welfare gains from the policy authorities' reaction to the target shock (even without cooperation) can be substantial. For instance, $(-U_o)^{1/4} - (-U_N)^{1/4}$ is 2.8% in GNP equivalent units with moderate capital mobility, (i.e. $(\phi_1, \phi_2) = (1, 5)$, see table 4.4). Also, given the same ratio of ϕ_1 to ϕ_2, these welfare gains are larger with higher capital mobility since the policy effects are stronger.

Generally, the size of ϕ_1 and ϕ_2 have opposite effects on the size of gains from co-ordination, as shown in tables 4.3 and 4.4. With a higher ϕ_2 (seen by moving from the third to the second lines in each three-line group in the tables), both the intercept and the slope of the reaction function decline, inducing a less depreciationary

Table 4.3 Changes in Selected Variables at Cournot-Nash Equilibrium with Various Capital Mobility Levels

Values of (ϕ_1,ϕ_2)	Selected Variables				
	Exchange Rate (% change)	Interest Rate Differential ($\hat{i}$ -$\hat{i}^{RW}$, %)	Inflation Rate (%)	Balance of Payments (ratio, %)	Employment Rate (% change)
(0,0)	3.337	2.840	0.6907	9.2507	1.0422
(1,5)E-3	3.333	2.837	0.6898	9.2531	1.0408
(5,5)E-3	3.333	2.837	0.6899	9.2543	1.0410
(5,1)E-3	3.337	2.840	0.6906	9.2526	1.0421
(1,5)E-2	3.295	2.805	0.6820	9.2744	1.0290
(5,5)E-2	3.299	2.808	0.6828	9.2855	1.0303
(5,1)E-2	3.333	2.837	0.6900	9.2693	1.0411
(1,5)E-1	2.954	2.514	0.6114	9.4457	0.9225
(5,5)E-1	2.974	2.532	0.6156	9.5114	0.9289
(5,1)E-1	3.292	2.802	0.6813	9.4056	1.0281
(1,5)	1.408	1.198	0.2914	9.8935	0.4396
(5,5)	1.413	1.203	0.2925	9.9320	0.4413
(5,1)	2.711	2.308	0.5611	9.8228	0.8467
(1,5)E+1	0.221	0.188	0.0456	9.9976	0.0689
(5,5)E+1	0.221	0.188	0.0457	9.9987	0.0689
(5,1)E+1	0.886	0.754	0.1833	9.9922	0.2766
(1,5)E+2	0.023	0.020	0.0048	10.0000	0.0073
(5,5)E+2	0.023	0.020	0.0048	10.0000	0.0073
(5,1)E+2	0.114	0.097	0.0235	9.9999	0.0355

Notes: 1. The exchange rate ($\hat{e}$) and the employment rate ($\hat{n}$) are percentage changes from the long-run rates; the inflation rate ($\hat{p}$), the interest rate ($\hat{i}$), and the balance of payments ($\hat{r}$) are the percentage point deviations from the long-run levels, where $\hat{r}$ is BOP/(long-run exports) ratio.

2. Welfare weights $(z_1,z_2,z_3) = (0.45, 0.1, 0.45)$ are used.

3. Each set of values of (ϕ_1,ϕ_2) is multiplied by a factor of 10, e.g. (1,5)E-2 = (0.01,0.05); except for the first row where no capital mobility is assumed, i.e. same as in chapter three.

4. Symmetric patterns in trade (pattern I) and capital flows (pattern A) are considered. (see ch. 3 for trading patterns)

Table 4.4 Sensitivity of Welfare Gains to Capital Mobility

Values of (ϕ_1,ϕ_2)	Welfare Costs $(-U_o)^{1/2}$, (%)	Welfare Costs $(-U_N)^{1/2}$, (%)	Welfare Gains (%) $(-U_o)^{1/2} - (-U_N)^{1/2}$	Welfare Gains (%) $(-U_N)^{1/2} - (-U_C)^{1/2}$	Welfare Gains $(-U_N)^{1/2}/(-U_C)^{1/2}$
(0,0)	3.16228	0.87153	2.29075	0.00001	1.0000071
(1,5)E-3	3.16228	0.87029	2.29199	0.00001	1.0000078
(5,5)E-3	3.16228	0.87029	2.29199	0.00001	1.0000097
(5,1)E-3	3.16228	0.87128	2.29100	0.00001	1.0000097
(1,5)E-2	3.16228	0.85933	2.30295	0.00001	1.0000120
(5,5)E-2	3.16228	0.85936	2.30292	0.00004	1.0000417
(5,1)E-2	3.16228	0.86909	2.29319	0.00004	1.0000431
(1,5)E-1	3.16228	0.76282	2.39946	0.00005	1.0000692
(5,5)E-1	3.16228	0.76337	2.39891	0.00060	1.0007921
(5,1)E-1	3.16228	0.84842	2.31386	0.00097	1.0011489
(1,5)	3.16228	0.35540	2.80688	0.00006	1.0001560
(5,5)	3.16228	0.35584	2.80644	0.00048	1.0013624
(5,1)	3.16228	0.68366	2.47862	0.00612	1.0090302
(1,5)E+1	3.16228	0.05541	3.10687	0.00000	1.0000074
(5,5)E+1	3.16228	0.05541	3.10687	0.00000	1.0000503
(5,1)E+1	3.16228	0.22257	2.93971	0.00039	1.0017527
(1,5)E+2	3.16228	0.00548	3.15680	0.00000	1.0000000
(5,5)E+2	3.16228	0.00548	3.15680	0.00000	1.0000005
(5,1)E+2	3.16228	0.02860	3.13368	0.00000	1.0000366

Notes: 1. 1% change in welfare costs or gains is interpreted as equivalent to around 1.04% change in GNP, using the formula $\hat{y} = \alpha\,(1/z_3)^{1/2}\,(-U)^{1/2}$, where $\alpha = 0.7$ and $z_3 = 0.45$.
2. $(-U_o)^{1/2}$ is the welfare cost caused by a change in the balance of payments target from zero to 10%, while implementing no policy and therefore inducing no change in the target variables; assuming zero for other targets, it is simply computed from the balance of payments target in the objective function, i.e. $(-U_o)^{1/2} = \{z_2(\hat{r}^t)^2\}^{1/2}$. Thus, for the varying degrees of capital mobility, $(-U_o)^{1/2}$ is constant.
3. Welfare weights $(z_1,z_2,z_3) = (0.45, 0.1, 0.45)$ are used.
4. Each set of values of (ϕ_1,ϕ_2) is multiplied by a factor of 10, e.g. (1,5)E-2 = (0.01,0.05); except for the first row where no capital mobility is assumed as in chapter three.
5. Symmetric patterns in trade (pattern I) and capital flows (pattern A) are considered. (see ch. 3 for trading patterns)

Cournot-Nash solution and thus smaller welfare costs and gains from co-ordination. But, the gains from non-cooperative policy compared with no policy action increase. With a higher ϕ_1 (seen by moving from the first to the second lines in each three-line group in the tables), the slope of the reaction function always increases and the intercept decreases, inducing a more depreciationary Cournot-Nash solution and thus larger welfare costs and gains from co-ordination; the gains from non-cooperative policy compared with no policy action slightly decrease. (For different parameter values, a higher ϕ_1 may induce a less depreciationary NE.)

