

Economic Policies in Developing and Emerging Market Economies

Three Essays in International and Development Economics

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Abstract

This thesis consists of three essays, which focus on different aspects of economic policy issues faced by developing and emerging market economies. The first essay explores the effect of monetary policy credibility on exchange rate volatility in a small open economy, even if the exchange rate is not an explicit target set by the monetary authority. Using an open economy framework modified from Galí and Monacelli (2005) and Walsh (2006), it shows that monetary policy credibility helps to stabilize the exchange rate as supply and demand side shocks hit the domestic economy. The monetary policy credibility can be achieved by the monetary authority's commitment to certain rules aiming for output/price smoothing. In the empirical analysis inflation targeting is used as a proxy variable for monetary credibility. The GARCH model of selected South-East Asian countries indicates that countries with inflation targeting policies have exhibited reduced exchange rate volatility when other factors are controlled.

The second essay looks at FDI inflows into developing economies. Two distinctive differences of FDI inflows between developed and developing economies are entry modes and evidence of government regulations. This essay investigates the incentives of FDI flows in terms of cost-saving merger, fixed cost of entry and the role of government policies. In particular it shows that, if the cost-saving effect is large and the government intervenes, the foreign firm will consider the FDI through either Greenfield or Brownfield, which corresponds to the situation for FDI

flows into developing economies. Otherwise, the foreign firm will only consider Brownfield or staying outside, which stands for the developed economy case. Since one remarkable feature of the FDI flows into developing countries is the benefit of cost-saving from low labour costs, this essay takes this effect into account and provides insights for economic "outsourcing". The multi-stage sequential game model presented in this chapter provides comparable results for the pattern of the FDI flows affected by regulation and institutional factors, which are not addressed by existing literature. Finally, it reveals some intuition and feature of a developing economy where the government regulations on FDI flows are more often observed.

The third essay deals with the resource/revenue reallocation within powerful groups in the economy and the impact of the rent-seeking behavior of these groups on the economic growth and the social welfare. In particular, it introduces a dynamic model of resource-grabbing by status-conscious agents, i.e., agents value not only their absolute consumption levels, but also the relative status within his/her reference group. The purpose of this paper is to explore the effect of the "positional externalities" on the urge to seek rent and to connect the "tragedy of the commons" problem with relative consumption. The model shows that the greater is agents' concern about their relative status, the more aggressively they tend to behave. Consequently, the social welfare is lower because the growth rate of the public asset is reduced due to higher extraction rate. After introducing heterogeneity, it shows that the social welfare decreases as the distribution of status-consciousness among

agents widens. Finally, it provides some policy suggestions that the government might consider to achieve a second best social outcome.

Résumé

Cette thèse se compose de trois essais, qui portent sur différents aspects des questions de politique économique et de développement auxquels font face les économies de marché émergentes. Le premier essai explore l'effet de crédibilité de la politique monétaire sur la volatilité des taux de change dans une petite économie ouverte, même si le taux de change n'est pas un objectif fixé explicitement par l'autorité monétaire. Utiliser une économie ouverte modifiés cadre de Galí et Monacelli (2005) et Walsh (2006), elle montre que la crédibilité de la politique monétaire contribue à stabiliser le taux de change que l'offre et la demande chocs frappé l'économie nationale. La crédibilité de la politique monétaire ne peut être réalisé par l'autorité monétaire à l'engagement de certaines règles visant à la production/prix de lissage. Dans l'analyse empirique ciblage de l'inflation sont utilisés comme variables pour la crédibilité monétaire. Le modèle GARCH de certains Asie du Sud-Est montre que les pays dont les politiques de ciblage de l'inflation ont montré réduit la volatilité du taux de change lorsque d'autres facteurs sont contrôlés.

Le deuxième essai se penche sur les flux d'IED dans les pays en développement. Deux différences de flux d'IED entre pays développés et pays en développement sont des modes d'entrée et de la preuve de la réglementation gouvernementale.

Cet essai étudie les incitations des flux d'IED en termes d'économie de fusion, a fixé le coût d'entrée et le rôle des politiques gouvernementales. En particulier, on montre que, si le coût d'économie d'effet est grande et que le gouvernement intervienne, l'entreprise étrangère va examiner les investissements étrangers directs, soit à travers les friches ou Greenfield, ce qui correspond à la situation pour les investissements étrangers directs dans les économies en développement. Sinon, l'entreprise étrangère ne considérera que les friches ou de rester en dehors, ce qui est favorable à l'économie développée. Étant donné que l'une des caractéristiques des flux d'IED vers les pays en développement est dans l'intérêt des économies à bas coûts de main-d'œuvre, ce texte prend en compte cet effet et donne un aperçu "de l'économie externalisation". Le multi-étapes séquentielles jeu modèle présenté dans ce chapitre donne des résultats comparables pour le schéma des flux d'IDE touchés par la réglementation et les facteurs institutionnels, qui ne sont pas traités par la littérature existante. Enfin, il révèle quelques caractéristiques de l'intuition et une économie en développement où la réglementation gouvernementale sur les flux d'IED sont le plus souvent observés.

Le troisième essai traite de la ressource/redistribution des revenus au sein des groupes puissants de l'économie et l'impact de la recherche de rentes comportement de ces groupes sur la croissance économique et le bien-être social. En particulier, elle introduit un modèle dynamique de l'accaparement des ressources par le statut des agents conscients, c'est-à-dire, non seulement les agents de la valeur absolue

de leurs niveaux de consommation, mais aussi la relative au sein de son groupe de référence. Le but de cet article est d'étudier l'effet des "externalités positionnelle" sur l'envie de demander un loyer et de connecter le "tragédie des biens communs" avec le problème de la consommation relative. Le modèle montre que les agents sont plus préoccupés de leur statut, la plus agressive, ils ont tendance à se comporter. En conséquence, la protection sociale est plus faible parce que le taux de croissance de l'actif public est réduit grâce à la hausse du taux d'extraction. Après l'introduction de l'hétérogénéité il montre que le bien-être social diminue à mesure que la distribution de l'état de conscience chez les agents s'élargit. Enfin, il fournit quelques suggestions politiques que le gouvernement pourrait envisager de parvenir à un deuxième meilleur résultat social.

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Contributions of Authors

The third chapter of this thesis is coauthored with my Ph.D. supervisor, Professor Ngo Van Long. He initiated the ideas and I analyzed the model and carried out the simulations. We both reviewed the literature on this topic and made revisions according to referees' comments.

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Preface

During the last two decades the world economy has undergone significant structural changes, including more flexible exchange rate arrangements, surges in international capital flows, redistribution of production and resources, just to name a few. One of the most important features during these movements is the good economic performance and increasing GDP shares of developing countries, with many of them now called emerging market economies.

In areas of international economics and development economics, substantial studies have focused on how a country could achieve first-best or market efficient outcome and better growth by increased competition and economics de-regulation (see Krueger 1997, Harberger 1998, 2005, Lucas 2001). Economic policies, such as trade liberalization, fiscal prudence and credible monetary policy have been intensively discussed. Compared to most advanced economies, policy issues in developing ones appear to be more demanding and complicated, due to many unique aspects of social and economic conditions in these countries.

What should these emerging market economies have in order to signal the likely source of their future success? Many economists believe they are all outstanding in the degree to which they undertook and accomplished significant structural adjustment and in the degree to which their economic policies reflected the broad outlines of the “Washington Consensus” of macroeconomic stability, domestic liberalization, and, of course, international openness. However, it is very difficult to find simple measures that summarize the

merits and demerits of a country's economic policy. Each country has different kinds of comparative advantage, geographic and demographic patterns, market structure, production efficiency, resource endowments and historical experiences. There is no such a panacea for all of them.

The purpose of this thesis is to address several aspects of economic policy issues faced by developing and emerging market economies, ranged from exchange rates and monetary policies, foreign direct investment (FDI) policy and issues of rent-seeking under imperfect property rights. This thesis does not aim to provide solutions to all the problems that a developing economy may have, rather it contributes to economic studies by exploring some unique features of these policies which are very different from the ones in advanced economies.

The thesis is divided into three essays. The first essay examines the impacts of monetary policy credibility on exchange rate volatility for a small open economy, in the case that the exchange rate is not an explicit target set by the central bank. Many developing countries have fixed exchange rate regimes and are considering the option of flexible ones. The most recent example is that given the large depreciation of the U.S. dollar in recent years, the OPEC countries seek to exit from pegging to the dollar and form a common currency for the region. Indeed, a floating exchange rate has many benefits. For example, it serves as a "shock absorber" to the domestic economy when there are exogenous shocks. And it would free the monetary authority from tedious targeting of its currency value and allow the central bankers to focus on other more important tasks such as inflation control. However, one disadvantage of a floating exchange rate is that it becomes more

volatile than a successfully fixed one. For countries which have made the shift either in a voluntary or involuntary way, i.e., South-East Asian countries during the 1997 financial crisis, their exchange rates became more volatile during and after the shift. Although the impact of exchange rate volatility on many macroeconomic variables is uncertain and the empirical evidence is mixed, it becomes one major concern for countries which are considering the option. Using an open economy framework modified from Galí and Monacelli (2005) and Walsh (2006), the essay shows that monetary policy credibility helps to stabilize the exchange rate as supply and demand side shocks hit the domestic economy. Therefore although the exchange rate is floating, it performs better under a credible monetary framework. The essay also provides empirical evidence from selected South-East Asian countries. It indicates that countries with inflation targeting policies (a proxy for monetary policy credibility) have exhibited reduced exchange rate volatility when other factors are controlled.

The second essay looks at FDI inflows into developing countries and the policy in directing the FDI entry modes. Two distinctive differences of FDI inflows between developed and developing economies are entry modes and evidence of government regulations (see World Investment Report 2000, 2005, UNCTAD). In developed countries, there are few policies in regulating the FDI flows and most of them are anti-trust policies. The majority pattern of FDI inflows to these countries occurs in the form of cross-border merger and acquisitions (Cross-border M&As or Brownfield FDI), while in many cases FDI enters emerging market economies by establishing new production facilities (Greenfield FDI) and there exist policies such as capital share limitations. This essay aims to address these

phenomenons by exploring cost-saving merger, fixed cost of entry and the role of government policies. The essay shows that, if the government has incentives to direct the FDI flows to maximize social welfare, the foreign firm will enter the local market through either Greenfield or Brownfield when the cost-saving effect is large. Otherwise, foreign firm considers either entering through Cross-border M&As or just staying outside. Since one well-known incentive of FDI flows into developing countries is the benefit of cost-saving from low labor costs, this essay takes this effect into consideration and provides a rationale for economic "outsourcing". By using a multi-stage sequential game model, the essay gives comparable results for the pattern of the FDI flows affected by regulation and institutional factors, which have not been discussed in previous studies (see Salant et al 1983, Qiu and Zhou 2006). Furthermore, it sheds light on the economic rationale and features of a developing economy where the government regulations on FDI inflows are more frequently observed and implemented.

In the third essay, we focus on rent-seeking activities in developing countries under imperfect property rights and relative consumption hypothesis. In discussing the pattern of economic development in the past thirty years, many economists point out that the most successful economies, such as the Asian tigers, are not well endowed with natural resources, while many resource-rich countries, such as Nigeria, seem to be stagnant. This observation has led to the notion of "resource curse": being well endowed with natural resources may be a burden (see Sachs and Warner 2001). Some economists have refined this view by adding factors that they consider necessary for the resource curse to take place:

imperfect property rights, rent-seeking and poor governance (see Baland and Patrick 2000, Torvik 2002, Mehlum, Moene and Torvik 2006).

The third essay deals with the resource/revenue reallocation within powerful groups in the economy and the impact of the rent-seeking behavior of these groups on economic growth and the social welfare. One unique feature of this study is that the concept of relative consumption is introduced in the literature for the first time. Since there are many empirical studies which have confirmed the presence of relative consumption or status in people's self-reported happiness indices (see Clark and Oswald 1996, Neumark and Postlewaite 1998, Luttmer 2005, Dynan and Ravina 2007), we consider it is necessary to build it into a dynamic model of resource-grabbing. The agents in this model are therefore status-conscious, i.e., they care not only their absolute consumption levels, but also the relative status within their reference group. The main purpose of this essay is to explore the role of the "positional externalities" in the incentives to seek rent and to discuss the "tragedy of the commons" problem in this content. The results from the model show that as agents' concern about their relative status increases, they tend to behave more aggressively in rent-seeking, and this exacerbates the "tragedy of the commons" problem.

Subsequently, the social welfare is worse off since the growth rate of the public asset is reduced due to higher extraction rates. Beyond these findings, the essay provides policy suggestions to remedy the cost of heterogeneity in agents and testable equations for further empirical tests.

Chapter 1

Impacts of Monetary Policy Credibility on Exchange Rate Volatility: a Small Open Economy Case

1.1 Introduction

Exchange rate volatility has been increasingly a matter of concern for countries that recently adopted flexible exchange rate regimes following some currency crisis, such as the Asian Financial crisis in 1997, and the Brazilian and Argentine crises in 1999 and 2001 respectively. Intuitively, high exchange rate volatility may result in misaligned currencies and distort terms of trade and investment flows. The empirical evidence on this issue is mixed since exchange rates are endogenously determined by many factors such as interest rate differential and inflation (see IMF 1984, 2004 and Rose 2000). Nevertheless, most studies agree that excessive volatility (especially short term) increases the exchange rate risk and the costs of hedging for traders and investors. Furthermore, it may make the price level more volatile via the pass-through effect. It is also partially the reason that some monetary authorities use the exchange rate as one of policy indicators, e.g., the Monetary Condition Index (MCI) employed by Bank of Canada before 2007.

The purpose of this study is to explore the effect of monetary policy credibility on exchange rate volatility in a small open economy model with optimizing agents and firms. The credibility of monetary policy is built on the commitment to some rules made by the monetary authority. This paper does not aim to compare the volatility between fixed and

flexible exchange rate regimes since a well-kept fixed regime has lower volatilities than the flexible one, *ceteris paribus*. Rather, the paper asks the following question: when the central bank does not explicitly target exchange rates, does monetary policy credibility matter to exchange rate volatility? While the advantages of monetary credibility in eliminating inflation bias and output smoothing are well-known, this paper looks for additional merits of monetary credibility, or the marginal effect of “rules versus discretion” on the exchange rate. The comparison, which hasn’t been addressed in the literature of New Open Economy Models (NOEM)¹, shows that under commitment to certain rules, exchange rate is less volatile when exogenous shocks hit the economy.

1.1.1 A short literature review

There are a large number of studies in the literature of exchange rate modeling. Many empirical studies since Meese and Rogoff (1983) have shown that exchange rate volatility is not closely related to the fundamentals, except in hyper-inflation countries. The old monetary approach developed in 1980s has been proved to be inefficient in explaining exchange rate changes. In most cases the exchange rate fluctuation can be better modeled as a random walk rather than any precisely described model (see also Flood and Rose 1995, 1999). Since the mid 1990s, economists started to reconsider the exchange rate modeling using sticky price, open economy models as described in Obstfeld and Rogoff (1995, 1996), Clarida, Galí and Gertler (2001, 2002). These studies assume optimizing agents and profit-maximizing firms, as in the New Classical economic theories. Therefore the results would

¹ Lane (2001) provides a complete survey of the literature of New Open Economy Models (NOEM).

be identical to the classical dichotomy if prices were assumed to be flexible. One important feature of the NOEM models is that they include the stickiness of prices by assuming firms adjust their prices with one-period lag (Obstfeld and Rogoff 1995) or in a staggered manner (Calvo 1983). With inflexible price and wage adjustment, the models are able to generate some persistent effects observed in the real economy and the possibility of overshooting of exchange rate, similar to earlier Keynesian models such as Dornbusch (1976). The studies above provide an alternative work horse with sound micro-foundations for the analysis of international monetary policy and exchange rate.

Another stream of literature related to this paper is about monetary policy credibility issues, i.e., rules versus discretion. This literature began with the seminal work of Kydland and Prescott (1977). This was followed by Barro and Gordon (1983), who show that the central bank could eliminate the inflation bias by committing to the public about its inflation targets. King (1997) and Svensson (1997) compare the loss functions of the central bank through a Lucas-type aggregate production function under commitment and discretion, respectively. Kuttner and Posen (1999, 2000) extend this idea to exchange rate volatility in such a way that under commitment to certain rules, the central bank could let the public anchor future inflation expectations so as to reduce the exchange rate volatility. One shortcoming of these studies is that most arguments are based on some aggregate relationships which lack micro-foundation and are subject to the Lucas critique that the parameters would shift according to shocks. A recent work using NOEM by Galí and Monacelli (2005) indicates that exchange rate volatility is quite asymmetric depending on the monetary policy targets, varying from domestic inflation targeting, CPI inflation targeting, to exchange

rate pegs. Yet the question of the impact of lack of credibility on exchange rate variability hasn't been discussed in the studies cited above, since they assumed all policy targets credible and well kept by the monetary authority.

1.1.2 A brief description of the methodology

The small open economy is described by a two-equation system known as New Keynesian Phillips Curve (NKPC) and New Keynesian IS curve (NKIS), developed from the behavior of optimizing agents, the profit-maximizing firms and labor market equilibrium. The monetary policy is conducted by the central bank using the interest rate adjustment and the central bank also has some loss functions made by a weighted average of inflation and output gap variations.

Discrete monetary policies mean the central bank only minimizes the single period loss function, and re-optimizes at the beginning of each period. Under commitment to certain rules the discounted sum of all future loss functions are considered. Both Svensson (1997) and Walsh (2006) show that there exist inflation bias and stabilizing bias under discrete policies if the economy faces supply side shocks. Therefore the central bank has policy tradeoffs when they choose between a more accommodative policy (allowing for more inflation) and a more defensive one (allowing for more output gap). Intuitively, if the central bank focuses more on price stability (put more weight on inflation), the interest rate would be increased to reduce inflation, given a negative supply shock. If the central bank makes a commitment to certain rules, previous studies also show that both inflation and stabilization bias can be eliminated so the inflation will not be so high compared to discrete

policies under the same shock. Assuming that the short-term exchange rate movement is determined by uncovered interest rate parity (UIP) and the long-term exchange rate parity is dominated by purchasing power parity (PPP), I can derive and compare the exchange rate responses caused by both supply and demand side shocks, given different focus and credibility of the central bank's policies. The response of the exchange rate can be simulated through model calibration and compared by the implied impulse-response functions.

For empirical evidence, the exchange rate volatility is analyzed through the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, with dummy variables standing for monetary policy credibility measures (i.e., announcement of inflation targeting), exchange rate regimes and period of crisis. Individual country data is examined to identify the effects of these factors on exchange rates. While it is true that the micro-market structure, i.e., bid-ask spreads, market size and risk premium, does contribute to the short-term exchange rate volatility, I limit the scope on the monetary side and explore the marginal effect of credibility issues such as keeping inflation within targets.

The rest of the paper is organized as follows: section 1.2 lays out the open economy model; section 1.3 derives and compares the exchange rate responses under both discrete and credible monetary policies, and some calibration and simulation of the model are presented; section 1.4 provides the empirical evidence from four South-East Asian countries, followed by concluding remarks in section 1.5.

1.2 A Small Open Economy Model for Policy Comparisons

In this section I present the open economy model, which is modified from Galí and Monacelli (2005) and Walsh (2006). Suppose there are two countries, Home and Foreign. The home and foreign countries are denoted by the superscript h and f , respectively. In both countries the preferences and technologies are the same, and they both produce traded consumption goods which are imperfect substitutes.

1.2.1 Consumers

Suppose the representative consumer consumes a CES composite of home and foreign goods, defined as,

$$C_t = \left[(1 - \gamma)^{\frac{1}{\eta}} (C_t^h)^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} (C_t^f)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \quad (1.1)$$

where C_t^h and C_t^f are indices of consumption of domestic and foreign produced goods. These indices are given by the CES aggregates of the quantities consumed of each type of the good as the following,

$$C_t^h = \left(\int_0^1 C_t^h(i)^{\frac{\tau-1}{\tau}} di \right)^{\frac{\tau}{\tau-1}} \text{ and } C_t^f = \left(\int_0^1 C_t^f(i)^{\frac{\tau-1}{\tau}} di \right)^{\frac{\tau}{\tau-1}} \quad (1.2)$$

From the CES form of consumption, it is obvious that the parameter η measures the substitution elasticity between domestic and foreign goods, and τ measures the substitution elasticity within each category². $\eta > 0$ and $\tau > 1$ are assumed.

² Without loss of generality, it assumes that elasticities of substitution of foreign goods and domestic goods are the same. However, this assumption can be relaxed and the main results still hold as long as they do not differ substantially.

The price indices for domestic and foreign goods are $P_t^h = (\int_0^1 P_t^h(i)^{1-\tau} di)^{\frac{1}{1-\tau}}$ and $P_t^f = (\int_0^1 P_t^f(i)^{1-\tau} di)^{\frac{1}{1-\tau}}$. The consumer price index for the home country is given by,

$$P_t = \left[(1-\gamma)(P_t^h)^{1-\eta} + \gamma(P_t^f)^{1-\eta} \right]^{\frac{1}{1-\eta}} \quad (1.3)$$

The domestic consumer's relative demand for C_t^h and C_t^f will depend on their relative prices. Given the CES specification for preferences³,

$$\frac{C_t^h}{C_t^f} = \left(\frac{1-\gamma}{\gamma} \right) \left(\frac{P_t^h}{P_t^f} \right)^{-\eta} \quad (1.4)$$

Using (1.1), (1.3) and (1.4), the optimal allocation of expenditures between domestic and foreign goods are given by,

$$C_t^h = (1-\gamma) \left(\frac{P_t^h}{P_t} \right)^{-\eta} C_t \quad \text{and} \quad C_t^f = \gamma \left(\frac{P_t^f}{P_t} \right)^{-\eta} C_t \quad (1.5)$$

The home consumer's utility depends on the consumption of the composite good and on its labor supply. Assume the sum of discounted utility is given by,

$$E_0 \sum_{t=0}^{\infty} \beta^t [U(C_t, N_t)] = E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right] \quad (1.6)$$

The home consumer's intertemporal budget constraint can be written as,

$$P_t C_t + E_t(Q_{t,t+1} D_{t+1}) \leq D_t + W_t N_t + T_t \quad (1.7)$$

where D_t, D_{t+1} are nominal value of security returns held by the consumer in period t and $t+1$, and $Q_{t,t+1}$ is the discount factor for nominal payoffs. W_t denotes for the nominal wage and T_t is the government taxes/transfers⁴. Under the assumption of complete

³ This is obtained by minimizing $P_t^h C_t^h + P_t^f C_t^f$ for given level of C_t .

⁴ It is worth noting that money appears neither in the budget constraint nor in the utility function. In most of the recent literature the money supply is assumed to be controlled by the central bank through the interest rate adjustment; hence, money is not introduced explicitly in the model. However, it can be viewed that there exists a money market which is always in equilibrium and the central bank continuously adjusts the money supply by open market operations to ensure that money supply equals money demand given shocks, and given

international financial markets, all agents can buy and sell these securities at any time therefore net holdings of securities are zero in the steady state.

The intertemporal optimization of (1.6) subject to (1.7) yields the following first-order condition,

$$C_t^\sigma N_t^\varphi = \frac{W_t}{P_t} \quad (1.8)$$

$$C_t^{-\sigma} = \beta R_t E_t \left(\frac{P_t}{P_{t+1}} \right) C_{t+1}^{-\sigma} \quad (1.9)$$

Where R_t is nominal gross interest rate⁵ and (1.9) is the standard intertemporal Euler equation.

Let lower case letters denote the percentage deviation of the steady state variables. The log-linearization of (1.1), (1.3), (1.8) and (1.9) yields⁶,

$$c_t = (1 - \gamma)c_t^h + \gamma c_t^f \quad (1.10)$$

$$p_t = (1 - \gamma)p_t^h + \gamma p_t^f \quad (1.11)$$

$$\varphi n_t + \sigma c_t = w_t - p_t^7 \quad (1.12)$$

the interest rate rule such as equation (1.52) below.

⁵ $R_t = E_t Q_{t,t+1}^{-1}$, which is the gross return of a risk-less one-period discount bond.

⁶ Following Uhlig (1998), let's denote $\hat{x}$ as the percentage deviations of a variable x around its steady state, where $x_t \equiv x^{ss}(1 + \hat{x}_t)$, the basic rules for log-linearization are: (1) $\ln x = \ln x^{ss}(1 + \hat{x}) = \ln x^{ss} + \ln(1 + \hat{x}) \approx \ln x^{ss} + \hat{x}$; (2) $x^\alpha = (x^{ss})^\alpha(1 + \hat{x})^\alpha \approx (x^{ss})^\alpha(1 + \alpha\hat{x})$, where (2) can be shown by taking logs and using (1). I assume $P_t^h = P_t^f$ in the steady state. For interest rates and inflation, the log-linearization formulas are: $\ln R_t = \ln(1 + i_t) \approx i_t$ and $\pi_t = \ln P_t/P_{t-1} = p_t - p_{t-1}$.

⁷ Clarida, Galí and Gertler (2001) add a stochastic wage markup μ_t^w to (1.12) to represent deviations from the marginal rate of substitution between leisure and consumption, so that, $\varphi n_t + \sigma c_t + \mu_t^w = w_t - p_t$. They motivate this markup as arising from the monopoly power of labor suppliers who set wages as a markup over the marginal rate of substitution. The markup is assumed to be subject to exogenous stochastic variations

$$c_t = E_t c_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}) \quad (1.13)$$

Where $\pi_t \equiv p_t - p_{t-1}$ is the CPI inflation of the home country (lower case letters denotes the variables in log form).

Let's define terms of trade as the relative price of foreign goods in terms of domestic goods,

$$\Delta_t \equiv \frac{P_t^f}{P_t^h} \text{ and } \delta_t \equiv p_t^f - p_t^h \quad (1.14)$$

From (1.11) and (1.14), it can be shown that,

$$p_t = (1 - \gamma)p_t^h + \gamma p_t^f = p_t^h + \gamma \delta_t \quad (1.15)$$

$$c_t^f = -\eta \delta_t + c_t^h \quad (1.16)$$

1.2.2 Domestic firms

Each firm in the home country produces a differentiated good with identical production functions given by,

$$Y_t^h(i) = e^{\varepsilon_t} N_t(i) \quad (1.17)$$

Let $Y_t \equiv \left[\int_0^1 Y_t(i)^{1-\frac{1}{\tau}} di \right]^{\frac{\tau}{\tau-1}}$ represents an index for aggregate output, similar to the one introduced for consumption. Note that $N_t \equiv \int_0^1 N_t(i) di$, so in aggregate,

$$Y_t^h = e^{\varepsilon_t} N_t \quad (1.18)$$

which is the aggregate production function of the home country.

known as supply side shocks. I don't include the wage markup in (1.12) but assume there is an exogenous cost shock to the economy.

The firm's marginal real cost is real wage divided by the marginal product of labour:

$$MC_t = \frac{W_t/P_t^h}{e^{\varepsilon_t}} \quad (1.19)$$

In terms of percentage deviations around the steady state, (1.19) becomes,

$$mc_t = w_t - p_t^h - \varepsilon_t \quad (1.20)$$

Assuming that firms set prices in a staggered way as in Calvo (1983), i.e., only of $1-\theta$ randomly selected firms set new prices each period, Galí and Monacelli (2005) show that the optimal price setting strategy for a firm resetting its price in period t can be represented by the (log-linear) rule,

$$\bar{p}_t^h = \ln \frac{\tau}{\tau-1} + (1-\beta\theta) \sum_{i=0}^{\infty} (\beta\theta)^i E_t(mc_{t+i} + p_t^h) \quad (1.21)$$

Where $\bar{p}_t^h$ denotes the (log) of newly set domestic prices. An analogous price setting rule obtains for firms in the foreign country.

Under the assumed price-setting structure, the dynamics of the domestic price index are described by,

$$P_t^h \equiv [(1-\theta)(\bar{P}_t^h)^{1-\tau} + \theta(P_{t-1}^h)^{1-\tau}]^{\frac{1}{1-\tau}} \quad (1.22)$$

Galí and Monacelli (2005) show that the domestic inflation, which is $\pi_t^h \equiv p_t^h - p_{t-1}^h$, can be rewritten by using (1.21) and (1.22) as,

$$\pi_t^h = \beta E_t \pi_{t+1}^h + \kappa mc_t, \text{ where } \kappa = \frac{(1-\theta)(1-\beta\theta)}{\theta} \quad (1.23)$$

1.2.3 The foreign country

It is assumed that the foreign country is very large relative to the home country. This assumption implies that it is unnecessary to distinguish between consumer price inflation and domestic inflation in the foreign country, and that the domestic consumption and output in the foreign country are always equal. Let c_t^{h*} denote the foreign consumption of the good produced by the home country. The foreign country's demand for the home country's output depends on the terms of trade. Assuming the preferences are the same across countries (so demand elasticities are the same), similar to (1.16), it can be shown that (in terms of percentage deviations from the steady state values),

$$c_t^{h*} = \eta\delta_t + y_t^f, \text{ where } y_t^f \text{ is the foreign output} \quad (1.24)$$

The Euler equation of foreign households is similar to the one of home country, given by (1.13), except that the foreign consumption and output are equal. So it gives,

$$y_t^f = E_t y_{t+1}^f - \frac{1}{\sigma} (i_t^f - E_t \pi_{t+1}^f) \quad (1.25)$$

Denoting $r_t^f = i_t^f - E_t \pi_{t+1}^f$ as the foreign real interest rate (as deviations from the steady state), it gives,

$$r_t^f = i_t^f - E_t \pi_{t+1}^f = \sigma (E_t y_{t+1}^f - y_t^f) \quad (1.26)$$

1.2.4 Equilibrium conditions

Equilibrium requires that domestic production and consumption (including goods consumed domestically and exported goods) are equal. For the home country, it implies that,

$$y_t = (1 - \gamma)c_t^h + \gamma c_t^{h*} \quad (1.27)$$

In addition, from the assumption of complete international financial markets, uncovered interest rate parity holds,

$$E_t \Delta e_{t+1} = i_t^h - i_t^f \quad (1.28)$$

where e is the log of the exchange rate denoted as domestic currency per unit of foreign currency (DC/FC), so an increase in e indicates exchange rate depreciation.

If the law of one price holds (PPP) holds⁸ such that $e_t = p_t^f - p_t^{f*}$, where p_t^{f*} is the price of imported goods denoted in foreign currency⁹, and use the definition of terms of trade in (1.14), plus (1.26), (1.28) can be rewritten as,

$$i_t^h - E_t \pi_{t+1}^h = r_t^f + E_t(\delta_{t+1} - \delta_t) \quad (1.29)$$

Where by definition, $\pi_t^h \equiv p_t^h - p_{t-1}^h$.

From (1.10) and (1.16) one can derive the aggregate consumption for home:

$$c_t = c_t^h - \gamma \eta \delta_t \quad (1.30)$$

Using (1.24) and (1.30), (1.27) can be written as,

$$y_t = (1 - \gamma)c_t + (2 - \gamma)\gamma \eta \delta_t + \gamma y_t^f \quad (1.31)$$

Using the Euler condition given by (1.13) to eliminate c_t , plus the uncovered interest rate parity condition given by (1.29) and rearrange terms, the output for the home country

⁸ If PPP holds, there is perfect exchange rate pass-through. This assumption can be relaxed by adding some additional disturbance into the PPP equation to account for deviations from the law of one price. However, this modification will not change the main results in section 3 since it will just add an additional error term in the NKPC equation. The deviations from the law of one price can also be viewed as exogenous supply side shocks and this is discussed in Monacelli (2002).

⁹ The PPP equation can also be written as: $e_t = p_t^h - p_t^{h*}$, where p_t^{h*} is the price of exported goods in foreign currency to the foreign country. Since the foreign economy is large, we don't differentiate between p_t^{h*} and p_t^{f*} .

can be solved as,

$$y_t = E_t y_{t+1} - \left(\frac{1+w}{\sigma} \right) \left[i_t^h - E_t \pi_{t+1}^h - \left(\frac{w}{1+w} \right) r_t^f \right], \text{ where } w = \gamma(\sigma\eta - 1)(2 - \gamma) \quad (1.32)$$

1.2.5 Equilibrium dynamics: deviation from the flexible price equilibrium

If prices are sticky, output and terms of trade can differ from their flexible price equilibrium values (see the Appendix for a detailed description of the flexible price equilibrium). Define the output gap as,

$$x_t \equiv y_t - y_t^0, \text{ where } y_t^0 \text{ is the level of output under flexible prices} \quad (1.33)$$

Note that the real marginal cost, given by (1.20) $mc_t = w_t - p_t^h - \epsilon_t$, is the gap between the real product wage and the marginal product of labor. (Note that all these variables are in log forms). When prices are sticky, the real wage can deviate from the marginal product of labor. Under flexible wages, the real consumption wage is still equal to the marginal rate of substitution between leisure and consumption. Therefore using (1.12), one obtains,

$$mc_t = [(\sigma + \varphi)y_t - \varphi\epsilon_t + \gamma(1 - \sigma)\delta_t] - \epsilon_t \quad (1.34)$$

In the appendix I show that the (log) marginal product of labor, ϵ_t , is equal to $\epsilon_t = (\sigma + \varphi)y_t^0 - \varphi\epsilon_t + \gamma(1 - \sigma)\delta_t^0$. Therefore substituting it into (1.34), it gives,

$$mc_t = (\sigma + \varphi)x_t + \gamma(1 - \sigma)(\delta_t - \delta_t^0) \quad (1.35)$$

Using (1.A5) in the Appendix of this chapter that $\delta_t^0 = \left(\frac{\sigma}{1+w} \right) (y_t^0 - y_t^f)$, it is easy to show that $(\delta_t - \delta_t^0) = \left(\frac{\sigma}{1+w} \right) x_t$. The domestic inflation can be rewritten from (1.23)

as,

$$\pi_t^h = \beta E_t \pi_{t+1}^h + \kappa \left[\sigma + \varphi + \left(\frac{\gamma \sigma (1 - \sigma)}{1 + w} \right) \right] x_t \quad (1.36)$$

Where (1.36) is the so-called New-Keynesian Philips Curve (NKPC) under inflexible prices.

From (1.32) and (1.33), it can be shown that the output gap is,

$$\begin{aligned} x_t &= E_t x_{t+1} - \left(\frac{1 + w}{\sigma} \right) \left[i_t^h - E_t \pi_{t+1}^h - \left(\frac{w}{1 + w} \right) r_t^f \right] + E_t y_{t+1}^0 - y_t^0 \\ &= E_t x_{t+1} - \left(\frac{1 + w}{\sigma} \right) [i_t^h - E_t \pi_{t+1}^h - r_t^0] \end{aligned} \quad (1.37)$$

Where r_t^0 is the real interest rate under flexible price equilibrium given by (1.A4) in the appendix. Equation (1.37) may be viewed as the New-Keynesian IS curve for the open economy.

1.3 Exchange Rate Responses to Shocks: Discretion Versus Commitment to Certain Rules

After describing the economy in a two-equation system given by (1.36) and (1.37), I can consider the problem of exchange rate variations to both supply and demand shocks. Kuttner and Posen (1999, 2000) show how the exchange rate responds to supply side shocks under central bank's monetary policy targets, i.e., under discretion or under commitment to certain rules. While they use an aggregate Lucas-type supply function and an ad-hoc IS equation to close the model and only consider supply shocks, the exchange rate response in this study is to be derived through the general equilibrium model in the previous section with optimizing agents and profit-maximizing firms.

Let's rewrite (1.28), the uncovered interest rate parity relationship, as

$$E_t \Delta e_{t+1} = i_t^h - i_t^f \quad (1.38)$$

The UIP equation can be iterated forward to yield:

$$e_t = E_t \sum_{j=0}^{\infty} (i_{t+j}^f - i_{t+j}^h) + \hat{e} \quad (1.39)$$

where $\hat{e}$ is the long-run equilibrium exchange rate. An increase in the domestic interest rate will lead to a decrease in the exchange rate (an appreciation).

The long run relationship represented by PPP determines the long run equilibrium exchange rate $\hat{e}$. Following Gali and Monacelli (2005), I obtain the following relationship via PPP (in log term)

$$\hat{e} = \lim_{j \rightarrow \infty} E_t (p_{t+j}^h - p_{t+j}^*)^{10} \quad (1.40)$$

Where p^h and p^* are domestic and foreign price levels. Since $\pi_t^h \equiv p_t^h - p_{t-1}^h$, this condition can also be expressed by the following,

$$\hat{e} = p_{t-1}^h - p_{t-1}^* + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - \pi_{t+j}^*) \quad (1.41)$$

Combining the equations of UIP and PPP, equation (1.41) becomes,

$$e_t = E_t \sum_{j=0}^{\infty} (i_{t+j}^f - i_{t+j}^h) + p_{t-1}^h - p_{t-1}^* + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - \pi_{t+j}^*) \quad (1.42)$$

This equation can provide us some intuition towards the exchange rate response to certain shocks under different policy regimes. For example, given that the foreign interest rate and foreign inflation are not changed, if there is a supply shock which increases

¹⁰ p^* denotes the foreign price level (in log term). Since the foreign country is relatively very large, its domestic inflation and CPI inflation are not differentiated.

domestic inflation, in the long run the exchange rate tends to depreciate due to higher inflation. If the central bank increases the interest rate to fight inflation, the exchange rate will appreciate. These two effects, when combined, mean the exchange rate can go in either direction, depending on the magnitude of shocks and interest rate changes. As it shows below, the exchange rate response can be different under central bank's discretion or commitment policy.