We summarize the results:

First, when we assume moderate capital mobility in equation (4.1) the welfare gains from co-ordination increase substantially in terms of the proportion of thechange, although the size of the gains is still small. (This is seen in the last column of table 4.4, by moving from other three-line groups to the fourth group.)

Second, given the "*target shock*", the Cournot-Nash equilibrium is superior to no action taken by the policy authorities, especially when capital mobility is high as shown in table 4.4. The higher is capital mobility, the larger are the gains from policy implementation (seen by moving from the top row to the bottom row in the third column of table 4.4), because the policy effects are stronger. (Note that the size of welfare cost with no policy reaction to the "*target shock*" is constant regardless of the degree of capital mobility as shown in the first column of table 4.4.)

And third, as capital mobility between the small countries (ϕ_1) increases (seen by moving from the first to the second lines in each three-line group in table 4.4), the size of gains becomes larger. This is because the cross-country effects of the other country's policy increase more (in proportion) than the overall effects of own policy, although the size of the changes is the same, inducing a steeper reaction function and a less elliptical indifference curve on the $\hat{e}$ and $\hat{e}^*$ plane. However, as capital mobility between one small country and the ROW (ϕ_2) increases (seen by moving from the third to the second lines in each three-line group in table 4.4) then the reverse holds, because the relative size of the cross-country effects between the small countries is reduced. (Note that, with high ϕ_2, the small countries can pass the welfare costs caused by shocks to the passive ROW.) In other words, co-ordination can reduce the cost of the excessive depreciation involved in the non-cooperative equilibria more, as the size of cross-country effects of the exchange rate policy increases between the small countries. But, smaller cross-country effects induce less divergence between alternative equilibria, and thus, the size of gains from co-ordination decreases.

2. Welfare Gains with External Shocks (positive $\hat{y}^{RW}$ and $\hat{i}^{RW}$)

Here, we set the balance of payments target back at zero in order to focus on the effects of shocks from the ROW. We can examine Tobin's (1978) concern by comparing the size of welfare costs following shocks from the ROW, with various degrees of capital mobility. We assume that all "*unshocked*" variables in the ROW remain at their long-run equilibrium levels because of appropriate IS/LM shifts following some policies there.

An expansion of GNP in the ROW increases the balance of trade of the small countries, raising the interest rate through an IS curve shift, resulting in net capital inflows for these countries. Thus, the degree of capital mobility affects the size of the welfare costs. If the authorities do not react to the shock, the welfare cost $(-U_0)^{1/2}$ is large when capital mobility is high; for example, $(-U_0)^{1/2} = 187.6471$ when $(\phi_1, \phi_2) = (100, 500)$ in table 4.6. This is mainly due to the large positive deviation in the balance of

Table 4.5 Effects of External Shocks[1] on the Selected Variables at Cournot-Nash Equilibrium with Various Capital Mobility Levels

Values of (ϕ_1,ϕ_2)	Selected Variables: Exchange Rate (% change)	Interest Rate Differential ($\hat{i}$ - $\hat{i}^{RW}$, %)	Inflation Rate (%)	Balance of Payments (ratio, %)	Employment Rate (% change)
1. Effects of ROW GNP Increase (5%)					
(0,0)	-1.4784	1.1116	0.4607	-0.2292	0.1358
(1,5)E-2	-1.4752	1.1144	0.4614	-0.2255	0.1368
(1,5)E-1	-1.4513	1.1347	0.4663	-0.1967	0.1443
(1,5)	-1.3809	1.1946	0.4809	-0.0846	0.1663
(1,5)E+1	-1.3544	1.2172	0.4864	-0.0124	0.1746
(1,5)E+2	-1.3517	1.2195	0.4870	-0.0013	0.1754
2. Effects of ROW Interest Rate Increase (5%)					
(0,0)	0.0000	0.0000	0.0000	0.0000	0.0000
(1,5)E-2	0.0824	-4.9299	0.0170	-0.0181	0.0257
(1,5)E-1	0.7385	-4.3714	0.1528	-0.1386	0.2306
(1,5)	3.5192	-2.0045	0.7284	-0.2664	1.0991
(1,5)E+1	5.5136	-0.3069	1.1412	-0.0599	1.7219
(1,5)E+2	5.8361	-0.0324	1.2080	-0.0066	1.8227

Notes: 1. ROW GNP shock is channeled through the current account, and ROW interest rate shock is through the capital account.

2. The exchange rate ($\hat{e}$) and the employment rate ($\hat{n}$) are percentage changes from the long-run rates; the inflation rate ($\hat{p}$), the interest rate ($\hat{i}$), and the balance of payments ($\hat{r}$) are the percentage point deviations from the long-run levels, where $\hat{r}$ is BOP/(long-run exports) ratio.

3. Welfare weights (z_1,z_2,z_3) = (0.45, 0.1, 0.45) are used.

4. Each set of values of (ϕ_1,ϕ_2) is multiplied by a factor of 10, e.g. (1,5)E-2 = (0.01,0.05); except for the first row where no capital mobility is assumed as in chapter three.

5. Symmetric patterns in trade (pattern I) and capital flows (pattern A) are considered. (see ch. 3 for trading patterns)

Table 4.6 Effects of External Shocks[1] on Welfare Costs and Gains with Various Capital Mobility Levels

Values of	Welfare	Costs	
(ϕ_1,ϕ_2)	$(-U_o)^{1/2}$, (%)	$(-U_N)^{1/2}$, (%)	$(-U_C)^{1/2}$, (%)
1. Effects of ROW GNP Increase (5%)			
(0,0)	1.42077090	0.33027771	0.33027335
(1,5)E-2	1.43726470	0.33063107	0.33062820
(1,5)E-1	1.58770900	0.33331933	0.33331839
(1,5)	3.18864230	0.34239449	0.34237254
(1,5)E+1	19.90431700	0.34669214	0.34669087
(1,5)E+2	187.64710000	0.34721316	0.34721314
2. Effects of ROW Interest Rate Increase (5%)			
(0,0)	0.00000000	0.00000000	0.00000000
(1,5)E-2	0.01581130	0.00214832	0.00214830
(1,5)E-1	0.15811380	0.01907035	0.01906903
(1,5)	1.58113880	0.88850870	0.88837002
(1,5)E+1	15.81138800	1.38588770	1.38587740
(1,5)E+2	158.11388000	1.46681890	1.46681880