1.3.1 Central bank's optimal policy decisions and the exchange rate response

Assume that when supply shocks hit the economy the central bank faces a trade-off between minimizing the impact on inflation versus output. Depending on the weights attached to the trade-offs that the central bank chooses this will impact the volatility in the exchange rate. Suppose the central bank's problem is to minimize the discounted sum of single-period loss functions of the form,

$$\text{Min } E_0 \left[\sum_{t=1}^{\infty} \beta^{t-1} (\pi_t^h{}^2 + \lambda x_t^2) \right] \quad (1.43)$$

Where π_t^h is the domestic inflation rate and x_t is the output gap, and without loss of generality I assume that the preferred inflation target is set to zero. The value of λ is the weight that the policy maker put on output stabilization and it is known to the public.

If the central bank's primary objective is price stability (assumption of an inflation targeting framework is not essential), so when there is a supply shock which threatens price stability, it raises the interest rate to insure that the inflation objective is met. If the market believes that the central bank's action is credible, i.e., that the interest rate increase is sufficient to deliver the inflation objective, expectations about the exchange rate will not

be affected and the exchange rate remains fairly unchanged. Thus, in this framework, the central bank's emphasis on price stability and the market's confidence in the ability of the central bank to deliver its objective, reduce the short-term volatility in the exchange rate.

On the other hand, if the central bank follows an accommodative policy in an attempt to reduce the negative impact on output that an interest rate increase may imply, inflation expectations will increase leading to a depreciation of both the short-run and the long-run exchange rate and also causing volatility in the exchange rate.

From Section 1.2, I use the New-Keynesian Phillips Curve and New-Keynesian IS Curve to describe the economy, and these two equations are reproduced below,

$$\pi_t^h = \beta E_t \pi_{t+1}^h + \hat{\kappa} x_t + \mu_t \quad (1.44)$$

$$x_t = E_t x_{t+1} - \frac{1}{\hat{\sigma}} [i_t^h - E_t \pi_{t+1}^h] + \psi_t \quad (1.45)$$

where $\hat{\kappa} = \kappa \left[\sigma + \varphi + \left(\frac{\gamma \sigma (1 - \sigma)}{1 + w} \right) \right]$, $\frac{1}{\hat{\sigma}} = \frac{1 + w}{\sigma}$.

I assume there is an exogenous but auto-correlated cost shock to the domestic economy, $\mu_t = \rho \mu_{t-1} + \nu_t$, which is the counterpart of the wage markup specified in Clarida, Galí and Gertler (2001, 2002). Also, $\psi_t = \left(\frac{1 + w}{\sigma} \right) r_t^0 = \rho \psi_{t-1} + \zeta_t$ denotes for the demand side shocks to the IS equation through the real interest rate under flexible prices. ν_t , ζ_t are mean-zero, white noises with $E_{t-1} \nu_t = E_{t-1} \zeta_t = 0$.

Based on expectations in period t of what the inflation would in next period, the central bank chooses the nominal short-term interest rate in such a way that it is consistent with the real rate which gives the desired combination of inflation and output. With auto-

correlated shocks, the problem becomes a dynamic one¹¹, and the policy maker must choose i in order to minimize the discounted sum of the current and future loss functions.

The problem of monetary policy under discretion and commitment was raised first by Kydland and Prescott (1977), followed by Barro and Gordon (1983), King (1997) and Svensson (1997). Most recently, by using NOEM models Walsh (2006) show that under discretion, the central bank will only minimize the current period loss function subject to the NKPC in (1.44). This leads to the following optimal policy,

$$\hat{\kappa}\pi_t^h + \lambda x_t = 0 \quad (1.46)$$

Where both coefficients are positive. The monetary authority accommodates supply shocks by allowing them to affect inflation. Substituting (1.46) into (1.44), I can solve the first-order difference equation and get the expression for equilibrium inflation and output gap as,

$$\pi_t^h = -\frac{\lambda}{\hat{\kappa}}x_t = \left(\frac{\lambda}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right) \mu_t \quad (1.47)$$

To derive how the exchange rate will respond to supply and demand side shocks under discrete monetary policy, by combining (1.45), (1.46) and (1.47), the short-term nominal interest rate can be solved as,

$$i_t^h = \left[\frac{\lambda\rho + (1 - \rho)\hat{\sigma}\hat{\kappa}}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] \mu_t + \hat{\sigma}\psi_t \quad (1.48)$$

The coefficients on both error terms are positive, indicating that an increase in interest rate is needed to reduce inflation, given a negative supply shock.

¹¹ Certainly the auto-correlated shock is not the only way to make this model dynamic, i.e., output persistence can also be introduced to add additional persistence, as Svensson (1997), Kuttner and Posen (1999, 2000) did.

Now suppose there is a negative supply shock $\nu_t = 1$, which will initially introduce a positive inflation and a negative output gap. Using the UIP and long term PPP relationship derived in (1.42), and assuming that the shocks affect the domestic economy only such that the foreign interest rate and inflation are stable, the exchange rate response under discrete optimal monetary policy can be solved as¹²,

$$e_{t+j} = - \left[\frac{(\hat{\sigma}\hat{\kappa} - \lambda)}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] \rho^j + \left[\frac{\lambda}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] \frac{1 - \rho^j}{1 - \rho} \quad (1.49)$$

The first component, which is negative¹³, is derived from the interest rate differential and tends to appreciate the exchange rate. It reflects the increase in domestic interest rates to dampen inflation. The second term captures the long term impact of the shock on the price level and it will lead to a depreciation since expected inflation is higher under negative supply shocks. The overall effect can go either way, but in the long run the first term will eventually die out so the second term will dominate. Therefore in the long run an adverse supply shock will cause exchange rate depreciation.

Under commitment, if the central bank can commit to a rule that targets a constant inflation (without loss of generality, let's assume the target is $\pi^* = 0$), the optimal monetary policy is to minimize the discounted sum of loss functions as shown in (1.43). Walsh (2006) shows that under such a rule, the optimal decision rule is given by,

$$\pi_t^h = \left[\frac{\lambda(1 - \beta\rho)}{\lambda(1 - \beta\rho)^2 + \hat{\kappa}^2} \right] \mu_t \quad (1.50)$$

¹² A detailed proof is shown in the Appendix 1.B.

¹³ I assume the central bank focus more on price stability such that λ is small and $\hat{\sigma}\hat{\kappa} - \lambda > 0$. Even if $\hat{\sigma}\hat{\kappa} - \lambda < 0$, the results on exchange rate volatility still hold. The simulation results are available upon request.

$$x_t = - \left[\frac{\hat{\kappa}}{\lambda(1 - \beta\rho)^2 + \hat{\kappa}^2} \right] \mu_t \quad (1.51)$$

Similarly, I can derive the equilibrium nominal interest rate and the response of the nominal exchange rate to a unit of negative supply shock as¹⁴,

$$i_t^h = \left[\frac{\lambda(1 - \beta\rho)\rho + (1 - \rho)\hat{\sigma}\hat{\kappa}}{\lambda(1 - \beta\rho)^2 + \hat{\kappa}^2} \right] \mu_t + \hat{\sigma}\psi_t \quad (1.52)$$

$$e_{t+j} = - \left[\frac{(\hat{\sigma}\hat{\kappa} - \lambda(1 - \beta\rho))}{\lambda(1 - \beta\rho)^2 + \hat{\kappa}^2} \right] \rho^j + \left[\frac{\lambda(1 - \beta\rho)}{\lambda(1 - \beta\rho)^2 + \hat{\kappa}^2} \right] \frac{1 - \rho^j}{1 - \rho} \quad (1.53)$$

Denoting $\hat{\lambda} = \lambda(1 - \beta\rho)$, which is less than λ , and comparing (1.53) to the exchange rate response (1.49) under discretion, it is quite straightforward that the first term is now larger (in absolute value), which represents a stronger appreciation effect under commitment to rules. Also the second term is smaller: $\lambda(1 - \beta\rho)$ reflects the effect of lower expected future inflation on the exchange rate. The overall effect is that the exchange rate will depreciate less under commitment than it does under discretion, indicating lower exchange rate volatility in both short run and long run.

What would happen if there are demand side shocks? Unlike supply shocks, demand shocks will not cause monetary policy trade offs since it always move the inflation and output gap in the same direction, e.g., a positive demand shock will increase the aggregate demand and cause inflation and a positive output gap simultaneously. Therefore an increase in interest rate would be sufficient to stabilize both inflation and output. From the above equations I can easily derive the exchange rate response under demand shocks. The exchange rate response will be the same for both discretion and commitment, i.e., a

¹⁴ See also Appendix 1.B for detailed calculation.

positive demand shock that $\zeta_t = 1$.

$$e_{t+j} = -\frac{\hat{\sigma}\rho^j}{1-\rho} \quad (1.54)$$

This indicates that the exchange rate tends to appreciate given a positive demand shock at period t , and this effect will eventually die out in the long run.

1.3.2 Model calibrations

The exchange rate response can also be solved numerically by calibrating the model in the previous section. There are five parameters to be specified: $\hat{\kappa}$, β , λ , $\hat{\sigma}$ and ρ . The discount factor, β , is set equal to 0.99, as suggested by Walsh (2006). The weight on output gap fluctuations, λ , is equal to 0.1, corresponding to a more conservative central bank (focus more on inflations)¹⁵. Jensen (2002) uses a baseline value of $\hat{\kappa} = 0.1$ for closed economy models, instead I use $\hat{\kappa} = 0.2$ for the open economy to capture the greater disturbance it faces. The coefficient of the NKIS, $\hat{\sigma}$ is set to 0.9 and the shock persistence parameter, ρ , is equal to 0.5.

Figure 1.1 and 1.2 give us the simulated impulse-response function for exchange rate given supply and demand side shocks. It is consistent to the arguments in previous section that the exchange rate will depreciate less under central bank's commitment to certain rules compared to discretion. Furthermore, under commitment the exchange rate even appreciates a little during the first period, indicating that the effect of interest rate differentials dominates in the short run.

¹⁵ Jensen (2002), McCallum and Nelson (2000) use the value of 0.25 for λ , but it doesn't change the results except that exchange rates will depreciate since the first period when there is a negative supply shock. The intuition behind this is that if the central bank puts more weight on output gap, it will increase the interest rate less given a negative supply shock, therefore the appreciation of the exchange rate is modest.

To summarize, the model in section 1.3 illustrates the exchange rate volatility under both supply and demand shocks. Compared to the pure discretion case, commitment to a rule by the central bank will transparently anchor future inflation expectations and reduce the inflation bias. Furthermore, under commitment the central bank becomes more conservative (λ becomes $\hat{\lambda} = \lambda(1 - \beta\rho)$), and it will raise the interest rate more to fight inflation. Therefore it produces a more stable exchange rate in both the short run and long run than it does under a discretionary policy, as indicated by calibration. It is worth noting that the real exchange rate volatility is not discussed in the model, but intuitively it should also be lower under commitment since the inflation will be more stable than under discretion.

1.4 Empirical Evidence: GARCH Models

From the theoretical model laid out in the previous section it is clearly shown that monetary policy credibility helps to reduce exchange rate volatility. To test this intuition, I apply some GARCH models for four South-East Asian countries, which are Indonesia, Korea, Philippines and Thailand, and investigate the marginal impact of changing monetary policy framework and exchange rate regimes on exchange rate volatility. After the Asian Financial Crisis, all these four countries in this region adopted more flexible exchange rate regimes and employed the inflation-targeting monetary policy (see Table 1.1 for a summary). Therefore this transition provides us a good opportunity to examine the issue of exchange rate volatility under different monetary policy frameworks. Yet one difficulty to incorporate central banks' credibility into empirical analysis is that there is no widely accepted measure for monetary policy credibility. Kuttner and Posen (2000) give certain criteria for the

evaluation of central banks' policy transparency, and provide an ordinal measure for the case of G3 countries, but I find it is difficult to apply it to South-East Asian countries due to lack of record and documentations. Alternatively, I use adoption of inflation targeting a proxy variable to indicate the credibility of monetary policy, in such a way that the central bank clearly announces its inflation target with enhanced communication to the public, which helps to build the central bank's policy credibility.

Figures 1.3 and 1.4 report nominal and real effective exchange rate volatility by using 12-month rolling standard deviation. I find that all four countries exhibit a period of high exchange rate volatility during the Asian Financial Crisis, accompanied by large depreciation both in nominal and real terms. Indonesia suffered from the crisis with its exchange rate depreciating by over 50% and recorded the highest exchange rate volatility during this period. Unlike the other three countries, where the fluctuations in the economy reduced substantially after the crisis, the high volatility continued in Indonesia for several years since 1997, and the gap is not closing until recently. Figure 1.5 gives a closer look of the exchange rate volatility after the crisis by using bilateral exchange rate with U.S. dollars and the Indonesia Rupiah still exhibits comparatively high volatility.

It has been shown that Figures 1.3, 1.4 and 1.5 capture clearly the degree of instability during and after the Asian crisis, as well as the changes in other social economic conditions such as the exchange rate regime and monetary policy target. The varying degree of exchange rate volatility displayed in these figures suggests that exchange rate volatility can be explained by GARCH models. While most GARCH-based empirical work on exchange rate volatility has ignored, both in the mean and variance equations, the potential role of

alternative monetary policy regimes, Edwards (2006) argues that we should consider the impact of inflation targeting on exchange rate volatility while controlling the exchange rate regime. So the correct policy question is that whether the adoption of inflation targeting changes the exchange rate volatility, given that the exchange rate regime is controlled. Let's consider the following GARCH(p, q) model for exchange rate volatility,

$$\Delta \log E_t = \phi_0 + \sum \phi_j z_{t-j} + CRISIS_t + \eta_t \quad (1.55)$$

$$\sigma_t^2 = \alpha_{1i} + \sum \alpha_i \eta_{t-i} + \sum \gamma_i \sigma_{t-i}^2 + \sum \delta_i y_i + DIT_t + FLOAT_t \quad (1.56)$$

Where E is the nominal or real effective exchange rate; the z 's are variables that affect changes in the exchange rate, and may include lagged values of $\Delta \log E_t$, as well as other domestic or international variables (in log difference), such as oil price, output gap, money supply and inflation; η_t are innovations to exchange rate changes, with zero mean and conditional variance σ_t^2 . The y_t in equation (1.56), are variables other than past squared innovations or lagged forecast variance that help explain exchange rate volatility.

Additionally, in equation (1.55) there is a dummy variable *CRISIS* for the Asian Financial Crisis in 1997, which represents a structural change in the mean equation. In equation (1.56) two more dummy variables are included for each country: (1). *DIT*, which takes the value of one after the country has implemented the inflation targeting policy, and zero otherwise. It is the variable used to control for monetary policy targets. By default, a value of zero means the country still targets the money aggregates with discretion. (2). *FLOAT*, which takes the value of one after the country has a floating/managed floating exchange rate regime, and zero otherwise.

1.4.1 Data description

Four South-East Asian economies: Indonesia, Korea, Philippines and Thailand are included in the sample. The monthly data is from January 1990 to April 2007. All price series and production indices are seasonally adjusted before estimation. The nominal and real effective exchange rate indices are defined such that an increase in the index implies domestic currency depreciation. For monetary policy variables, base money (M0) is used for Korea, Philippines, and Thailand. Due to data availability, I alternatively use M1 for Indonesia. The output gap is obtained by using the HP filter to the natural log of the industrial production index. The oil price is the US dollar based monthly average and I use monthly CPI index to denote inflation. The data sources for all variables are IMF, International Financial Statistics and CEIC Asia database.

Table 1.1 gives us a summary of current monetary policy and exchange regimes for each country. After the Asian crisis, many countries have adopted inflation targeting to stabilize the economy with a more flexible exchange rate arrangement. More specifically, Indonesia implemented inflation-targeting policy in July 2005, Korea in January 1998, Philippines in January 2002, and Thailand in May 2000. Accordingly, in these countries the exchange rate regimes have been changed to more flexible ones to complement this policy.

1.4.2 GARCH results

I estimated the GARCH model for each individual country with an inflation targeting policy. The selected results are reported by Table 1.2 and Table 1.3, for nominal and real

effective exchange rates, respectively. First, the impact of monetary policy targets on exchange rate volatility is reflected by the coefficients of the dummy variable *DIT* in (1.56). From both Tables 1.2 and 1.3 I find that the coefficients of *DIT* are significantly negative for three out of four countries with the exception of Philippines, for which the coefficient is negative but not significantly different from zero for nominal exchange rate volatility¹⁶. Overall, the negative coefficients of *DIT* do indicate that the adoption of inflation targeting indeed reduces the exchange rate volatility in both nominal and real terms for most of the countries.

Second, the exchange rate regime also plays an important role in explaining exchange rate volatility. A negative coefficient on *FLOAT* means that the shift from fixed to float exchange rate regime increases both nominal and real exchange rate volatility. For individual countries, Indonesia, Korea and Thailand show increased volatility after floating. Again Philippines does not have a significant coefficient in either table. Since keeping a fixed exchange regime successfully is another indicator of monetary credibility, it is not surprising that exchange rates become more volatile after floating due to the lack of nominal anchors as before. Somehow I do not give merit to fixed exchange rate regimes since not many countries manage to do so (see examples from Flood and Garber (1984), Flood, Garber and Kramer (1996)). Moreover, the overall benefit of a floating exchange rate regime is greater since the flexible exchange rate is well known as a "Shock Absorber".

Finally, the Asian Financial Crisis contributes to large exchange rate depreciation in both real and nominal terms, as expected. Note that the variable of *CRISIS* only appear in

¹⁶ To address this problem, in next section there is additional argument about the effectiveness of inflation targeting.

(1.55) since it is assumed that the crisis affects the mean of the equilibrium exchange rate as a structural change but does not contribute to the volatility. Although I did robustness checks by adding it into the conditional variance equation, in most cases it is not significant.