Notes: 1. ROW GNP shock is channeled through the current account, and ROW interest rate shock is through the capital account.
2. 1% change in welfare costs or gains is interpreted as equivalent to around 1.04% change in GNP, using the formula $\hat{y} = \alpha\,(1/z_3)^{1/2}\,(-U)^{1/2}$, where $\alpha = 0.7$ and $z_3 = 0.45$.
3. $(-U_o)^{1/2}$ is the welfare cost due to no reaction of the policy authorities to the external shocks which induce the target variables to deviate from their long-run equilibrium levels, where all the three targets are assumed to be zero. Hence, the varying degrees of capital mobility affect the size of $(-U_o)^{1/2}$.
4. Welfare weights $(z_1, z_2, z_3) = (0.45, 0.1, 0.45)$ are used.
5. Each set of values of (ϕ_1, ϕ_2) is multiplied by a factor of 10, e.g. (1,5)E-2 = (0.01,0.05); except for the first row where no capital mobility is assumed as in chapter three.
6. Symmetric patterns in trade (pattern I) and capital flows (pattern A) are considered. (see ch. 3 for trading patterns)

payments target.

An increase in the ROW interest rate results in net capital outflows from the small countries. Hence, the degree of capital mobility again matters for the size of welfare costs. (The shock has no effect on the internal target variables since the capital account has no impact on the real sector, unless the authorities optimize their objective function with exchange rate policy.) As shown in table 4.6, if the authorities do not implement exchange rate policy, the welfare cost $(-U_o)^{1/4}$ is large when capital mobility is high, solely due to the large negative gap in the balance of payments target.

Let us now clarify what Tobin (1978) suggests. The main concern of Tobin isthat, under fixed or flexible exchange rates, very efficient world capital markets restrain the capability of the policy authorities to adjust to the disturbances in capital markets without a significant sacrifice of the internal targets. Thus, he proposes to *"throw some sand in the wheels of excessively efficient international money markets"* by taxing all inter-currency transactions to reduce the efficiency in capital markets.

We can illustrate Tobin's proposal as follows: First, as shown in the first column of table 4.6, the welfare losses are large with no reaction of the authorities to the external shocks. This result supports the observation of Tobin that the massive capital flows caused by the disturbances in the excessively efficient capital markets create large welfare costs. We may be able to reduce these welfare costs by taxing all inter-currency transactions, as Tobin suggests, to reduce the efficiency in the capital markets. Second, however, as long as the authorities optimize through exchange rate policy, with or without co-ordination, the welfare costs ($(-U_N)^{1/4}$ or $(-U_C)^{1/4}$) can be reduced significantly (see the second and the third columns in table 4.6). In this case, the motivation is much weaker for imposing Tobin's tax on inter-currency transactions.

Meanwhile, as shown in table 4.6, the size of gains from co-ordination is still small; for example, for a ROW GNP shock of 5%, the welfare gain, $(-U_N)^{1/2} - (-U_C)^{1/2}$, is around 0.00002% in GNP equivalent units with moderate capital mobility of $(\phi_1, \phi_2) = (1, 5)$. For both GNP and interest rate shocks from the ROW, moderate capital mobility induces larger gains from co-ordination than high or low capital mobility.

C. Effects of Exchange Rate Policy and Capital Market Patterns

We have tested the effects of capital market patterns on the interaction of the policy authorities (i.e. change in the slope of the reaction function) and on the gains from co-ordination from each exchange rate policy. The degree of capital mobility between the home country and the ROW, ϕ_2, increases from 5 to 10 in pattern B; the level of capital mobility between the foreign country and the ROW, ϕ_2^*, decreases from 5 to 0 in pattern C; and the level of capital mobility between the small countries, $\phi_1 \equiv \phi_1^*$, decreases from 1 to 0 in pattern D. (See table 4.2 for a description of the capital market patterns.) The effects of exchange rate policy on the balance of payments and thus on the slopes of the reaction functions are different in each pattern.

As noted earlier, an increase in ϕ_1 ($\equiv \phi_1^*$) steepens the slope and an increase in ϕ_2 (or ϕ_2^*) induces the opposite. Hence when ϕ_1 ($\equiv \phi_1^*$) decreases in pattern D, the slope of the reaction function becomes flatter and the indifference curves become more elliptical; i.e. $d\hat{e}/d\hat{e}^*$ ($d\hat{e}^*/d\hat{e}$) is smaller for the Home (Foreign) country's indifference curves on the $\hat{e}$ and $\hat{e}^*$ plane such as in figures 2-1 and 3-1. Thus, as discussed in section II of chapter two, the distance between the Cournot-Nash and the cooperative equilibria decreases, reducing the absolute gains from co-ordination. On the contrary, an increase (decrease) in ϕ_2 (ϕ_2^*) in pattern B (C) flattens (steepens) the slope of the reaction function, and the indifference curves become more (less) elliptical. Thus, the gains from co-ordination decrease (increase) in pattern B (C).

The size of welfare gains in each pattern is consistent with the result in table 4.4. That is, when ϕ_1 ($\equiv \phi_1^*$) increases or ϕ_2 (or ϕ_2^*) decreases, the gains from co-ordination become larger since the cross-country effects of exchange rate policy between the small countries increase.

As in chapter three, "*Hegemonic Stability*" may be feasible contradicting Eichengreen's (1985) result. For example, in pattern B, where ϕ_2^* is lower than ϕ_2, the Foreign country is better off by taking leadership than other non-cooperative equilibria in response to its own money demand shock.

The numerical results of exchange rate policy on the values of the selected variables and the welfare levels in alternative equilibria in each pattern are reported in Appendix 4B.

V. Concluding Remarks

The cost of an efficient world capital market to macroeconomic policy (resulting from an excessive interdependence of policy) has often been discussed in the literature where perfect capital mobility has been assumed. However, the effects of capital market efficiency on the size of gains from policy co-ordination have never been discussed.

We have examined the following questions by testing the sensitivity of the size of welfare costs and the gains from co-ordination to the capital mobility levels assuming imperfect capital mobility: Can a less efficient capital market increase the welfare gains from policy co-ordination? Is policy intervention against the external shocks desirable, compared with no reaction of the authorities?

The following results are obtained:

(1) If the authorities do not react to the external shocks from the ROW, the welfare cost is large with high capital mobility. This result supports Tobin's suggestion to levy a tax on inter-currency transactions to reduce the excessive efficiency in capital market.