1.4.3 The performance of inflation targeting policies

Inflation targeting is used as an indicator or proxy variable for monetary policy credibility in the above GARCH models. It is worth noting that in some cases even though the central bank announces such a policy, but does not implement it successfully or the inflation targets are not met, it might not enhance the credibility. Figure 1.6 examines the inflation target and actual inflation for these four countries, which are Indonesia, Korea, Philippines and Thailand, after they adopt inflation targeting. It shows that in Korea and Thailand the inflation is generally kept well within the target, compared to the large deviation from the target in Philippines. This can partially explain why the coefficient of inflation targeting is not significant for Philippines in both nominal and real exchange rate GARCH models since inflation targeting might not be a good indicator of credibility in this sense. For Indonesia, it seems that the inflation is slightly above the target since late 2005 due to the oil price increase. The Bank Indonesia (the central bank) adjusted the median target by 2% in 2006, reflecting the oil price changes. If core inflation which excludes the food and energy price is considered, it is still within the target.

1.5 Concluding Remarks

This study examines exchange rate volatility in the content of monetary policy credibility and the central bank's policy target. Using an open economy model with new Keynesian features, I show that exchange rate volatility is lower when central banks adhere to a commitment-of-rule based monetary policy (thus establishing credibility) vis-a-vis a discretion-based policy (when the market is left to guess the central bank's reaction to a shock). I take inflation targeting as representing the former kind of policy and find a negative correlation between exchange rate volatility and the existence of inflation targeting regime, as confirmed by the empirical evidence shown in GARCH models¹⁷.

Of the four countries, Indonesia has the highest exchange rate volatility, although it has declined. In general, exchange rate volatility is affected by various factors, including both supply and demand side shocks, and how the central bank responds to them. As shown in section 1.4, commitment to certain rules by the central bank and successfully meeting these commitments (e.g. inflation targets under an inflation targeting framework) helps to build credibility and to reduce exchange rate volatility. For these countries recovering from the Asian crisis, if the central bank implements inflation targeting as envisaged, the volatility may decline further. The results from this essay may provide a guideline for promoting independent monetary institutions in developing countries. Transparent, responsible and credible monetary policy has been proved to be the best stabilization tool in advanced economies and it is highly possible that this applies to developing ones. The model

¹⁷ Thacker and Wang (2007) also attribute the difference in exchange volatility to the degree of central bank intervention or to market turnover (in terms of thinness of the foreign exchange market), while in this study I focus on the monetary side of the economy and explore the marginal effect of monetary policy credibility on exchange rate volatility.

in this chapter can be further modified to suit special needs, i.e., capital account openness, endogenous price flexibility and further empirical studies for individual countries.

An Appendix to Chapter 1

1.A The flexible price equilibrium

Let's denote the lower case letters as percentage deviations from the steady state level under the flexible price equilibrium. The flexible price equilibrium satisfies,

$$y_t^0 = c_t^0 + \gamma \delta_t^0 \quad (1.A1)$$

Where (1.A1) is derived from balanced trade condition under flexible prices $P_t^h Y_t^0 = P_t C_t^0$.

The next equation (1.A2) is from the labor market equilibrium (1.12) and the production function (1.18) when the marginal product of labor is equal to the real product wage (which implies the percentage deviation of the marginal cost, mc_t , is zero under flexible prices).

$$\varepsilon_t = (\sigma + \varphi)y_t^0 - \varphi\varepsilon_t + \gamma(1 - \sigma)\delta_t^0 \quad (1.A2)$$

From (1.29), the real interest rate under flexible prices can be represented by,

$$r_t^0 = r_t - E_t \pi_{t+1}^h = r_t^f + E_t \delta_{t+1}^0 - \delta_t^0 \quad (1.A3)$$

From (1.32), (1.A3) can be rewritten as,

$$r_t^0 = \left(\frac{\sigma}{1+w} \right) (E_t y_{t+1}^0 - y_t^0) + \left(\frac{w}{1+w} \right) r_t^f \quad (1.A4)$$

Under flexible price, all future expectations on the percentage deviations are zero, I can derive the terms of trade under flexible prices as,

$$\begin{aligned} \delta_t^0 &= \left(\frac{\sigma}{1+w} \right) \left[(E_t y_{t+1}^f - y_t^f) - (E_t y_{t+1}^0 - y_t^0) \right] \\ &= \left(\frac{\sigma}{1+w} \right) (y_t^0 - y_t^f) \end{aligned} \quad (1.A5)$$

If substituting (1.A5) into (1.A2) to eliminate the terms of trade, one can get the flexible-price equilibrium output as,

$$y_t^0 = \frac{(1 + \varphi) \varepsilon_t + \left(\frac{\gamma \sigma (1 - \sigma)}{1 + w} \right) y_t^f}{\sigma + \varphi + \left(\frac{\gamma \sigma (1 - \sigma)}{1 + w} \right)} \quad (1.A6)$$

Therefore if the price is flexible, the output in the small open economy is linked to the productivity changes ε_t , as well as the foreign income effect y_t^f .

1.B The exchange rate response to shocks

To derive the exchange rate response to both supply and demand side shocks, I use the NKPC and NKIS equations to derive the equilibrium short term interest rate for given shocks, and then substitute it into the UIP and long run PPP relationship.

Under discretion, $\hat{\kappa} \pi_t^h + \lambda x_t = 0$, so it gives,

$$i_t^h = \left[\frac{\lambda \rho + (1 - \rho) \hat{\sigma} \hat{\kappa}}{\lambda (1 - \beta \rho) + \hat{\kappa}^2} \right] \mu_t + \hat{\sigma} \psi_t \quad (1.B1)$$

(1.B1) shows that an increase in interest rate is needed to reduce inflation, given a negative supply shock.

Now suppose there is a negative supply shock with $\nu_t = 1$, which will initially introduce a positive inflation and a negative output gap. If I assume that the shocks affect the domestic economy only such that the foreign interest rate and inflation are stable. Without loss of generality, we take foreign interest rate and price as numeraire and one can have,

$$e_t = E_t \sum_{j=0}^{\infty} (i_{t+j}^* - i_{t+j}^h) + p_{t-1}^h - p_{t-1}^* + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - \pi_{t+j}^*) = E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - i_{t+j}^h) + p_{t-1}^h \quad (1.B2)$$

Substituting (1.B1) and the inflation relationship (1.47) into (1.B2), it gives

$$e_t = - \left[\frac{(1 - \rho)(\hat{\sigma}\hat{\kappa} - \lambda)}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] E_t \left(\sum_{k=0}^{\infty} \mu_{t+k} \right) + p_{t-1}^h \quad (1.B3)$$

Suppose the economy is in equilibrium at $t - 1$ before the shock occurs, given that the initial output gap $x_{t-1} = 0$, $p_{t-1}^h = 0$, $\nu_t = 1$ and $E_t v_{t+1} = 0$, it gives,

$$e_t = - \left[\frac{(\hat{\sigma}\hat{\kappa} - \lambda)}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] \quad (1.B4)$$

Similarly, by iterating forward, it gives,

$$\begin{aligned} e_{t+j} &= - \left[\frac{(1 - \rho)(\hat{\sigma}\hat{\kappa} - \lambda)}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] E_t \left(\sum_{k=0}^{\infty} \mu_{t+k+j} \right) + p_{t+j-1}^h \\ &= - \left[\frac{(1 - \rho)(\hat{\sigma}\hat{\kappa} - \lambda)}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] E_t \left(\sum_{k=0}^{\infty} \mu_{t+k+j} \right) + \sum_{j=0}^{j-1} \pi_{t+j-1}^h \\ &= - \left[\frac{(\hat{\sigma}\hat{\kappa} - \lambda)}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] \rho^j + \left[\frac{\lambda}{\lambda(1 - \beta\rho) + \hat{\kappa}^2} \right] \frac{1 - \rho^j}{1 - \rho} \end{aligned} \quad (1.B5)$$

Which gives us (1.49), the exchange rate response given one unit of adverse supply shocks under discretion.

Under commitment to a rule, if comparing (1.50) and (1.51) to (1.47) one will find that everything in (1.50) and (1.51) remain the same except that $\hat{\lambda} = \lambda(1 - \beta\rho)$ is different from λ . By substituting $\hat{\lambda} = \lambda(1 - \beta\rho)$ for λ into (1.B5), one can get (1.53).

Under demand side shocks such that $\zeta_t = 1$, if I substitute it into (1.B1) under both discretion and commitment the interest rate will be given by $i_t^h = \hat{\sigma}\psi_t$. Using (1.B2), it gives,

$$e_t = - \frac{\hat{\sigma}}{1 - \rho} \text{ and } e_{t+j} = - \frac{\hat{\sigma}\rho^j}{1 - \rho} \quad (1.B6)$$

which yields (1.54).

Fig. 1.1. Exchange rate response to one unit of negative supply shock

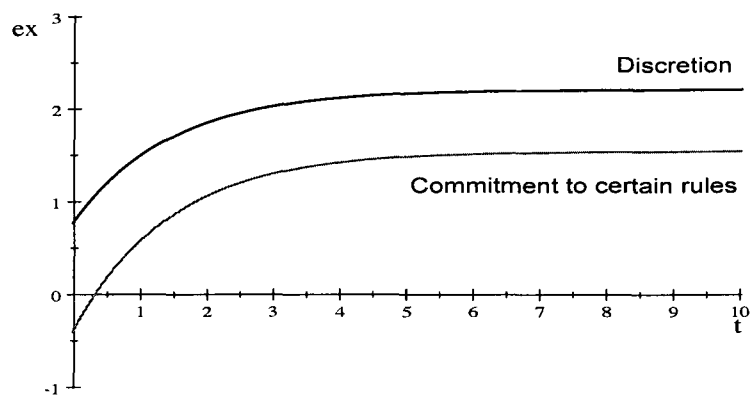


Fig. 1.2. Exchange rate responses to one unit of positive demand shock

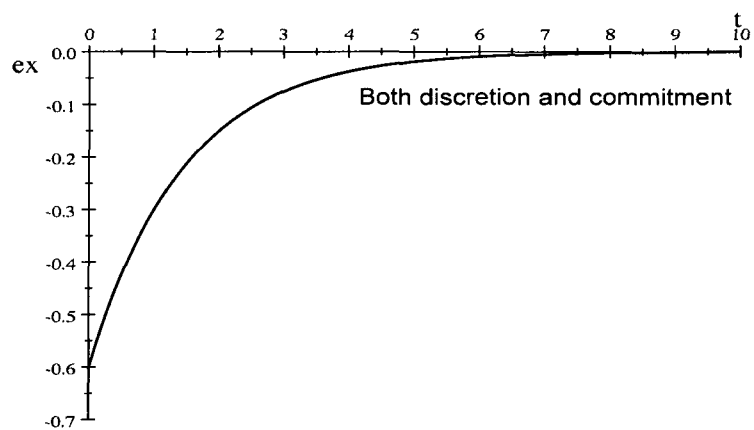


Fig. 1.3. NEER monthly volatility: 1990-2006

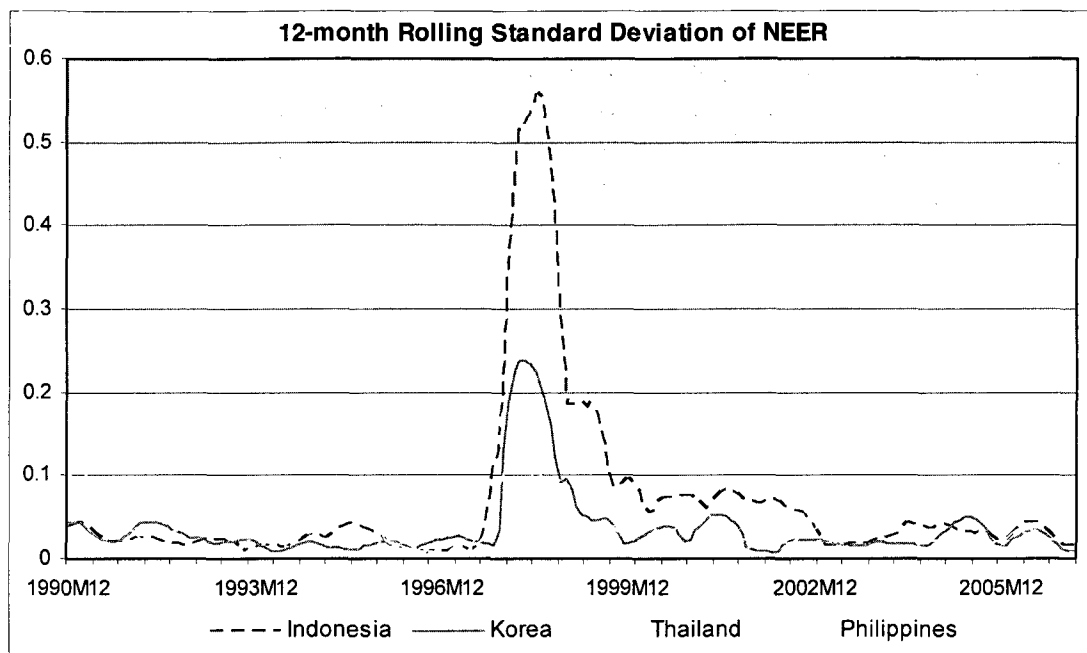


Fig. 1.4. REER monthly volatility: 1990-2006

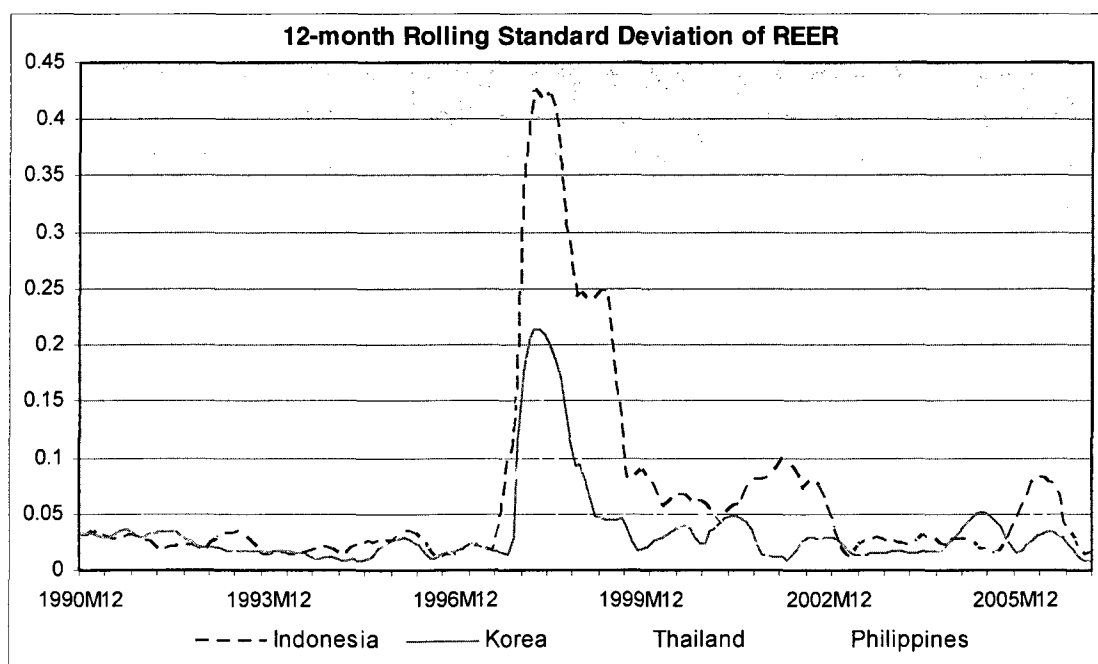


Fig. 1.5. Bilateral exchange rate volatility with U.S. dollar

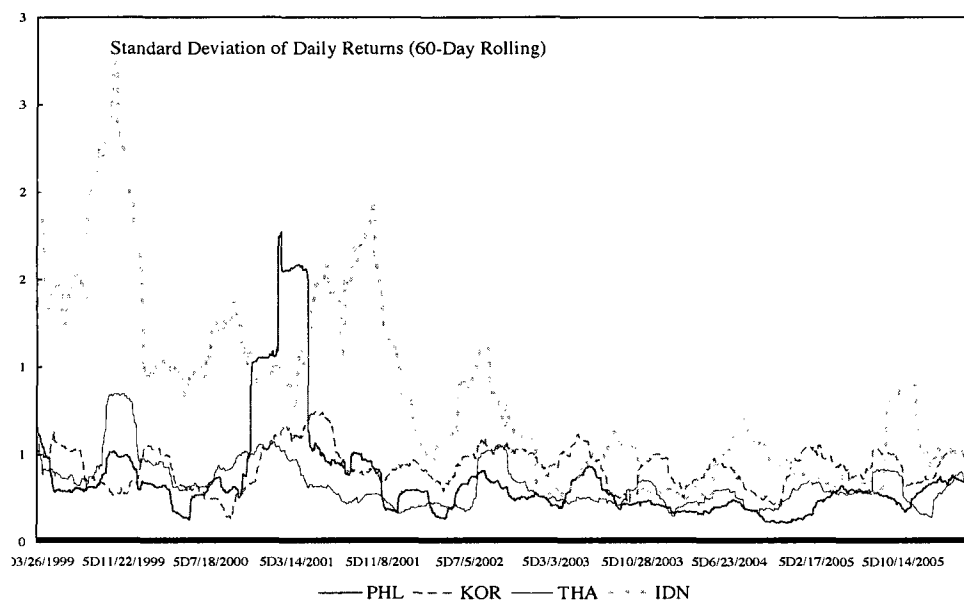


Fig. 1.6. Inflation targets and actual inflation

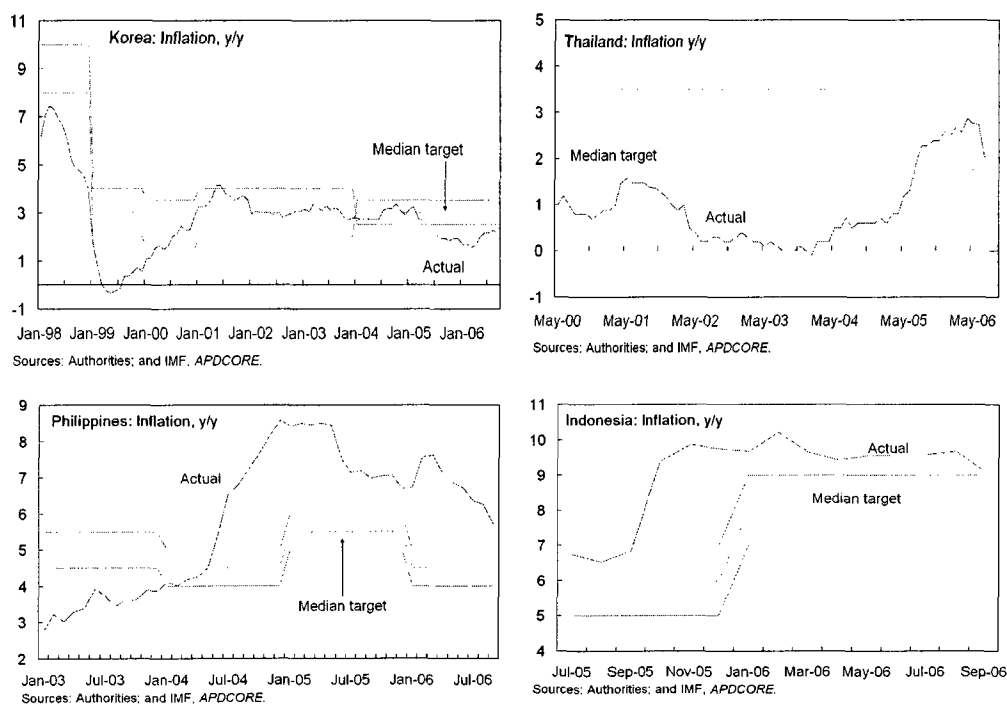


Table 1.1 Monetary policy and exchange rate regimes

	Monetary policy regime	Exchange rate regime ¹
Indonesia	Inflation targeting (07/2005)	Managed float (07/1997)
Korea	Inflation targeting (01/1998)	Independent float (12/1997)
Philippines	Inflation targeting (01/2002)	Independent float (03/1998)
Thailand	Inflation targeting (05/2000)	Managed float (07/1997)

Note:

1. Exchange rate regimes are de facto.

Source: "De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework", IMF, 2006

Table 1.2 GARCH estimates: nominal exchange rate volatility, selected results
(Monthly data: 1990:1-2007:4)

Country	GARCH	CRISIS	DIT	FLOAT
Indonesia	(0,1)	0.028** (4.960)	-5.870e-04** (-2.603)	4.820e-04** (2.128)
Korea	(1,1)	0.026** (11.196)	-1.307e-03** (-12.338)	1.324e-03** (10.977)
Philippines	(1,1)	0.039** (9.369)	-8.125e-05 (-1.060)	9.480e-05 (1.578)
Thailand	(1,1)	0.032** (5.641)	-4.960e-04** (-21.103)	4.920e-04** (27.244)

Note:

1. The numbers in brackets are z-statistics.

2. "***" indicates significance at 5 percent, "*" for 10 percent.