(2) The policy authorities, however, can reduce the welfare costs by reacting (even without cooperation) to the shock compared to no reaction, and this gain is significantly larger when capital mobility is higher. This result implies that the motivation is not strong for levying Tobin's tax.

(3) With asymmetry in economic structure induced by asymmetric patterns in capital flows, the Stackelberg leader-follower solution may be feasible, implying "*Hegemonic Stability*". This contrasts with the result of Eichengreen (1985).

(4) With a positive balance of payments target ("*target shock*") or the shocks from the ROW, moderate capital mobility induces substantially (in terms of the proportion of change) larger welfare gains from co-ordination than in the case of extremely high or low capital mobility.

(5) When the degree of capital mobility between the small countries increases, the size of gains from co-ordination increases, but if capital mobility between small countries and the ROW increases then the reverse holds.

Our framework has shed some light upon the above issues. However, we have assumed that the money supply is exogenous (perfect sterilization) in the short-run, to reduce the analytical complexity. This restriction seems to have caused the absolute size of welfare gains from co-ordination to be very small in our simulation compared to other studies. The possible impacts of the increase in the money supply on the inflation and the employment rates, which would have induced larger tradeoffs among targets, were not captured. This assumption needs to be relaxed for future extension.

APPENDIX 4A

Derivation of The Balance of Payments Equation

A. Model

The derivation of equation (4.1) is described here in detail. The variables denoted by upper case letters and the nominal interest rate i are in level form. The superscripts ^{L}, ^{S}, and ^ denote the long-run, short-run, and the deviation from the long-run equilibrium value. Most of the variables are defined in table 3A. The additional variables and coefficients in chapter four are defined in table 4A.

Table 4A Definitions of Variables and Coefficients Undefined in Table 3A

Endogenous variables		
S	=	nominal product price
X	=	real exports
x	=	real exports in logarithmic form
IM	=	real imports
im	=	real imports in logarithmic form
T	=	real balance of trade
K	=	nominal net capital inflows
K_1	=	nominal net capital inflows from the foreign country
K_2	=	nominal net capital inflows from the rest of the world
R	=	nominal balance of payments
Exogenous variables		
E	=	nominal exchange rate (domestic currency price of one unit of ROW currency)
c_2	$\equiv$	e^E, expected rate of depreciation in domestic currency
Coefficients		
Φ_1	=	interest rate sensitivity of capital flows between the home country and the foreign country
Φ_2	=	interest rate sensitivity of capital flows between the home country and the rest of the world
ϕ_1	=	Φ_1 divided by the long-run real exports (X^L)
ϕ_2	=	Φ_2 divided by the long-run real exports (X^L)

The Balance of Payments:

$$R = ST + K \quad \text{where } T = X - IM,\; K = K_1 + K_2$$

$$K_1 = \Phi_1 \{i - i^* - (e^E - e) + (e^{E*} - e^*)\}$$

$$= \Phi_1 \{i - i^* - c_2 + c_2^*\}$$

$$K_2 = \Phi_2 \{i - i^{RW} - (e^E - e) + (e^{ERW} - e^{RW})\}$$

$$= \Phi_2 \{i - i^{RW} - c_2 + c_2^{RW}\}$$

where

$\Phi_1 = \Phi_1^*$,

Φ_2 is assumed to be larger than Φ_1,

K_1 and K_2 are net capital inflows in two separate capital markets.

$$\Delta R = \Delta(ST) + \Delta K$$

$$\approx T\,\Delta S + S\,\Delta T + \Delta K_1 + \Delta K_2$$

$$= T^L(S^S - S^L) + S^L(T^S - T^L) + (K_1^S - K_1^L) + (K_2^S - K_2^L)$$

Assuming $S^L = 1$ and $T^L = 0$, which are the values we always begin with in the simulations,

$$\Delta R \approx (T^S - T^L) + (K_1^S - K_1^L) + (K_2^S - K_2^L)$$

Thus,

$$\hat{r} = \Delta R/S^L X^L = \Delta R/X^L$$

$$\approx (T^S - T^L)/X^L + (K_1^S - K_1^L)/X^L + (K_2^S - K_2^L)/X^L$$

$$= \hat{t} + (\Phi_1/X^L)\{\hat{i} - \hat{i}^* - \hat{c}_2 + \hat{c}_2^*\} + (\Phi_2/X^L)\{\hat{i} - \hat{i}^{RW} - \hat{c}_2 + \hat{c}_2^{RW}\}$$

$$= \hat{t} + \phi_1\{\hat{i} - \hat{i}^* - \hat{c}_2 + \hat{c}_2^*\} + \phi_2\{\hat{i} - \hat{i}^{RW} - \hat{c}_2 + \hat{c}_2^{RW}\}$$

where $\phi_1 = \Phi_1/X^L$, $\phi_2 = \Phi_2/X^L$, and r is defined as the short-run nominal balance of payments divided by long-run nominal exports, i.e. $r = R^S/S^L X^L = R^S/X^L$ since S^L is assumed to be one.

The modified or the additional parametric constants used in equations (4.2) and (4.3) are defined as follows:

$$G = A\theta_1 + (b_2 + b_4)\alpha_1 - (\phi_1 + \phi_2)\pi_1\alpha_1/\pi_2 - (\phi_1 + \phi_2)\beta_1\theta_1/\pi_2 + \phi_1\beta_2^*\theta_1/\pi_2^*$$

$$H = (a_1 + b_1)\theta_1^* + a_2\alpha_1^* + (\phi_1 + \phi_2)\beta_2\theta_1^*/\pi_2 - \phi_1\pi_1^*\alpha_1^*/\pi_2^* - \phi_1\beta_1^*\theta_1^*/\pi_2^*$$

$$I = A + (\phi_1 + \phi_2)(1 - \beta_1)/\pi_2 + \phi_1\beta_2^*/\pi_2^*$$

$$J = (a_1 + b_1) + (\phi_1 + \phi_2)\beta_2/\pi_2 + \phi_1(1 - \beta_1^*)/\pi_2^*$$

$$L = (a_3 + b_3) + (\phi_1 + \phi_2)\beta_3/\pi_2 - \phi_1\beta_3^*/\pi_2^*$$

$$x_2' = I - H(CE^* - DZ^*)/(CC^* - ZZ^*) - G(C^*D - E^*Z)/(CC^* - ZZ^*)$$

$$y_2' = J - H(CD^* - EZ^*)/(CC^* - ZZ^*) - G(C^*E - D^*Z)/(CC^* - ZZ^*)$$

$$q_2' = GC^*\gamma_1/(CC^* - ZZ^*) - HZ^*\gamma_1/(CC^* - ZZ^*) + (\phi_1 + \phi_2)/\pi_2$$

$$t_2' = HC\gamma_1^*/(CC^* - ZZ^*) - GZ\gamma_1^*/(CC^* - ZZ^*) + \phi_2/\pi_2^*$$

$$\Omega_1 = z_1x_1y_1 + z_2x_2'y_2' + z_3x_3y_3, \quad \Omega_6 = z_2x_2'\phi_1$$

$$\Omega_2 = z_2x_2'q_2' - z_1x_1q_1 - z_3x_3q_3, \quad \Omega_7 = z_1x_1$$

$$\Omega_3 = z_1x_1t_1 + z_2x_2't_2' + z_3x_3t_3, \quad \Omega_8 = z_2x_2'$$

$$\Omega_4 = z_2x_2'\phi_2, \quad \Omega^9 = z_3x_3$$

$$\Omega_5 = z_2x_2'(\phi_1 + \phi_2), \quad \Omega_{10} = z_1x_1^2 + z_2x_2'^2 + z_3x_3^2$$

B. **Algebraic Analysis of Reduced Form Multipliers**

Here we proove that the $t_2' > 0$, and $x_2' > y_2' > 0$; i.e. in equation (4.2), the effect of an increase in the foreign money supply on domestic balance of payments is positive, that of a foreign exchange rate depreciation is negative, and the slope of the reaction function (4.3), Ω_1/Ω_{10}, is less than 1. Since the two small countries are assumed to be symmetric in patterns I and A, we ignore the notation for the foreign country, *, in the following analysis.

The assumptions used in Appendix 3A are summarized as:

Assumption 1: $D > E > 0$. ($C > Z > 0$ if $E > 0$.)

Assumption 2: $\beta_1 > \beta_2$.

Assumption 3: $a_2 = a_4 = b_2 = b_4$.

Assumption 4: $(CE - DZ) > 0$.

Assumption 5: $1/a_2 > (a_3 + b_3)/(a_1 + b_1) - 1$.

Proposition 1: y_2' is positive.

Proof: Let $\Delta y_2 = y_2' - y_2$.

Since $y_2 > 0$ (Proposition 6 in Appendix 3A), if $\Delta y_2 > 0$ then $y_2' > 0$.

$$\begin{aligned}\Delta y_2(C^2 - Z^2)\pi_2 &= \{(\phi_1 + \phi_2)\beta_2 + \phi_1(1 - \beta_1)\}(C^2 - Z^2) \\ &\quad - \{(\phi_1 + \phi_2)\beta_2\theta_1 - \phi_1\pi_1\alpha_1 - \phi_1\beta_1\theta_1\}(CD - EZ) \\ &\quad - \{\phi_1\beta_2\theta_1 - (\phi_1 + \phi_2)\pi_1\alpha_1 - (\phi_1 + \phi_2)\beta_1\theta_1\}(CE - DZ) \\ &= (\phi_1 + \phi_2)\beta_2\{(C^2 - Z^2) - \theta_1(CD - EZ)\} + \phi_1\theta_1\{\beta_1(CD - EZ) - \beta_2(CE - DZ)\} \\ &\quad + \phi_1(1 - \beta_1)(C^2 - Z^2) + \phi_1\pi_1\alpha_1(CD - EZ) + (\phi_1 + \phi_2)(\pi_1\alpha_1 + \beta_1\theta_1)(CE - DZ)\end{aligned}$$

From assumptions above, $\beta_1 > \beta_2$, $(C^2 - Z^2) > 0$, and $(CD - EZ) > (CE - DZ) > 0$. Hence, if $(C^2 - Z^2) > \theta_1(CD - EZ)$ then $\Delta y_2 > 0$.

$$(C^2 - Z^2) - \theta_1(CD - EZ) = C(C - D\theta_1) - Z(Z - E\theta_1).$$

$$(C - D\theta_1) = \alpha_1\pi_2(1 + 2a_2) + \alpha_1(\pi_1 + \theta_1)\gamma_1,\ (Z - E\theta_1) = \alpha_1\pi_2 a_2,\ C > Z > 0.$$

Thus $\Delta y_2 > 0$ and $y_2' > 0$.

<u>*Proposition 2*</u>: $x_2' > y_2'$.

Proof: $x_2' - y_2' = (I - J)(C + Z)(C - Z) - (G - H)\{(CD - EZ) - (CE - DZ)\}$

$$= (C + Z)\{(I - J)(C - Z) - (G - H)(D - E)\}$$

$$(I - J) = [\{A - (a_1 + b_1)\} + \phi_2\beta_3/\pi_2]$$

$$(G - H) = [\{A - (a_1 + b_1)\}\theta_1 + \alpha_1 a_2 - \phi_2\pi_1\alpha_1/\pi_2 - \phi_2(1 - \beta_3)\theta_1/\pi_2]$$

$$(C - Z) = \{\alpha_1(1 + b_2 + b_4)\pi_2 - \pi_2 a_2\alpha_1 + (\pi_1\alpha_1 + \theta_1)\gamma_1 + \theta_1(D - E)\}$$

$$= \theta_1(D - E) + \alpha_1(1 + a_2)\pi_2 + (\pi_1\alpha_1 + \theta_1)\gamma_1$$

$$(I - J)(C - Z) = \{A - (a_1 + b_1)\}\theta_1(D - E) + \theta_1(D - E)\phi_2\beta_3/\pi_2$$

$$+ [\{A - (a_1 + b_1)\} + \phi_2\beta_3/\pi_2]\alpha_1\pi_2$$

$$+ [\{A - (a_1 + b_1)\} + \phi_2\beta_3/\pi_2]\alpha_1 a_2\pi_2$$

$$+ [\{A - (a_1 + b_1)\} + \phi_2\beta_3/\pi_2](\pi_1\alpha_1 + \theta_1)\gamma_1$$

$$(G - H)(D - E) = \{A - (a_1 + b_1)\}\theta_1(D - E) + \alpha_1 a_2(D - E) - (D - E)\phi_2\pi_1\alpha_1/\pi_2$$

$$- (D - E)\phi_2(1 - \beta_3)\theta_1/\pi_2$$

$$= \{A - (a_1 + b_1)\}\theta_1(D - E) + \alpha_1 a_2[\{A - (a_1 + b_1)\}\pi_2 - \beta_3\gamma_1]$$

$$- (D - E)\phi_2\pi_1\alpha_1/\pi_2 - \theta_1(D - E)\phi_2/\pi_2 + \theta_1(D - E)\phi_2\beta_3/\pi_2$$

Thus,

$$\{(I - J)(C - Z) - (G - H)(D - E)\}$$

$$= (a_3 + b_3)\alpha_1\pi_2 + \phi_2\beta_3\alpha_1(1 + a_2) + (a_3 + b_3)(\pi_1\alpha_1 + \theta_1)\gamma_1 + \phi_2\beta_3(\pi_1\alpha_1 + \theta_1)\gamma_1/\pi_2$$

$$+ \alpha_1 a_2\beta_3\gamma_1 + (D - E)\phi_2\pi_1\alpha_1/\pi_2 + (D - E)\phi_2\theta_1/\pi_2$$

> 0, and so $x_2' > y_2'$.