Table 1.3 GARCH estimates: real exchange rate volatility, selected results
(Monthly data: 1990:1-2007:4)

Country	GARCH	CRISIS	DIT	FLOAT
Indonesia	(1,0)	0.090** (10.310)	-5.611e-03** (-38.665)	5.543e-03** (130.10)
Korea	(1,1)	0.024** (10.454)	-1.995e-03** (-16.523)	1.997e-03** (18.032)
Philippines	(2,1)	0.027** (5.114)	-1.180e-04* (-1.878)	4.330e-05 (0.703)
Thailand	(1,1)	0.024** (3.675)	-8.210e-04** (-5.333)	8.160e-04** (5.259)

Note:

1. The numbers in brackets are z-statistics.

2. "***" indicates significance at 5 percent, "*" for 10 percent.

Chapter 2

Cross-border Mergers and Entry Modes of FDI Inflows

2.1 Introduction

During the past two decades Foreign Direct Investment (FDI) has become a major source of capital inflows for both developed and developing economies. These investments are often made by multinational firms which enter a local market through either the so called Greenfield or Brownfield mode. By definition, Greenfield FDI refers to investments that create new production facilities in host countries (for example, starting a new plant), while Brownfield FDI refers to cross-border mergers and acquisitions (Cross-border M&As).

According to World Investment Report (UNCTAD, 2000, 2005), it is interesting to note that there are remarkable differences in entry modes of FDI inflows between developed and developing economies. To give some numbers, until 1999 the value ratio of cross-border mergers to total FDI inflows was nearly 100% for the former, rising from 80% in the mid-1990s. However in developing economies the ratio was closer to 40%, with considerable variation across regions: from 20% in emerging Asia to 60% in Latin America and the Caribbean, as presented in Figure 2.1 and 2.2. From the year 2002 to 2004, the value ratio varied between 58.9% and 83.1% for developed economies, and the ratio was still 30%-40% lower on average for developing ones (see Figure 2.3). To summarize, as observed, FDI inflows take mostly the form of cross-border M&As (Brownfield) in devel-

oped economies, but more frequently appear as Greenfield investments in emerging market regions, i.e. building a new local firm.

Given the difference above, the purpose of this paper is to provide theoretical arguments for the motivation and entry modes of FDI inflows in terms of cost-saving merger, fixed cost of entry and the role of government policies. It gives a model with imperfect competition and government regulation to analyze the incentives and welfare implications of different entry modes. The structure of the model is a four-stage, noncooperative sequential game with government moving first by setting up the policy, followed by the foreign firm's decision, local firms' response and market competition. The rationale to take the role of government into consideration is that various restrictions on FDI inflows have been observed across countries. The most frequently observed policies on FDI inflows, according to World Investment Report (2000), are limitations on the foreign capital share ownership. The layout of those restrictions vary across countries as well as across sectors within the country. For example, considering the basic telecommunication industry in Asia, Philippines has a high degree of competition along with restrictions on foreign capital partnership. Other countries like Pakistan and Sri Lanka have only permitted a low level of foreign equity ownership for strategic investors, and postponed introducing competition for several years. The only exception is Korea, which allows increased participation of foreign equity more rapidly than competition¹⁸. In the banking industry, China, as one of

¹⁸ World Investment Report (2000), pp. 15: "Indeed, perhaps the most common concern about cross-border M&As — in distinction to Greenfield FDI — is their impact on domestic competition...Governments therefore increasingly realize that effective competition policy is vital, and a large number of countries have adopted (or are in the process of preparing) competition laws."

the fastest growing emerging market economies, still requires the foreign equity share of many joint-venture entities be less than 50% to ensure that they are state-owned enterprises (SOEs). Political economy models with agents or interest groups lobbying for capital allocation may provide alternative insights for some specific policies, but they are abstracted from this analysis.

The primary objective of this paper is to shed light on the economic rationale behind these policies and consider FDI inflows in different entry modes under government intervention. By assuming that the local government has incentives to direct the FDI flows in regarding to social welfare, I show that the equilibrium outcome can be either the foreign firm enters through Greenfield or Brownfield, or staying outside. Moreover, the equilibrium outcome depends very much on the cost-saving effect and marginal cost difference between local and foreign firms. This difference stands for motives of technology diffusion and production cost variations between countries. This model provides us comparable results for the FDI flows that are affected by regulation and institutional factors, which are not addressed by existing literature about cross-border mergers and FDI. Finally, it reveals some intuition and feature of a developing economy where government regulations on FDI flows are more often observed.

To link this study with other ones, recent literature can be reviewed in two streams. First, there are a few studies that consider the entry modes of FDIs. Some researchers have been focusing on the technology transfer and preferred entry mode of foreign firms¹⁹.

¹⁹ For example, Mattoo *et al.* (2004) show the trade-off between market competition and technology transfer is one of the key determinants of preferences. They examine the situation in which the government and foreign firm's decisions differ, and domestic social welfare is greater by limitations on FDI in such a way that it forces the foreign firm to choose the socially preferred entry mode. Lee and Shy (1992) show that

Others tend to use bidding strategies of foreign entrants on target firms or cooperative games to analyze the probability of Greenfield vs Brownfield investment²⁰. The literature on entry modes of FDI has tended to focus on the behavior of multinational firms that the foreign firm tries to prevent its technological advantage from dissipation (see Ethier and Markusen 1996, Saggi 1996, 1999 and Markusen 2001). Another study by Yu and Tang (1992) give several possible motivations for international acquisition, which include cost saving, risk sharing and increased market power. Some empirical studies, including Di Giovanni (2003), Rossi and Volpin (2003), explore the cross-country factors of international M&As, and they find that cross-border M&As are more likely to enter regions with good records of investor protection and well-developed capital markets. Second, this paper is closely related to the literature of horizontal mergers. Among these, the first paper that concerns this problem is Salant *et al.* (1983), which show that the merger will not be profitable unless more than 80% of the firms are involved, under Cournot competition with homogeneous good, linear demand and constant marginal costs. Some studies on merger focus on the content of domestic merger under trade liberalization. Long and Vousden (1995) show that only a unilateral tariff reduction increases the incentive to merge between

restrictions on foreign equity ownership will reduce the quality of technology transferred, but the foreign firm is forced to establish a joint venture. Roy *et al.* (1999) consider the case that a foreign firm already enters the domestic market and looks for other cooperative deals with another local firm. They identify the degree of cost asymmetry between the foreign and local firm, and the market structure as crucial to determining the optimal choice of policy.

²⁰ Among these, Horn and Persson (2001), Norbäck and Persson (2004) show that multinational firms enter a new market by acquisitions may make a lower profit than those entering Greenfield. They find that the bidding competition between the foreign firms drives up the acquisition price to such a level that being a successful greenfield entrant is, *ex post*, more profitable.

domestic firms. The effect on the gain from merger depends on savings in marginal costs resulting from the merger, while a bilateral tariff reduction has the opposite effect. Gaudet and Kanouni (2001), Benchekroun and Ray-Chaudhuri (2004) give numerical examples of prohibitive tariff and non-marginal change in tariff reduction, i.e. tariff abolition.

In regarding with cross-border merger, Qiu and Zhou (2006) explain why cross-border M&A would happen under asymmetric information held between domestic and foreign firms. They assume the only difference between domestic and foreign firms is that the domestic firms hold private information about the market demand fluctuations, and information sharing between the firms tends to encourage cross-border merger. Most of studies above consider the exogenous merger problem in such a way that the necessary condition for merger to happen is the increasing joint profit after merger, while previous research provides only a few models of endogenous mergers. Important contributions are also made by Kamien and Zang (1990, 1992), Barros (1998), Gowrisankaran (1999), Fauli-Oller (2000), and Gowrisankaran and Holmes (2004). A major complexity of all such models is the multiplicity of equilibria. To deal with this problem, in these studies the number of firms are limited, i.e., three in Barros (1998) and four in Fauli-Oller (2000), or it assumes that firms acted in a pre-determined order (Gowrisankaran 1999). Some researchers also employ co-operative game models for endogenous mergers (Barros 1998).

Different from existing literature on cross-border merger and entry modes of FDI, in this model the government in the local country plays an important role in directing FDI inflows. I assume the government sets up a profit sharing rule for the merged domestic and foreign firm in a way that this rule maximizes the domestic social welfare. This policy

assumption can be viewed as the equity share restrictions applied by many countries and the foreign firm can only obtain the profit subject to its maximum equity share after merger. Also, the endogenous merger problem is partially considered in this paper such that the foreign firm has the option to propose a merger offer and the home firm has options to accept or decline it.

The rest of the paper is organized as the following. The model and its assumptions are set up in Section 2.2. Section 2.3 builds some preliminary results that are crucial in deriving Subgame Perfect Nash Equilibria (SPNEs) of the model. In Section 2.4, some special cases are analyzed and numerical examples are given. Section 2.5 concludes, followed by a discussion of policy implications and intuitions of the findings.

2.2 A simple model with FDI policies and entry choices

In this section, the model is described with certain assumptions. I consider an industry that consists of n identical domestic firms ($H_i, i = 1, \dots, n$) and one foreign firm (FF), with marginal cost c and c_f , respectively. Further, let's assume $c_f \neq c > 0$ such that the foreign firm produces at a different marginal cost to the home firm. There is one representative consumer with a quadratic utility function in the home country and no foreign consumers. All firms compete in the domestic market and the market structure is Cournot competition with homogeneous goods²¹. Additionally, the foreign firm can export all its goods to the domestic market and there are no transportation costs. Now the government opens its

²¹ In Section 2.4 there are some arguments for the case of Bertrand competition. If firms produce differentiated goods, as long as they are substitutes and the elasticity is large enough, the main results still hold.

capital account and allows for FDI inflows. Therefore the foreign firm has three options, which are continuing exports (staying outside), Greenfield or Brownfield FDI. It is worth noting that the market structure is similar to Qiu and Zhou (2006), except that I don't assume private information and product differentiation, instead here I tend to introduce cost heterogeneity, entry choices and government policies.

The market demand function is linear, which comes from the assumption that the representative consumer in the home country has quadratic utility functions,

$$P = A - Q \quad (2.57)$$

Where

$$Q = q_f + \sum_{i=1}^n q_i$$

q_f denotes for the output of FF and q_i is the output of H_i . Also, A is large enough to ensure every firm to produce a positive output under any circumstance.

Now let's consider the entry modes of FF . The FDI is done through Greenfield or Brownfield. FF may consider the option between merger with a home firm and building a new plant in the home country. Suppose FF chooses to merge, it faces a given profit sharing rule set by the home government such that it gets certain part of the joint profit, and the merged home firm gets the rest. This type of policy represents the current situation that most existing FDI policies are capital share limitations, therefore the foreign firm will get the proportion of the joint-profit according to its capital share. It is important to note that FF can bypass this policy by choosing staying outside or Greenfield FDI since they represent 100% ownership.

Further, I assume that if merger happens, the joint merger profit is denoted by π^M , and the marginal cost for the joint entity will be reduced to zero, which indicates a cost-saving benefit for both merged firms. To understand it, one can imagine that this is a labor-intensive industry such that FF has superior production technology (or more efficient management) but higher wage cost, and H_i has less advanced technology but lower wage cost, then the merger of the two firms can have even lower marginal cost than before. So the benefits of a potential merger comes from two sources. One is from more market power due to fewer number of firms in the market, and the other is the profit gain from cost-saving. However, if FF chooses Greenfield investments, there is a lump-sum fixed cost F and its marginal cost will also be reduced to zero (it is the case that FF becomes a local producer in the home country by starting a new firm, it gets access to the cheaper local labor market as well).

The game structure of the model is as follows. It consists of a four-stage, noncooperative game presented by Figure 2.4. The home government moves first by choosing the FDI policy. Specifically, it sets up a profit sharing rule, α , which is the profit share of the joint profits for FF , and $1 - \alpha$ for H_1 (without loss of generality, assuming FF makes the merger offer to H_1). Once set, the policy will not be changed regardless that merger happens or not in following stages. In the second stage, the foreign firm makes its decisions. FF has three options: 1. it can stay outside with no action (exporting, denoted by N). 2. it can build a new plant in the home country and shift all production there (Greenfield, denoted by B). 3. it can make a merger offer to H_1 (Brownfield, denoted by M). If FF chooses M , there is a third stage that the domestic firm can either accept or decline

the merger offer. If the latter happens, the foreign firm will again choose between B or N . After all decision have been made, all firms engage in Cournot competition.

It is interesting to note that unlike existing literature of exogenous mergers, in this model the necessary condition for the merger to happen is no longer that the joint profits are greater than before. Now the domestic government sets up the joint profit sharing rule between the domestic firm and the foreign firm, given by,

$$\pi_f^M = \alpha \pi^M \quad (2.58)$$

$$\pi_1^M = (1 - \alpha) \pi^M, \alpha \in [0, 1] \quad (2.59)$$

Therefore H_1 will compare the ex ante profit obtained from accepting or declining the merger offer made by FF . In this sense, the model partially considers the endogenous merger problem that merger may not happen even if the joint profit is greater since the home firm will decline the offer as long as it is not sufficiently compensated according to the profit sharing rule.

2.3 Solving for subgame perfect equilibria of the game

2.3.1 Firms' profits under different entry modes

To get any subgame perfect equilibrium, let's derive the payoffs of all firms in every node of the game specified in Figure 2.4. Noting that there are in total three outcomes, let's consider each case separately. The first one, which is the simplest case that FF maintains its status as a foreign producer (staying outside). It becomes a problem of static Cournot

competition with heterogeneous marginal cost. All firms' problems are given by,

$$\max \pi_f^N = Pq_f - c_f q_f \quad (2.60)$$

$$\max \pi_i^N = Pq_i - c_i q_i \quad (2.61)$$

FOCs for FF and any home firm are as follows,

$$\begin{aligned} \frac{\partial}{\partial q_f} \pi_f^N &= A - c_f - 2q_f - \sum_{i=1}^n q_i = 0 \\ \frac{\partial}{\partial q_j} \pi_j^N &= A - q_f - 2q_j - \sum_{i=1, i \neq j}^n q_i - c = 0 \end{aligned}$$

By symmetry, $q_i = q_j \neq q_f$, it gives,

$$\frac{\partial}{\partial q_f} \pi_f^N = A - 2q_f - nq - c_f = 0 \quad (2.62)$$

$$\frac{\partial}{\partial q_j} \pi_j^N = A - q_f - (n+1)q - c = 0 \quad (2.63)$$

The equilibrium quantities, market price, profits are given by,

$$q_i^N = \frac{1}{n+2} (A - 2c + c_f) \quad (2.64)$$

$$q_f^N = \frac{1}{n+2} (A - c_f - nc_f + cn) \quad (2.65)$$

$$P^N = \frac{1}{n+2} (A + c_f + cn) \quad (2.66)$$

$$\pi_f^N = \frac{1}{(n+2)^2} (A - c_f - nc_f + cn)^2 \quad (2.67)$$

$$\pi_i^N = \frac{1}{(n+2)^2} (A - 2c + c_f)^2, i = 1, 2, \dots, n \quad (2.68)$$

Next, let's consider the case that merger happens in a way that FF chooses M and H_1 accepts the offer. By assumption the marginal cost will become zero for the new merged firm. The joint profit after merger is:

$$\pi^M = P(q_f + q_1) = (A - q_f - q_1 - \sum_{i=2}^n q_i)(q_f + q_1) \quad (2.69)$$

FOC:

$$\frac{\partial}{\partial(q_f + q_1)} \pi^M = A - 2(q_f + q_1) - \sum_{i=2}^n q_i = 0$$

Since under symmetry $q_f = q_1$, it yields

$$\frac{\partial}{\partial(q_f + q_1)} \pi^M = A - 4q_f - \sum_{i=2}^n q_i = 0 \quad (2.70)$$

For domestic firm $j \neq 1$,

$$\pi_j = Pq_j - cq_j = (A - q_f - q_1 - \sum_{i=2}^n q_i)q_j - cq_j \quad (2.71)$$

FOC:

$$\frac{\partial}{\partial q_j} \pi_j = A - q_f - q_1 - 2q_j - \sum_{i=2, i \neq j}^n q_i - c = 0$$

By symmetry, $q_j = q, j = 2, \dots, n$

$$\frac{\partial}{\partial q_j} \pi_j = A - 2q_f - (n+1)q_j - c = 0 \quad (2.72)$$

So equilibrium price and joint profit after merger are:

$$P^M = \frac{1}{n+1} (A - c + cn) \quad (2.73)$$

$$\pi^M = \frac{1}{(n+1)^2} (A - c + cn)^2 \quad (2.74)$$

According to the profit sharing rule given in Section 2.2, I can compute the profit of FF under given sharing rule:

$$\pi_f^M = \alpha \pi^M = \frac{\alpha}{(n+1)^2} (A - c + cn)^2 \quad (2.75)$$

The profit of the merged domestic firm H_1 is:

$$\pi_1^M = (1 - \alpha) \pi^M = \frac{1 - \alpha}{(n+1)^2} (A - c + cn)^2 \quad (2.76)$$

The profit of the rest domestic firms $j \neq 1$ is

$$\pi_j^M = Pq_j - cq_j = \frac{(A - 2c)^2}{(n + 1)^2}, j = 2, 3, \dots, n \quad (2.77)$$

Finally, if FF chooses to build a new factory (denoted by B) in either the second or the fourth stage (the merger offer is rejected), let's derive the payoffs for both firms. By assumption, FF 's marginal cost will also become zero and there is a fixed cost of building, denoted by F . The difference compared with the merger case is that the number of firms in the market is still $n + 1$, not n as two firms getting merged. Similarly to the calculation above, the equilibrium outputs and profits are computed as,

$$q_i^B = \frac{1}{n + 2} (A - 2c) \quad (2.78)$$

$$q_f^B = \frac{1}{n + 2} (A + cn) \quad (2.79)$$

$$P^B = \frac{1}{n + 2} (A + cn) \quad (2.80)$$

$$\pi_f^B = \frac{1}{(n + 2)^2} (A + cn)^2 - F \quad (2.81)$$

$$\pi_i^B = \frac{1}{(n + 2)^2} (A - 2c)^2, i = 1, 2, \dots, n \quad (2.82)$$

So far all payoffs for each type of firms have been derived and it is ready to look for SPNEs in the next section.