Note that the slope of the reaction function is less than one because $x_1 > y_1$, $x_2' > y_2'$, and $x_3 > y_3$.

APPENDIX 4B

Tables for the Numerical Results

TABLE A Description of Equilibria with a Balance of Payments Target Shock (10%) in Pattern A

	Home	Country					
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{r}$	$\hat{n}$	$\hat{i}$	U
NE	1.4077	1.4077	0.2914	9.8935	0.4396	1.1982	-0.126312E-6
SE_L	1.4071	1.4074	0.2912	9.8872	0.4394	1.1975	-0.126308E-6
SE_F	1.4074	1.4071	0.2914	9.8935	0.4396	1.1981	-0.126295E-6
CE	1.4049	1.4049	0.2908	9.8737	0.4388	1.1958	-0.126272E-6
BP	-2.5236	-7.0000	0.1248	9.9918	-0.0415	0.1914	-0.007788E-6
SRF = 0.467585,			INT = 0.007495				

Notes: 1. A shift in the balance of payments target from zero to 0.1 is referred to as a target shock.
2. The exchange rate ($\hat{e}$) and the employment rate ($\hat{n}$) are percentage changes from the long-run rates; the inflation rate ($\hat{p}$), the interest rate ($\hat{i}$), and the balance of payments ($\hat{r}$) are the percentage point deviations from the long-run levels, where $\hat{r}$ is BOP/(long-run exports) ratio.
3. NE - Nash equilibrium, SE_L (SE_F) - Stackelberg equilibrium as a leader (follower), CE - cooperative equilibrium, BP - bliss point, SRF - slope of the reaction function, INT - Intercept of the reaction function.

TABLE B Description of Equilibria with a Balance of Payments Target Shock (10%) in Pattern B

	Home		Country				
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{r}$	$\hat{n}$	$\hat{i}$	U
NE	1.0364	1.2341	0.1859	9.9954	0.2907	0.7789	-0.053800E-4
SE_L	1.0363	1.2340	0.1859	9.9952	0.2907	0.7788	-0.053800E-4
SE_F	1.0362	1.2336	0.1859	9.9954	0.2907	0.7788	-0.053794E-4
CE	1.0353	1.2327	0.1858	9.9439	0.2904	0.7781	-0.053793E-4
BP	-2.1328	-6.0000	0.1176	9.9930	-0.0211	0.2057	-0.006427E-4
SRF = 0.438100,			INT = 0.004958				

	Foreign		Country				
	$\hat{e}^*$	$\hat{e}$	$\hat{p}^*$	$\hat{r}^*$	$\hat{n}^*$	$\hat{i}^*$	U^*
NE^*	1.2341	1.0364	0.2840	9.8978	0.4184	1.1538	-0.116113E-4
SE_L^*	1.2336	1.0362	0.2839	9.8923	0.4182	1.1532	-0.116110E-4
SE_F^*	1.2340	1.0363	0.2840	9.8978	0.4184	1.1537	-0.116110E-4
CE^*	1.2327	1.0353	0.2837	9.8862	0.4179	1.1524	-0.116096E-4
BP^*	-2.5236	-7.0000	0.1248	9.9918	-0.0415	0.1914	-0.007788E-4
SRF^*= 0.467585,			INT^*= 0.007495				

Note: See notes in table A.

TABLE C Description of Equilibria with a Balance of Payments Target Shock (10%) in Pattern C

	Home Country						
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{r}$	$\hat{n}$	$\hat{i}$	U
NE	1.9700	2.6104	0.3152	9.8794	0.5085	1.3422	-0.162499E-4
SE_L	1.9691	2.6098	0.3150	9.8703	0.5081	1.3412	-0.162491E-4
SE_F	1.9645	2.5985	0.3150	9.8795	0.5078	1.3408	-0.162120E-4
CE	1.9543	2.5877	0.3129	9.8119	0.5047	1.3325	-0.162237E-4
BP	-2.5236	-7.0000	0.1248	9.9918	-0.0415	0.1914	-0.007788E-4
SRF = 0.467585,			INT = 0.007495				

	Foreign Country						
	$\hat{e}^*$	$\hat{e}$	$\hat{p}^*$	$\hat{r}^*$	$\hat{n}^*$	$\hat{i}^*$	U^*
NE^*	2.6104	1.9700	0.6329	9.5295	0.9220	2.5566	-0.584938E-4
SE_L^*	2.5985	1.9645	0.6295	9.4742	0.9173	2.5432	-0.584617E-4
SE_F^*	2.6098	1.9691	0.6328	9.5296	0.9219	2.5564	-0.584830E-4
CE^*	2.5877	1.9543	0.6272	9.4420	0.9138	2.5337	-0.583924E-4
BP^*	-2.9363	-8.0000	0.1243	9.9936	-0.0724	0.1471	-0.009313E-4
SRF^*= 0.556336,			INT^*= 0.015144				

Note: See notes in table A.

TABLE D Description of Equilibria with a Balance of Payments Target Shock (10%) in Pattern D

	Home Country						
	$\hat{e}$	$\hat{e}^*$	$\hat{p}$	$\hat{r}$	$\hat{n}$	$\hat{i}$	U
NE	1.4052	1.4052	0.2908	9.8758	0.4388	1.1961	-0.126273E-4
SE_L	1.4051	1.4052	0.2908	9.8753	0.4388	1.1960	-0.126273E-4
SE_F	1.4052	1.4051	0.2908	9.8758	0.4388	1.1961	-0.126272E-4
CE	1.4049	1.4049	0.2908	9.8737	0.4388	1.1958	-0.126272E-4
BP	-2.1627	-8.0000	0.3962	9.8879	0.2982	1.2099	-0.111913E-4
SRF = 0.379355,			INT = 0.008721				

Note: See notes in table A.

CHAPTER FIVE

SUMMARY AND CONCLUDING REMARKS

I. Summary and Conclusions

The growing integration of the world economy and interdependence of economic policies among industrial countries have led to an extensive literature on the subject of international policy co-ordination. One of the major issues discussed in this literature is whether the policy authorities can obtain welfare gains from international co-ordination and if so, how large these gains are. Although many earlier writings predicted mutual gains from international policy co-ordination, recently numerous empirical studies indicate that the size of gains from co-ordination is small, even negative in some cases. Thus, there have been various attempts recently to find cases where policy co-ordination pays. The other issue concerns the feasibility of the Stackelberg leadership of a dominant country, so-called "*Hegemonic Stability*" (see Eichengreen (1985, 1987)).