2.3.2 The SPNEs of the entire sequential game

Now payoffs for all firms are known and I can solve the game through backward induction. To simplify the arguments, only pure strategy equilibrium is discussed. First, let's consider the following proposition.

Proposition 1 *For the foreign firm, there exists a threshold value of its marginal cost, denoted by $\hat{c}_f$, such that all other things equal,*

(a) if c_f is above the threshold value $\hat{c}_f$, staying outside (N) is a dominated strategy to building a new firm (B).

(b) if c_f is below the threshold value $\hat{c}_f$, building a new firm (B) is a dominated strategy to staying outside (N).

Proof. $\hat{c}_f$ can be solved as follows:

$$\text{let } \pi_f^N = \frac{1}{(n+2)^2} (A - c_f - nc_f + cn)^2 = \pi_f^B = \frac{(A + cn)^2}{(n+2)^2} - F$$

So it gives,

$$\hat{c}_f = \frac{1}{n+1} \left(A + cn - \sqrt{(A + cn)^2 - (n+2)^2 F} \right)$$

Given that π_f^N is monotonic decreasing in c_f , if c_f is above the threshold value $\hat{c}_f$ which implies $\pi_f^B \geq \pi_f^N$, N is dominated by strategy B, vice versa. ■

Remark: the intuition behind Proposition 1 is straightforward. Without considering the merger option, the trade off between choosing staying outside and building a new firm is the cost-saving effect ($c_f = 0$) versus the fixed cost F . In other words, as long as the cost-saving effect is large enough and it outweighs the profit loss from fixed cost, building is always more profitable than no entry.

Proposition 1 can help us sorting out the SPNEs and let's consider the following two cases separately.

Case (a). c_f is above the threshold value $\hat{c}_f$, staying outside (N) is a dominated strategy to building a new firm (B). So FF will never choose staying outside.

Now following Figure 2.4, let's go back one stage and examine the domestic firm. If accepting the merger offer is more profitable for the domestic firm, such that $\pi_1^M \geq \pi_1^D$, from (2.76) it implies,

$$\frac{1 - \alpha}{(n + 1)^2} (A - c + cn)^2 \geq \frac{(A - 2c)^2}{(n + 2)^2} \quad (2.83)$$

so it gives

$$\alpha \leq 1 - \frac{(n + 1)^2 (A - 2c)^2}{(n + 2)^2 (A - c + cn)^2} = \alpha_h, \quad (2.84)$$

Under given α , it is obvious that H_1 will accept the merger offer if and only if $\alpha \leq \alpha_h$.

Now moving to the second stage, and FF has only two options, B and M . Again the profits of FF from choosing B or M have to be compared.

Suppose $\alpha \leq \alpha_h$, (given the assumption that H_1 accepts the merger offer), if merger is also more profitable for the foreign firm, it needs $\pi_f^M \geq \pi_f^B$. So it must be the case

$$\frac{\alpha}{(n + 1)^2} (A - c + cn)^2 \geq \frac{1}{(n + 2)^2} (A + cn)^2 - F > 0 \quad (2.85)$$

which indicates

$$\alpha \geq \frac{(n + 1)^2 [(A + cn)^2 - (n + 2)^2 F]}{(n + 2)^2 (A - c + cn)^2} = \alpha_l \quad (2.86)$$

In this case, FF will choose to make a merger offer and it will be accepted by H_1 , if $\alpha \in [\alpha_l, \alpha_h]$ ²². It chooses B otherwise.

Now let's go back to the first stage of the game and consider the domestic government's problem. It will maximize the domestic social welfare by choosing α . The social

²² α_l, α_h are values for the incentive compatible constraints for both foreign and domestic firms to agree to merge. It is not necessarily true that α_l must be less than α_h . If α_l is greater than α_h , merger will not happen. Additional arguments are given in Section 4.

welfare for the home country is defined as the sum of total consumer surplus and domestic producer surplus, which are the profits of all domestic firms.

In the above case, the representative consumer surplus is given by:

$$CS = \int_0^{Q^*} D(Q)dQ - P^*Q^* = \frac{(c + An - cn)^2}{2(n+1)^2} \quad (2.87)$$

Domestic producer surplus is the sum of the total profits of all domestic firms:

$$PS = \sum_{i=1}^n \pi_i = \frac{(1-\alpha)(A-c+cn)^2}{(n+1)^2} + \frac{(n-1)(A-2c)^2}{(n+1)^2} \quad (2.88)$$

The social welfare is given by,

$$SW = CS + PS = \frac{(c + An - cn)^2}{2(n+1)^2} + \frac{(1-\alpha)(A-c+cn)^2}{(n+1)^2} + \frac{(n-1)(A-2c)^2}{(n+1)^2} \quad (2.89)$$

It can be easily shown that $\frac{\partial SW}{\partial \alpha} = \frac{-1}{(n+1)^2} (A-c+cn)^2 < 0$

If $\alpha_l \leq \alpha_h$, the government will certainly choose $\alpha = \alpha_l$. Substituting it into the social welfare, the social welfare under merger is:

$$SW^M = CS^M + PS^M = \frac{(c + An - cn)^2}{2(n+1)^2} + \frac{(1-\alpha_l)(A-c+cn)^2}{(n+1)^2} + \frac{(n-1)(A-2c)^2}{(n+1)^2} \quad (2.90)$$

So the government will just choose α_l to maximize domestic social welfare and make the foreign firm indifferent between M and B . Since only pure strategy equilibria is considered, in this case FF will choose M , H_1 will choose accept, and this is one of the SPNEs. The intuition behind this result is that the domestic firm benefits from the merger through

cost-saving effect and increasing market power of fewer firms. The government tries to pay as less as possible to the foreign firm to maximize social welfare.

From the above case it is straightforward that if $\alpha \in [0, \alpha_l)$, FF will choose B and there are only two stages of the game. Given this, the social welfare under build is derived similarly as below,

$$SW^B = CS^B + PS^B = \frac{(A + An - cn)^2}{2(n+2)^2} + \frac{n(A - 2c)^2}{(n+2)^2} \quad (2.91)$$

If $\alpha \in (\alpha_h, 1]$, H_1 will decline the merger offer even if it is profitable for FF . In this situation, FF will also choose B , so the social welfare will be SW^B .

Case (b). Let's consider another case that c_f is below the threshold value $\widehat{c}_f$, i.e., building a new firm (B) is a dominated strategy to staying outside (N) for the foreign firm. In this case FF will only consider N or M in either stage. If merger is more profitable for FF , such that, $\pi_f^M \geq \pi_f^N$, the foreign firm will make a merger offer.

So it must have

$$\pi_f^M = \frac{\alpha}{(n+1)^2} (A - c + cn)^2 \geq \frac{1}{(n+2)^2} (A - c_f - nc_f + cn)^2 = \pi_f^N \quad (2.92)$$

which indicates

$$\alpha \geq \frac{(n+1)^2 (A - c_f - nc_f + cn)^2}{(n+2)^2 (A - c + cn)^2} = \alpha_l^* \quad (2.93)$$

Recall the underlying condition for H_1 accepting the merger offer does not change, which is $\alpha \leq 1 - \frac{(n+1)^2 (A - 2c + c_f)^2}{(n+2)^2 (A - c + cn)^2} = \alpha_h$. Therefore if $\alpha \in [\alpha_l^*, \alpha_h]$, FF will choose to make a merger offer and it will be accepted by H_1 .

From the same arguments as in previous case, the local government will also choose α_l^* to maximize social welfare.

The social welfare is given by,

$$SW^{M*} = CS + PS = \frac{(c + An - cn)^2}{2(n+1)^2} + \frac{(1 - \alpha_l^*)(A - c + cn)^2}{(n+1)^2} + \frac{(n-1)(A - 2c)^2}{(n+1)^2} \quad (2.94)$$

It is easy to show that if $\alpha \in [0, \alpha_l^1)$, merger is not profitable for the foreign, $\pi_f^M < \pi_f^N$, and the foreign firm will choose to stand alone, N . The social welfare under this case will be,

$$SW^N = CS^N + PS^N = \frac{(A + An - c_f - cn)^2}{2(n+2)^2} + \frac{n(A - 2c + c_f)^2}{(n+2)^2} \quad (2.95)$$

Where SW^N is derived from the situation that FF chooses N (stay outside as a foreign producer).

If $\alpha \in (\alpha_h, 1]$, H_1 will decline the merger offer. Since in this case $\pi_f^B \leq \pi_f^N$, FF will choose N and the social welfare will again be SW^N .

To summarize, one can refer to Table 2.1 for a complete description of all possible cases and SPNEs. It is worth noting that α_l or α_l^* is not necessarily less than α_h . If α_l or α_l^* is greater than α_h , it indicates there is a conflict on profit sharing between firms and equilibria that FF chooses to merge does not exist. In that case, the FDI policy does not matter and the outcome will depend on the condition that the foreign firm's marginal cost c_f is below or above the threshold value $\widehat{c}_f$.

2.4 Merger conditions, welfare analysis and examples

After all possible SPNEs of the game are described, in this section let's examine several special cases and compare the results with existing studies in the literature. Specifically, it is interesting to find sufficient and necessary conditions for merger to happen. Also, in the general form of the model the social welfare is not comparable but I try to give some intuitive results.

1. The benchmark case: there is no cost-saving effect such that $c = 0$ and $c_f = 0$.

This case is identical to the one with perfect information in Qiu and Zhou (2006) except that there is no product differentiation. Their result is that merger will not happen unless the products is enough differentiated and the number of firms is limited. In this paper, I get similar outcomes in a different mechanism in which the profit sharing rule deters merger.

Proposition 2 *If $c = 0$ and $c_f = 0$, merger never happens. The foreign firm will always choose N , which is no entry. If $n = 1$, the government chooses $\alpha \in [0, \frac{4}{9}) \cup (\frac{5}{9}, 1]$. If $n > 1$, the government chooses $\alpha \in [0, 1]$ and the social welfare will always be SW^N .*

Proof. Since $\pi_f^N = Pq_f - c_f q_f = \frac{A^2}{(n+2)^2}$ and $\pi_f^B = Pq_f - F = \frac{(A+cn)^2}{(n+2)^2} - F = \frac{A^2}{(n+2)^2} - F < \pi_f^N$, the foreign firm will never choose B and it is shown in Proposition 1.

Now let's consider the possibility of merger, one can get,

$$\alpha_h = 1 - \frac{(n+1)^2 (A - 2c + c_f)^2}{(n+2)^2 (A - c + cn)^2} = 1 - \frac{(n+1)^2}{(n+2)^2},$$

$$\alpha_l^* = \frac{(n+1)^2 (A - c_f - nc_f + cn)^2}{(n+2)^2 (A - c + cn)^2} = \frac{(n+1)^2}{(n+2)^2}, \text{ (one can refer to the plots in}$$

Figure 2.5)

The government will choose a to maximize social welfare, it can be shown that,

$$SW^{M*} - SW^N = \left(-\frac{1}{2}\right) A^2 \frac{(2n+3)}{(n+1)^2 (n+2)^2} < 0,$$

Noting that n can only be integers, $\alpha_h > \alpha_l^*$ when $n = 1$, and $\alpha_h < \alpha_l^*$ if $n > 1$, the SPNE would be the following,

If $n = 1$, to make a subgame perfect decision, government chooses $\left[0, \frac{4}{9}\right) \cup \left(\frac{5}{9}, 1\right]$ and FF chooses N . Social welfare will be SW^N . If $n > 1$, similarly government chooses any $\alpha \in [0, 1]$ and FF choose N . Social welfare will also be SW^N . ■

The intuition behind this result is that when there is no cost-saving in the FDI process for the foreign firm, first, the foreign firm will never consider to build directly in the home country due to the fixed cost. Second, when there is only one domestic firm, the merger of the two firms will make them a monopoly, which decreases the domestic social welfare and the government tries to deter it. If there are more than one domestic firms, the merger will also not happen due to the well known results of Salant *et. al.*(1983), which show that with homogeneous good and cournot competition, the merger is profitable only if it includes at least 80% of total firms.

Obviously, if this model is modified to the one without government intervention, it becomes a three-stage game that FF moves first by choosing entry mode, and H_1 chooses accept or decline the merger offer. It leads to the following proposition.

Proposition 3 *If $c = 0$ and $c_f = 0$, and the government does not set up the profit sharing rule, the foreign firm will only consider staying outside or making a merger offer. Merger happens if and only if $n = 1$.*

Proof. Since I have derived the profits of FF by choosing N and B , and $\pi_f^N > \pi_f^B$, B is a strictly dominated strategy by N . Without the profit sharing rule, the merger happens when the joint profit of the merged firm is higher than the sum of their original profits. In our case, it requires $\pi^M = \frac{1}{(n+1)^2} > \frac{2}{(n+2)^2} = (\pi_f^N + \pi_1)$, which gives $n < 1.414$. So if $n = 1$, merger will happen and it will be accepted by H_1 . This result is consistent with Salant *et al.* (1983) since if $n = 2$, the number of firm involved in merger only consists 2/3 of the the total firms. ■

2. The more general case with $c_f \neq c > 0$.

As FF 's marginal cost c_f increases, under given fixed cost F , the profit π_f^N is monotonic decreasing. As shown in Proposition 1, if $\pi_f^B \geq \pi_f^N$, it refers to case (a) in previous section. Under this situation, the government need to only compare SW^B and SW^M to decide the profit sharing rule. In particular, recall that

$$SW^B = \frac{1}{2(n+2)^2} (A + An - cn)^2 + \frac{n(A-2c)^2}{(n+2)^2}$$

$$SW^M = \frac{1}{2(n+1)^2} (c + An - cn)^2 + \frac{1-\alpha_l}{(n+1)^2} (A - c + cn)^2 + (n-1) \frac{(A-2c)^2}{(n+1)^2}$$

In most cases they are not comparable given the unknown parameter values. However, I can characterize the conditions for merger to happen in following propositions.

Proposition 4 *If c_f is above the threshold value $\hat{c}_f$ which implies $\pi_f^B \geq \pi_f^N$, merger happens if and only if two conditions holds: (1) $SW^M \geq SW^B$, such that the home government has incentive to choose $\alpha = \alpha_l$, and FF is willing to make a merger offer. (2)*

$0 \leq \alpha_l \leq \alpha_h \leq 1$, such that the SPNE of merger is sustained by the ex ante profit sharing rule. Otherwise, FF will choose to build a new plant.

Proof. In section 3.3 it shows that, if $\pi_f^B \geq \pi_f^N$, the social outcome will only be either SW^B or SW^M , therefore the government will choose a higher social welfare. Further, even the government has chosen α_l , if $\alpha_l > \alpha_h$, H_1 will decline the merger offer so FF ends up with the profit π_f^N . According to sequential rationality, FF will choose B instead to assure a higher profit. This is the rational for the second condition. In numerical simulations it shows that α_l can exceed α_h with given parameter's value, so it does not support the sequential rationality choice of FF . ■

Remark. This proposition can be viewed as an explanation to the FDI entry modes in developing economies. It indicates that as long as the cost-saving effect is large enough ($c_f \geq \hat{c}_f$), the foreign firm always chooses to enter the local market in either Greenfield or Brownfield. The entry modes will depend on the market conditions and government policies. Given various market structures and policies across developing economies, people may observe high or low ratios of Brownfield in total FDI.

If c_f is below the threshold value $\hat{c}_f$, which implies $\pi_f^B < \pi_f^N$. B becomes a strictly dominated strategy for FF and it will never consider building a new plant. Back to the government's problem, it now only need to compare SW^N and SW^{M*} when choosing α . Recall that,

$$SW^{M*} = \frac{1}{2(n+1)^2} (c + An - cn)^2 + \frac{1 - \alpha_l^1}{(n+1)^2} (A - c + cn)^2 + (n-1) \frac{(A - 2c)^2}{(n+1)^2}$$

$$SW^N = \frac{1}{2(n+2)^2} (A + An - c_f - cn)^2 + \frac{n(A - 2c + c_f)^2}{(n+2)^2}$$

Proposition 5 *if c_f is below the threshold value $\hat{c}_f$ which implies $\pi_f^B < \pi_f^N$, merger happens if and only if the following two conditions holds: (1) $SW^{M*} \geq SW^N$ such that the home government has incentive to choose $\alpha = \alpha_i^*$, under which FF is willing to make a merger offer. (2) $0 \leq \alpha_i^* \leq \alpha_h \leq 1$, such that the SPNE of merger is sustained by the ex ante profit sharing rule. Otherwise, FF will choose to N , which implies staying outside.*

Proof. Similar to Proposition 4. ■

Remark. This proposition, combined with proposition 3, can provide some intuition for the FDI entry modes in developed economies. That is, in developed economies with similar technology progress and production costs, the cost saving effect is small. Therefore building a new firm or outsourcing is seldom considered. If the foreign firm enters the home market or FDI ever happens, it will take the form of cross-border merger. In most developed economies government policies in regulating FDI do not involve capital share limitations directly and most of them are anti-trust policies.

3. Degree of competition and the market structure.

In the above analysis I assume that the fixed cost and number of firms are given and only consider the effect of cost-saving on the entry modes of the firms. The welfare of each cases are not comparable due to unknown parameter values. Now let's suppose the number of firms in the home country varies, I have the following results.

Proposition 6 *If the number of domestic firms is large and $0 < c_f < 2c$, the social welfare with merger is always greater than those that the foreign firm stays outside or builds a new plant.*

Proof. If $n \rightarrow \infty$, the welfare of each case can be computed as

$$\begin{aligned} SW^M &= \frac{1}{2} (A - c)^2 + F \\ SW^{M*} &= \frac{1}{2} (A - c)^2 + c_f(2c - c_f) \\ SW^N &= \frac{1}{2} (A - c)^2 \\ SW^B &= \frac{1}{2} (A - c)^2 \end{aligned}$$

From the above equations, the proposition can be easily proved. ■

Remark. The intuition behind it is that if market is very competitive (number of firms is large), then firm's profit are nearly zero. In the merged case, at least one domestic firm benefits from cost-saving effect since its marginal cost becomes zero after merger and this effect will dominate. However if the foreign firm chooses to build or stay outside, there is no benefit to the domestic firms at all. Certainly, it is worth noting that given proposition 4 and 5, the government can not always achieve the greatest social welfare due to the conditions for profit sharing rules. If the number of firms is finite, the results are ambiguous since it depends on the scale of cost-saving and fixed costs.

Finally, what would happen if Bertrand competition is introduced instead? Since under the profit sharing rule set by the government, even if the merger would always be beneficial to both firms under Bertrand competition (Deneckere and Davidson 1985), it may not happen due to the conflicts of interests between domestic firms and foreign firms. Again, the government would compare the social welfare to decide the optimal sharing rule. Also, if Bertrand competition is considered, heterogeneous goods must be introduced to the model and it adds to the complexity of the model. I expect that the general results will

still hold except changes of some equilibria conditions, i.e., the elasticity of substitution between differentiated products being large enough.

2.4.1 Numerical examples

In this section I present some numerical examples in order to show that in general there exist multiple equilibria of the game. So the outcome varies according to different marginal costs, fixed costs and number of firms.

Example table 2.2 $A = 200, c = 3, c_f = 5, F = 100$

	$n = 1$	$n = 2$	$n = 3$	$n = 10$	$n = 11$
α_h	0.559	0.459	0.402	0.354	0.362
α_l	0.447	0.557	0.621	0.627	0.602
SW^M	10521.	14964	16736	19044.	19110.0
SW^N	12937.	15791.	17108.	19025.	19084.
SW^B	12938.	15731.	17030.	18964.	19026.
π_f^N	4138.8	2280.1	1428.8	212.67	177.09
π_f^B	4478.8	2552.3	1647.2	267.36	221.24
$SPNEs$	$[0, \alpha_l) \cup (\alpha_h, 1], B, B$	$[0, 1], B, B$	$[0, 1], B, B$	$[0, 1], B, B$	$[0, 1], B, B$
$Outcome$	SW^B	SW^B	SW^B	SW^B	SW^B

	$n = 17$	$n = 20$	$n = 50$ or more
α_h	0.422	0.453	0.683
α_l	0.392	0.264	-1.181
SW^M	19313	19359.	19472.
SW^N	19261	19300.	19390.0
SW^B	19217.	19261.	19372.
π_f^N	71.803	49.638	3.3376
π_f^B	74.518	39.669	-54.697
$SPNEs$	α_l, M, B	α_l^*, M, N	$[0, 1], N, N$
$Outcome$	SW^M	SW^{M*}	SW^N

From the above example one can find that sometimes government policies are irrelevant (i.e., $n = 2, 3, 10, 11$) since the foreign firm will choose Greenfield investment anyway when it is more profitable than staying outside and $\alpha_l > \alpha_h$, which indicates that the conflict of participating constraints deters merger.

2.5 Concluding remarks

Two distinctive differences of FDI inflows between developed and developing economies are entry modes and evidence of government regulations. To address these differences, in this essay I have investigated the incentives of FDI flows in terms of cost-saving merger, fixed cost of entry and the role of government policies. In particular it shows that, if the cost-saving effect is large ($c_f \geq \hat{c}_f$) and the government sets up the profit sharing rule for mergers, the foreign firm will consider the FDI investment through either Greenfield or Brownfield, which corresponds to the situation for FDI flows into developing countries (See proposition 4). Otherwise, the foreign firm will only consider merger or staying outside (See proposition 3 and 5), which stands for the developed economy case. Since it is well-known that one distinctive feature of the FDI flows into developing countries is the benefit of cost-saving from low labour costs and cheaper raw materials, this paper takes this effect into account and provides some insights for economic "outsourcing". The results from this model can generate some testing hypothesis for future empirical analysis. Clearly one of them is that the greater the cost-saving effect (or equivalently the lower the fixed cost), the more frequently FDI enters as Brownfield.

This paper provides certain explanation, together with some numerical examples, for the entry mode of FDI and the incentive for the government intervention in directing the FDI flows. In the analysis I do not consider product differentiation or asymmetric information between producers, as Qiu and Zhou (2006) did. One reason is that I want to focus on the entry mode choice, the cost synergy and the difference between developed and developing economies; another reason is that more parameters introduced will result

in even more multiple equilibria and unanalytical solutions. Certainly all those factors not considered may also be determinants of the FDI flows and are subject to further research.

Fig. 2.7. Ratios of cross-border M&As to FDI inflows, world and by group of economies, 1987-1999, World Investment Report 2000 (in percentage)

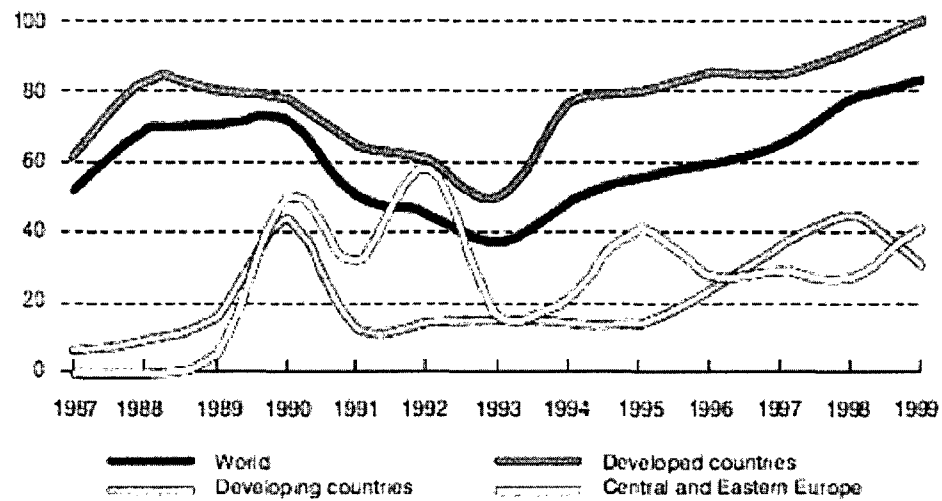


Fig. 2.8. Ratios of cross-border M&As to FDI inflows, by regions, 1987-1999, World Investment Report 2000 (in percentage)

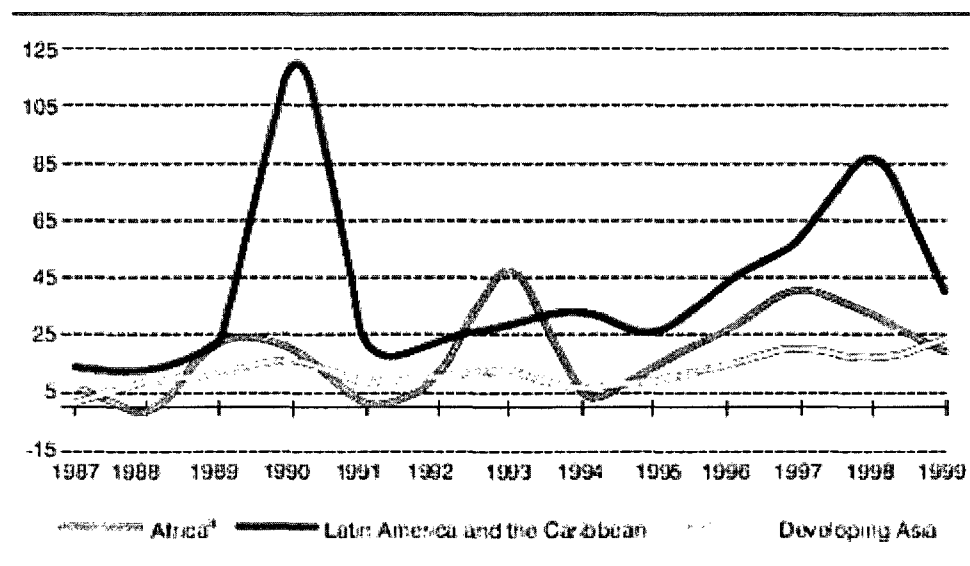


Fig. 2.9. Ratio of cross-border M&A sales to FDI inflows, 2002-04, World Investment Report 2005

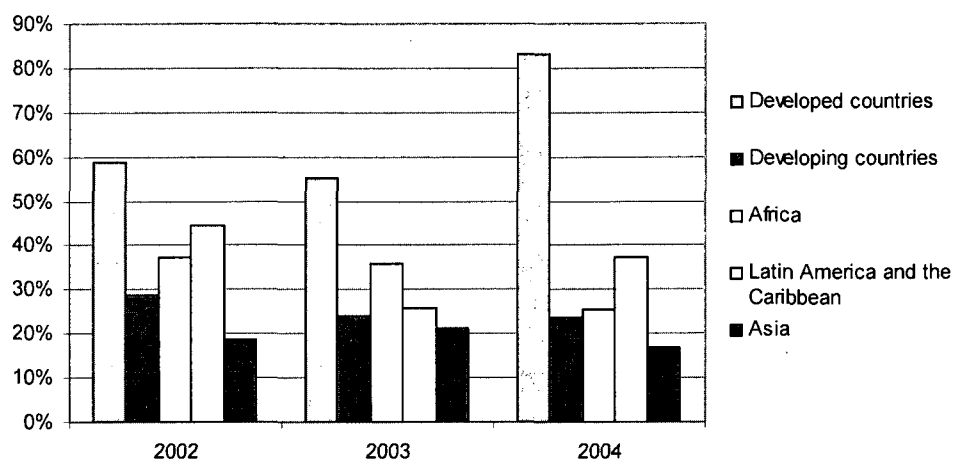


Fig. 2.10. The structure of the game

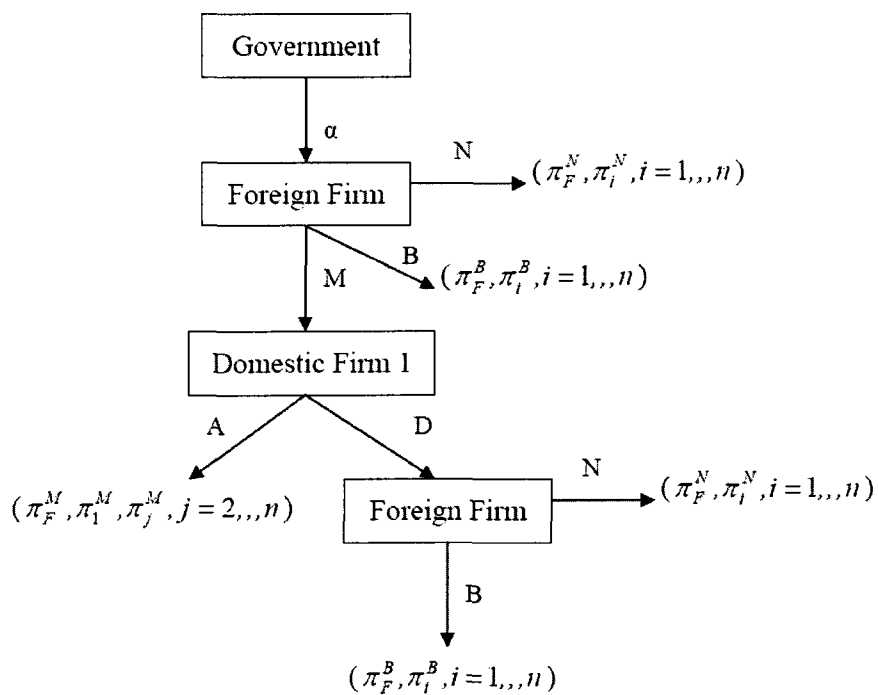


Fig. 2.11. Incentive compatible constraints for profit sharing rules

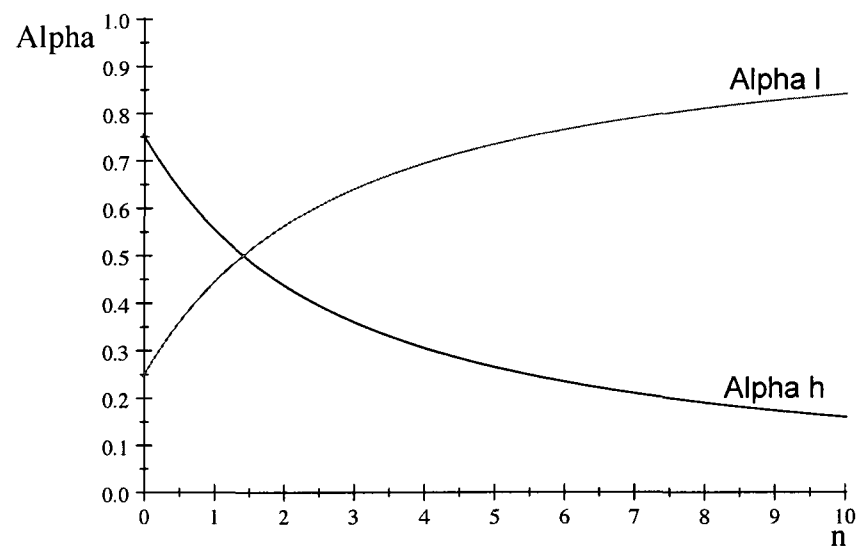


Table 2.1 Subgame perfect equilibria of the game

Stage 4: foreign firm	Stage 3: home firm	Stage 2: foreign firm	Stage 1: government
Case (a): $c_f > \hat{c}_f$, N is dominated by B. Foreign firm chooses "B".	$\alpha \leq \alpha_h$, home firm chooses "Accept"	$\alpha \geq \alpha_l$, foreign firm chooses "M"	If $\alpha_l \leq \alpha_h$ and $SW^M \geq SW^B$, government chooses $\alpha = \alpha_l$. $SW = SW^M$
		$\alpha < \alpha_l$, foreign firm chooses "B"	If $\alpha_l \leq \alpha_h$ and $SW^M < SW^B$, government chooses $\alpha < \alpha_l$ or $\alpha > \alpha_h$. $SW = SW^B$
	$\alpha > \alpha_h$, home firm chooses "Decline"	$\alpha \geq \alpha_l$, foreign firm chooses "M"	If $\alpha_l > \alpha_h$, government chooses $\alpha \in [0, 1]$. $SW = SW^B$
			If $\alpha_l \leq \alpha_h$ and $SW^M \geq SW^B$, government chooses $\alpha = \alpha_l$. $SW = SW^M$
		$\alpha < \alpha_l$, foreign firm chooses "B"	If $\alpha_l \leq \alpha_h$ and $SW^M < SW^B$, government chooses $\alpha < \alpha_l$ or $\alpha > \alpha_h$. $SW = SW^B$
			If $\alpha_l > \alpha_h$, government chooses $\alpha \in [0, 1]$. $SW = SW^B$
Case (b): $c_f \leq \hat{c}_f$, B is dominated by N. Foreign firm chooses "N".	$\alpha \leq \alpha_h$, home firm chooses "Accept"	$\alpha \geq \alpha_l^*$, foreign firm chooses "M"	If $\alpha_l^* \leq \alpha_h$ and $SW^{M^*} \geq SW^N$, government chooses $\alpha = \alpha_l^*$. $SW = SW^{M^*}$
		$\alpha < \alpha_l^*$, foreign firm chooses "N"	If $\alpha_l^* \leq \alpha_h$ and $SW^{M^*} < SW^N$, government chooses $\alpha < \alpha_l^*$ or $\alpha > \alpha_h$. $SW = SW^N$
			If $\alpha_l^* > \alpha_h$, government chooses $\alpha \in [0, 1]$. $SW = SW^N$
	$\alpha > \alpha_h$, home firm chooses "Decline"	$\alpha \geq \alpha_l^*$, foreign firm chooses "M"	If $\alpha_l^* \leq \alpha_h$ and $SW^{M^*} \geq SW^N$, government chooses $\alpha = \alpha_l^*$. $SW = SW^{M^*}$
		$\alpha < \alpha_l^*$, foreign firm chooses "N"	If $\alpha_l^* \leq \alpha_h$ and $SW^{M^*} < SW^N$, government chooses $\alpha < \alpha_l^*$ or $\alpha > \alpha_h$. $SW = SW^N$
			If $\alpha_l^* > \alpha_h$, government chooses $\alpha \in [0, 1]$. $SW = SW^N$

Chapter 3

Exploitation of Common Property Resources when Happiness Depends on Relative Consumption

3.1 Introduction

In discussing the pattern of economic growth in the past several decades, two common characteristics of developing economies are frequently observed: the ambiguity of property rights and the presence of multiple powerful groups in the society. For example, the lobbying and rent-seeking occur in the redistribution of fiscal revenue from the central government to provincial governments, also they are seen in the allocation of quota rents and windfall revenue of oil exports.