Previous studies involve a wide variety of modelling strategies as shown in chapter two. Some common features among them are: (1) the money supply (sometimes with fiscal policy) as a policy instrument, (2) two policy targets (usually internal), (3) a two-country model, and (4) symmetry between countries.

The present thesis extends the literature by developing a Keynesian three-country model to examine the issue of policy co-ordination between two small countries. The exchange rate was used as the instrument of monetary policy for pursuing three targets -- the inflation rate, the employment rate, and the balance of payments. Through simulations we measured the size of gains from co-ordination in GNP equivalent units, and we examined several suggestions made in previous studies.

In chapter two, the literature was briefly surveyed and the differences between existing studies were compared in selected categories.

In chapter three, assuming no capital mobility to focus on the effects of trade price elasticities on the welfare gains from co-ordination, we investigated the following three issues: (1) Can higher interdependence between the small countries, measured as the ratio of transmission effects to own effects of policy, increase the gains from co-ordination as Canzoneri and Minford (1986) presume? (2) Do low trade price elasticities induce large welfare gains from co-ordination as Turnovsky and d'Orey (1986) argue? These two issues were reviewed by a sensitivity test of the gains from co-ordination to the trade price elasticities. (3) Is "*Hegemonic Stability*" feasible between asymmetric economies? We examined this question, raised by Eichengreen (1985, 1987), assuming asymmetric trading patterns. This issue was examined again in chapter four assuming asymmetric capital flows.

Meanwhile, many economists have noted that the integration of world capital markets (say, perfect capital mobility) causes excessive interdependence of macroeconomic policy. Tobin (1978) suggested that we should make the international capital market less efficient by imposing a tax on all inter-currency transactions; Dornbusch (1988) has supported this proposal. To investigate this issue in chapter four, we assumed varying degrees of capital mobility based on imperfect substitutability in assets as in Oudiz and Sachs (1984). By a sensitivity test of the welfare losses from shocks, originating at the rest of the world (ROW), to the capital mobility levels, we examined whether capital market efficiency increases these welfare losses as Tobin suggests. We also examined whether policy intervention against the shocks is desirable, compared with no reaction from the authorities.

In brief, results in this thesis can be summarized as follows where (1), (2), and (3) are found in chapter three, and (3), (4), (5), and (6) in chapter four:

(1) The size of welfare gains from co-ordination is very small. But in general, the gains from co-ordination are larger when overall trade price elasticities are lower, confirming the finding of Turnovsky and d'Orey.

(2) When the trade price elasticities with the ROW increase, both interdependence between the small countries and the gains from co-ordination decrease, supporting the Turnovsky-d'Orey and Canzoneri-Minford results. In other words, the small countries can shift the welfare costs from the "*target shock*" to the passive ROW.

However, when the trade price elasticities between the small countries increase, enhancing interdependence between them, support for their results depends on the levels of trade price elasticities with the ROW. The gains from co-ordination increase significantly if the trade price elasticities with the ROW are low, in contrast with (in support with) the suggestion of Turnovsky and d'Orey (Canzoneri and Minford). But the gains from co-ordination decrease slightly if these trade price elasticities with the ROW are high, in contrast with (in support with) the result of Canzoneri and Minford (Turnovsky and d'Orey).

(3) Two symmetric countries are generally considered in the literature. In our analysis, however, asymmetric trading and capital market patterns provide one way to analyze the effects of asymmetry in policy co-ordination. With asymmetry in economic structure, the leader-follower noncooperative co-ordination may be feasible,

implying "*Hegemonic Stability*" in international co-ordination: Followership is superior to leadership for one country, while leadership dominates over followership for the other country. Also the leader can gain (compared to the Cournot-Nash solution) more than the follower. This result contrasts with Eichengreen's (1985) finding that the Stackelberg leadership is not feasible even with asymmetry because both countries prefer being the follower.

(4) With no reaction from the policy authorities, massive capital flows following the shocks from the ROW cause large welfare losses, supporting Tobin's observation.

(5) As long as the authorities actively optimize their objective function using exchange rate policy, they can reduce the welfare costs significantly, with or without co-ordination. Compared with no reaction from the authorities, this gain from policy reaction is larger with higher capital mobility. Thus the motivation for levying Tobin's tax on inter-currency transactions is weaker when we allow for or assume a policy response.

(6) Analogous to the results in (2), the gains from co-ordination are larger when capital mobility between the small countries increases. When capital mobility between small countries and the ROW increases, then the reverse holds.

In conclusion, our three-country framework sheds some light upon the issue of policy co-ordination between small economies. A two-country model implicitly assumes co-ordination between fairly large economies, such as the U.S. and the ROW or the U.S. and the non-U.S. OECD countries, which have a large share in world trade and which are sensitive to the other party's policy. Our three-country setting emphasizes the co-ordination problem between small export-oriented economies such as NICs, while the ROW is assumed to be too large to be influenced by these countries' policies and so is passive in the game. The links between the small countries and the ROW play a crucial role in our main results. When the goods or financial assets transactions of the small countries are sensitively linked (high trade price elasticity or capital mobility) to the ROW, the benefits of joint policy-making between the small economies turn out to be very small. However, our model has some drawbacks which will be noted in the next section, with a few suggestions for future extension.

II. Suggestions For Future Research

The following issues ought to be explored for further research:

A. Non-Passive Rest of The World

In our model, for analytical symplicity, we assumed that the ROW is not affected by the outcome of the game between small countries, and thus it remains at the long-run equilibrium level and passive in the game. That is, the variables of the ROW were treated as exogenous. Modelling the ROW similarly to the small countries, however, would allow for changes in the ROW economy following the small countries' policies, and therefore repercussion effects on the small economies. Then we could analyze co-ordination between small countries with varying characteristics of the ROW, or co-ordination between one small country and the large ROW.

B. Asymmetry

In theoretical literature, symmetry has been generally assumed between two countries. Hence asymmetry in the size of the economies, economic environments and preferences, and the authorities' perception of the economic system has been commonly ignored. There is no doubt that we should take these asymmetric features for more plausible modelling. The following measures of asymmetry can be considered.

1. Size of Country: In our model, we imposed asymmetry between small countries by assuming different patterns in trade and capital flows based on structural parameters such as the trade price elasticity and the interest rate elasticity of financial assets demand (capital mobility). But, since the relative price and interest rate elasticities are based on substitutability between goods or assets, which rely on the characteristics of goods or assets and their demand, they do not necessarily coincide with the size of country.

The values of reduced-form parameters (policy multipliers) may be used for this purpose. As shown in Eichengreen (1987), the ratio of transmission effect to own effect (defined as interdependence in Canzoneri and Minford (1986) and our analysis) may be assumed to be low for a large country.

2. Openness of Country: We could consider asymmetry in the degree of "*openness*" of an economy to the world trade -- the ratio of exports to GNP. In our model, we assumed that this ratio equals the marginal propensity to save out of income, in order to set the parameter of the balance of trade in the aggregate demand equation to one (see Appendix 3A). The country which has a higher export/GNP ratio could be more sensitive to a policy or shocks abroad.

3. Economic Environment and Preferences: Asymmetric economic situation in the baseline should be considered. As we noted earlier, the preferences for targets (marginal utilities) at the baseline depends on the economic environment. One country may have inherited inflation while the other has severe recession and

unemployment. The first country would take an anti-inflationary (contractionary) stance while the second country would take an expansionary position. Then the authorities will decide what target variables to be included in the objective function, which also relates to the issue of how to choose "*optimal*" welfare weights or target values. Which target should be considered more important to the economy given the initial economic environment would depend on the attitude of the policy makers.

4. Disagreement about The Model: This issue was raised in Frankel and Rockett (1988) with a conclusion that cooperation may result in welfare losses. Each country may believe a different size or sign for the policy effects. Even with symmetric economies, the authorities' reaction can be asymmetric based on their belief about the true policy effects. This issue can be addressed by using different sets of parameter values -- true vs wrong. It may involve asymmetric modelling of supply side of the economy. For example, assume nominal wage rigidity for one country while real wage rigidity is assumed for the other.

5. Policy Instruments: We could consider the case where each country uses a different policy instrument. One example is found in the recent episode in the mid 1980s among the U.S., Japan, and the NICs (Newly Industrialized Countries). The U.S used money supply policy under a flexible exchange rate, some NICs fixed their currencies to the U.S. dollar by putting a large weight on the U.S. dollar in the central bank currency basket, and Japan used expansionary fiscal policy to ease the pressure from the U.S. to reduce Japan's trade surplus against the U.S.. Even in a case of symmetric economies, since the policy multipliers could be different in sign or size for each instrument, we can expect an asymmetric outcome of the game.

C. Dynamic Features

In our model, we ignored the dynamic elements of policy co-ordination to avoid analytical complexity in the three-country model. Thus the money supply was assumed to be exogenous (i.e. perfect sterilization) in the impact period under a fixed exchange rate system. This restriction constrained our ability to analyze the effects of the balance of payments surplus on the economy through the money supply change under a fixed exchange rate. The following extensions can be taken.

1. Intrinsic Dynamics: We may introduce intrinsic dynamics by specifying a money-stock-accumulation equation which equates the change in money supply to the change in foreign reserves (the balance of payments). With this channel, the strong assumption of perfect sterilization policy can be relaxed. By assuming interest rate parity (which captures the LM curve shift due to the money supply change), we can introduce perfect capital mobility, which was excluded in our model. Under perfect capital mobility, as in Oudiz and Sachs (1984) who assume a flexible exchange rate, the balance of trade can be used as an external target variable instead of the balance of payments. But under a fixed exchange rate, the huge capital inflows following a depreciation might increase the foreign reserve stock to be higher than a desired level. Thus the motivation for pursuing the current account surplus would be weaker. Also, to analyze the intertemporal effects of the balance of payments on the economy and the "*time consistency*" issue, we need to introduce a fully dynamic model, either in discret or continuous time.

2. Dynamic Analysis

(1) The intertemporal effects of the balance of payments on the economy can be analyzed, under either imperfect or perfect capital mobility in a fully featured dynamic

model. Under perfect capital mobility, a depreciation shifts both IS and LM curves via current account surplus and capital inflows. (Note that the LM shift effect of capital flows was not captured in our static analysis.) A larger income effect on foreign exports and lowered foreign inflation would induce a positive transmission effect on the foreign country. Since inflation and the employment rate also increase significantly, the tradeoff among the target variables would be larger, increasing welfare costs. Then the absolute welfare gains from co-ordination might be larger.

(2) The Time Consistency Issue: In a single-period game with money supply policy, cooperation can increase welfare level by an international commitment to expand, preventing contractionary bias at the Cournot-Nash solution. However, in a dynamic multi-period game, the outcomes are different.

One of the major issues discussed in dynamic co-ordination analyses is the problem of "*time inconsistency*" (or crediblility) of government policy announcements, which arises from the inability of the current government to bind the actions of future governments or of themselves in the future. Many authors find that the inability to bind the future policies leads to an inflationary bias to the economy (see Miller and Salmon (1985), Rogoff (1983, 85), Barro and Gordon (1983)). Rogoff, for example, argues that cooperation between central banks exacerbates this bias because cooperation removes currency depreciation for both countries and thus increases the output-inflation tradeoff compared to unilateral expansion. Thus, the authorities are tempted to implement more expansionary policy than the announced policy. The forward-looking private agents, who demand a higher nominal wage rate before the policy is implemented, lead to higher inflation and a welfare loss from "*time-consistent*" international co-ordination.

In a fully featured dynamic model, we can analyze the time consistency issue by assuming rational expectations of the private agents for inflation or forward-looking wage setters as in Rogoff (1983, 85). (We assume here a positive balance of trade target and a full employment rate target as in present thesis for discussion.) If the authorities pursue a current account surplus under perfect capital mobility, huge capital inflows following a depreciation would increase inflation and the employment rate significantly. Expected inflation as a positive function of the employment rate would increase, reducing real investment. Suppose that co-ordination induces a less depreciationary policy. Analogously with other studies, this policy may not be credible since cooperation can result in lower inflation and the government might be tempted to depreciate further. Then the private sectors expect higher inflation and reduce more real investment, decreasing excessive employment rate. Thus the time-consistent cooperative solution may increase welfare level. If we assume forward-looking wage setters, the higher expected inflation would increase wage rate and actual inflation rate. Then we may find a welfare-reducing time-consistent cooperative solution as in Rogoff.

(3) Dynamic Stackelberg Game: Turnovsky-Basar-d'Orey (1988) find that Stackelberg leadership has an advantage over equal-split cooperation, which dominates the Cournot-Nash solution, and Stackelberg followership is the worst. (Note that these solutions are all time consistent.) According to them, the Stackelberg leader has enough time to exploit his position in the long run. This result contrasts with Miller and Salmon's (1985), where the Stackelberg leadership is not preferable. Following the dynamic Stackelberg equilibrium concepts in Turnovsky-Basar-d'Orey (1988), we would be able to analyze "*Hegemonic Stability*" issue in dynamic

framework.

Finally, despite these possibilities for future works, we feel that the present study has contributed to our understanding of co-ordination issue. To my knowledge, this thesis has been the first in a theoretical literature, to use three countries, to use three targets, and to use an exchange rate as a policy instrument in an operable model.

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