Many economists attribute poor growth to rent-seeking activities. Some have modelled a dynamic rent-seeking game, where agents extract from a common-property resource (either in the literal sense of a natural resource stock, as in Baland and Patrick 2000, Torvik 2002, Mehlum, Moene and Torvik 2006, or in the figurative sense of capital stocks, as in Lane and Tornell 1996, Tornell and Lane 1999). These models are based on the assumption that rent-seekers' utility is dependent only on their absolute consumption level. Therefore the externality in their models come from only the rent-seeking behavior itself, i.e., a substitute for entrepreneurship (Baland and Patrick 2000), or "voracity effects" (Tornell and Lane 1999).

On the other hand, there is mounting empirical evidence that supports the view that individuals care a great deal about their relative consumption, i.e., a person's happiness depends on the comparison of her consumption level with that of other members of her peer group. An individual is happier the more her consumption (or income) level exceeds the per-capita consumption (or income) of her reference group, as shown in the empirical studies by Clark and Oswald (1996), Neumark and Postlewaite (1998), Luttmer (2005), Dynan and Ravina (2007), and others. The literature of relative consumption can be traced back to Smith (1759) and Veblen (1899). Duesenberry (1949) and Pollak (1976) were among the first to formalize the theory of relative consumption. In the more recent literature, the interdependence in consumption has been subjected to rigorous refinements, and has been variously described as "keeping up with the Joneses" (Gali 1994), "status" (Fisher and Hof 2000), "jealousy" (Dupor and Liu 2003), or "envy" (Eaton and Eswaran 2003). These authors maintain the assumption that each person is the owner of his capital stock, and therefore the problem of rent-seeking does not arise in their models of status-seeking²³.

To better address the effects of rent-seeking on common property resources in an economic growth context, in this paper we introduce a dynamic rent-seeking model combined with status-seeking and interdependent preference. There are an increasing number of studies which focus on the impacts of status-seeking in the macroeconomics or endogenous growth literature. These models, known as "Ramsay status models", show that if utility is gained from relative consumption and agents are patient enough, the consumption

²³ Another study related to ours is Alvarez-Cuadrado and Long (2007), who assume, however, that property rights are perfectly enforced and that there is no rent-seeking. Our paper is different from theirs in that we deal with a common-property resource stock, and we explore the impact of the "status-consciousness" on the "tragedy of the commons" problem.

is too little and the growth rate is inefficiently high (see in Gali 1994, Persson 1995, Harbaugh 1996, Rauscher 1997, Grossmann 1998, Fisher and Hof 2000, and Ljungqvist and Uhlig 2000). However, the purpose of this paper is to explore the effect of this “positional externalities” on the urge to seek rent and to connect the “tragedy of the commons” problem with relative consumption. We model rent-seeking as exploitation from a common-property resource stock, as in Tornell and Velasco (1992), and Tornell and Lane (1999). Yet our model is different from theirs in two important aspects: first, we look for externalities not only from rent-seeking, but also from status-seeking, and second, they assume that rent-seekers are homogeneous²⁴. In contrast, we assume that agents gain utility from both absolute consumption and relative consumption, and we also consider the case where agents differ with respect to some characteristics such as the status preference and costs of rent-seeking.

More specifically, in this paper we model the representative agent of each powerful group who deals with rent-seeking and status-seeking simultaneously, and analyse the “status-seeking effect” on the “tragedy of the commons” problem. We find results for both cooperative equilibrium and Markov perfect equilibrium (MPE) by using a differential game setup. Compared to static models, the dynamic setup allows us to explore the growth rate of resource stocks, the equilibrium path of steady states and welfare comparisons, i.e., cooperative equilibrium versus Markov perfect ones. To summarize our main findings, we show that an increase in the status-seeking parameter (e.g., an increase in

²⁴ Furthermore, agents in their models can transfer revenue from a public capital stock to personal accounts, in which property rights are perfectly secured. Long and Sorger (2006) extend the model to the case of heterogeneous agents, and explicitly introduce effort costs.

the degree of envy) worsens the problem of over-exploitation of resources. Agents tend to behave more aggressively if they are more concerned about their relative status. Consequently, the social welfare is lower. In addition, the growth rate of the public asset is reduced due to higher extraction rates. We also show that with rent-seeking, an exogenous technical progress in the resource-extraction sector can reduce welfare, and the magnitude of this welfare-worsening effect is an increasing function of the status-seeking parameter. In a final section, we introduce heterogeneity, and show that the social welfare decreases if agents become more heterogeneous in terms of status-seeking, but it increases if they become more heterogeneous in terms of appropriation costs. By the very nature of rent-seeking and status seeking, so far we don't have much empirical evidence that could decompose these two effects. However, the examples and simulation results given in the final section do indicate that one can derive reduced form equations from this model for future empirical testing, or use it as a guideline for future case studies.

The rest of the paper is organized as follows. Section 3.2 presents the model and discuss the key assumptions. Section 3.3 characterizes the solution to a cooperative equilibrium (or the solution of a social planner's problem). Section 3.4 characterizes the Markov Perfect Nash Equilibrium and offer welfare comparisons. This is followed by introducing heterogeneity among agents, and studying the implications of increases in heterogeneity. Some concluding remarks and some discussion on policy implications are offered in Section 3.5.

3.2 A Simple Model

There are n agents. Let $c_i(t)$ denote the absolute consumption level of agent i at time t . Let $C_{-i}(t)$ denote the average consumption level of agent i 's peers:

$$C_{-i}(t) \equiv \frac{1}{n-1} \sum_{j \neq i} c_j(t) \quad (3.96)$$

We define $z_i(t)$ to be agent i 's relative consumption level:

$$z_i(t) \equiv \frac{c_i(t)}{C_{-i}(t)} \quad (3.97)$$

Let $E_i(t)$ denote agent i 's extraction rate from a common-property resource. We assume that the consumption rate $c_i(t)$ is a fraction of the extraction rate $E_i(t)$. Specifically, $E_i(t) = (1 + \theta_i)c_i(t)$. Here θ_i is a non-negative number that represents agent i 's “wastage rate”, which may be interpreted as reflecting his degree of inefficiency in transforming the extracted resource into the consumption good, or perhaps as the bribes or penalties that he must pay to third parties in his illicit resource-appropriation process.

Let $X(t)$ denote the stock level of the common-property resource. We assume that the rate of growth of X is given by the differential equation

$$\dot{X}(t) = AX(t) - \sum_{i=1}^n E_i(t) \quad (3.98)$$

where $A \geq 0$ is a constant. In what follows, we will omit the time index for simplicity of notation.

The *net-utility function* of agent i is denoted by $V(z_i, c_i, X, E_i)$ where

$$V = U(z_i, c_i, X) - \kappa_i E_i \quad (3.99)$$

The variable X appears in the utility function, because the stock X provides a flow of amenities (e.g. recreational uses) that each agent values. The non-negative parameter κ_i represents “the effort cost” of extracting the resource. This parameter may represent (a) a technological coefficient between effort and harvest level, so that a fall in κ_i represents a technological progress in resource extraction, or (b) the difficulty with which the agent hides his illegal activities. Note that we have introduced two separate parameters, θ_i and κ_i , that represent different types of cost of appropriation: κ_i is the “effort cost” which is measured in utility units, while θ_i is the “wastage cost”, which acts like an income tax.

We assume that each individual’s *gross-utility function* $U(z_i, c_i, X)$ is non-decreasing in her relative consumption, z_i , and increasing in her absolute consumption, c_i , and in the amenities provided by the stock, X :

$$\frac{\partial U}{\partial z_i} \geq 0, \frac{\partial U}{\partial c_i} > 0, \frac{\partial U}{\partial X} > 0$$

Furthermore, for any given C_{-i} , we denote by U_{c_i} the total derivative of U with respect to c_i :

$$U_{c_i} \equiv \frac{\partial U}{\partial z_i} \frac{dz_i}{dc_i} + \frac{\partial U}{\partial c_i} = \frac{\partial U}{\partial z_i} \frac{1}{C_{-i}} + \frac{\partial U}{\partial c_i}$$

and we assume that $U_{c_i} > 0$ and $U_{c_i c_i} < 0$. This means that, for any given C_{-i} , the individual’s utility is strictly increasing and strictly concave in his own consumption level, c_i . Strict concavity is assumed so that the second order condition for individual maximization is satisfied. To proceed further, we make the following specific assumptions:

Assumption A.1: The gross-utility function takes the form

$$U(z_i, c_i, X) = G(z_i)F(c_i, X)$$

where $F(c_i, X)$ is homogeneous of degree one²⁵, strictly-quasi-concave, and increasing in (c_i, X) , and $G(z_i)$ is positive and non-decreasing in z_i .

Without loss of generality, we set $G(1) = 1$. If $G'(\cdot) > 0$, we say that the agents are envious (concerned about relative consumption), while if $G'(\cdot) = 0$ identically, we say that the agents are non-envious.

For given z_i , the marginal rate of substitution of consumption c_i for X is

$$MRS_{c_i X} \equiv \frac{F_{c_i}}{F_X}$$

It is useful to define the ratio of consumption to amenity services by $\beta_i = c_i/X$. Since $F(c_i, X)$ is homogeneous of degree 1, we obtain

$$F(c_i, X) = XF(\beta_i, 1) \equiv Xf(\beta_i)$$

Under Assumption A1, it follows that $f'(\beta_i) = F_c > 0$, $f''(\beta_i) < 0$, $r(\beta_i) \equiv f(\beta_i) - \beta_i f'(\beta_i) = F_X > 0$ and $r'(\beta_i) = -\beta_i f''(\beta_i) > 0$. Hence

$$MRS_{c_i X} \equiv \frac{F_{c_i}}{F_X} = \frac{f'(\beta_i)}{f(\beta_i) - \beta_i f'(\beta_i)} \equiv \omega(\beta_i)$$

Clearly the marginal rate of substitution is diminishing in β_i :

$$\omega'(\beta_i) = \frac{f(\beta_i)f''(\beta_i)}{[f(\beta_i) - \beta_i f'(\beta_i)]^2} < 0$$

Assumption A.2: The function f satisfies the following Inada conditions:

$$\lim_{\beta \rightarrow 0} f'(\beta) = \infty, \quad \lim_{\beta \rightarrow \infty} f'(\beta) = 0$$

²⁵ The assumption of homogeneity of degree one in (c_i, X) is borrowed from Sorger (2005). It greatly simplifies the analysis.

Our analysis at a general level does not rely on a specific functional form for F nor G , however at places it will be convenient to specialize in the following Cobb-Douglas case:

$$U(z_i, c_i, X) = z_i^\lambda c_i^\mu X^{1-\mu} \text{ where } \lambda > 0 \text{ and } 0 < \mu < 1 \text{ and } \lambda + \mu < 1$$

Here, the parameter λ is an indicator of the strength of the status-consciousness. Note that U is strictly concave and increasing in c_i for given C_{-i} :

$$U_{c_i} = \lambda z_i^{\lambda-1} c_i^{\mu-1} X^{1-\mu} \left(\frac{1}{C_{-i}} \right) + \mu z_i^\lambda c_i^{\mu-1} X^{1-\mu} = X^{1-\mu} c_i^{\mu+\lambda-1} C_{-i}^{-\lambda} (\lambda + \mu) > 0$$

$$U_{c_i c_i} = (\mu + \lambda - 1) X^{1-\mu} c_i^{\mu+\lambda-2} C_{-i}^{-\lambda} (\lambda + \mu) < 0$$

3.3 The Cooperative Equilibrium

It is useful to begin with the following benchmark scenario. All agents are identical, and they cooperate by agreeing on a common rate of resource extraction: $E_i(t) = E(t)$. It follows that $c_i(t) = c(t)$ and $z_i(t) = 1$. It is as if there were a social planner seeking to solve the following optimization problem. Choose $c(t)$ to maximize

$$\int_0^\infty e^{-\rho t} [G(1)F(c, X) - \kappa(1 + \theta)c] dt \quad (3.100)$$

subject to

$$\dot{X} = AX - n(1 + \theta)c$$

with $X(0) = X_0$ and

$$\lim_{t \rightarrow \infty} X(t) \geq 0$$

To ensure convergence of the integral, we will assume:

Assumption A.3: The rate of discount exceeds the natural growth rate of the stock:

$$\rho > A.$$

Recall that $G(1) = 1$. The social planner's problem reduces to finding the time path of the control variable $\beta(t)$ that maximizes the welfare of the representative agent:

$$W^p = \int_0^\infty e^{-\rho t} [f(\beta) - \kappa(1 + \theta)\beta] X dt$$

subject to

$$\dot{X} = X [A - n(1 + \theta)\beta]$$

with $X(0) = X_0$ and

$$\lim_{t \rightarrow \infty} X(t) \geq 0$$

Let ψ denote the shadow price of the stock X . The Hamiltonian function is

$$H = [f(\beta) - \kappa(1 + \theta)\beta] X + \psi X [A - n(1 + \theta)\beta]$$

The necessary conditions include

$$\frac{\partial H}{\partial \beta} = X \{f'(\beta) - \kappa(1 + \theta) - n\psi(1 + \theta)\} = 0$$

$$\dot{\psi} = (\rho - A)\psi - [f(\beta) - (1 + \theta)(\kappa + n\psi)\beta]$$

and the transversality condition is

$$\lim_{t \rightarrow \infty} \psi(t)e^{-\rho t} \geq 0, \lim_{t \rightarrow \infty} X(t) \geq 0, \lim_{t \rightarrow \infty} \psi(t)e^{-\rho t} X(t) = 0 \quad (3.101)$$

Let us consider a candidate solution where $\beta(t) = \bar{\beta}$ (a constant). This yields a corresponding constant $\bar{\psi}$ where

$$f'(\bar{\beta}) = (1 + \theta)(\kappa + n\bar{\psi}) \quad (3.102)$$

or

$$\bar{\psi} = \frac{1}{n} \left[\frac{f'(\bar{\beta})}{(1+\theta)} - \kappa \right] \quad (3.103)$$

which implies that $\dot{\psi} = 0$, hence

$$(\rho - A)\bar{\psi} = f(\bar{\beta}) - (1 + \theta)(\kappa + n\bar{\psi})\bar{\beta} \quad (3.104)$$

Using (3.102) and (3.104),

$$(\rho - A)\bar{\psi} = f(\bar{\beta}) - \bar{\beta}f'(\bar{\beta}) > 0 \quad (3.105)$$

Substituting (3.103) into (3.105), we get the following equation which determines the optimal $\bar{\beta}$, say $\bar{\beta}^*$

$$\left[\frac{f'(\bar{\beta})}{(1+\theta)} - \kappa \right] = \frac{n [f(\bar{\beta}) - \bar{\beta}f'(\bar{\beta})]}{\rho - A} \quad (3.106)$$

Proposition 1: *Under Assumptions A1, A2 and A3, the cooperative solution consists of following the consumption strategy $c = \bar{\beta}^* X$, where $\bar{\beta}^*$ is the unique positive solution of equation (3.106).*

Proof:

First, let us show that $\bar{\beta}^*$ is unique. As shown in Figure 3.1, the left-hand side (LHS) of equation (3.106) is decreasing in $\bar{\beta}$, and as $\bar{\beta}$ varies from zero to infinity, the LHS varies from infinity to $-\kappa$. The RHS is positive for all positive $\bar{\beta}$, and increases as $\bar{\beta}$ increases. Thus the curve that represents the LHS must intersect the curve that represents the RHS exactly at one value, say $\bar{\beta}^*$. At $\bar{\beta}^*$, we have

$$\frac{f'(\bar{\beta}^*)}{(1+\theta)} - \kappa > 0 \quad (3.107)$$

(This is because the numerator of the right-hand side of (3.106) is positive for all $\beta > 0$, and the denominator is positive because $\rho > A$).

At the constant ratio $\bar{\beta}^*$ of consumption to stock, the growth rate of the stock is

$$g \equiv \frac{\dot{X}}{X} = A - n(1 + \theta)\bar{\beta}^* < A < \rho$$

(which may be positive or negative) and thus

$$X(t) = X_0 e^{gt}$$

Next, to show that the strategy $c = \bar{\beta}^* X$ is optimal, we can verify that all the necessary and sufficient conditions are satisfied. The transversality condition (3.101) is met, because $\psi(t) = \bar{\psi}^* > 0$ by (3.103) and (3.107), and because

$$\lim_{t \rightarrow \infty} \psi(t) e^{-\rho t} X(t) = 0 = \bar{\psi}^* X_0 \lim_{t \rightarrow \infty} e^{-\rho t} e^{gt} = 0$$

Since the objective function (3.100) is concave in (c, X) , and the constraints are linear, the necessary conditions are also sufficient. ■

Remark 1: Condition (3.106) has a straightforward interpretation. Given any $\bar{\beta}$, consider a small decrease in per-capita extraction, say dE at time zero. This will lead to a small decrease in consumption by $dc = dE/(1 + \theta)$. The marginal utility loss from reduced consumption (net of reduced extraction cost κ) is thus $[f'(\bar{\beta})(1 + \theta)^{-1} - \kappa] dE$. On the other hand, the impact effect on the stock is an increase by ndE , which leads to a stream of gain in marginal utility of amenities:

$$\int_0^\infty e^{-\rho t} \{ [f(\bar{\beta}) - \bar{\beta} f'(\bar{\beta})] (ndE) e^{At} \} dt = \frac{n [f(\bar{\beta}) - \bar{\beta} f'(\bar{\beta})]}{\rho - A} dE$$

At the optimal $\bar{\beta}^*$, the marginal utility loss from reduced consumption must equal the marginal utility gain from increased amenity services.

Remark 2: In the Cobb-Douglas case, assuming $\kappa = 0$, it can be verified that

$$\bar{\beta}^* = \frac{\mu(\rho - A)}{n(1 - \mu)(1 + \theta)} \quad (3.108)$$

and thus the growth rate of the public asset is

$$g = A - \frac{\mu(\rho - A)}{1 - \mu} \quad (3.109)$$

which can be negative or positive.

Proposition 2: *The welfare of the representative agent under cooperation is*

$$W^{coop} = \bar{\psi}^* X_0$$

where

$$\bar{\psi}^* = \frac{1}{n} \left[\frac{f'(\bar{\beta}^*)}{(1 + \theta)} - \kappa \right]$$

An increase in κ or in θ will reduce both $\bar{\beta}^*$ and welfare.

Proof: Since $X(t) = X_0 e^{gt}$

$$W^{coop} = \int_0^\infty e^{-\rho t} \left[f(\bar{\beta}^*) - \kappa(1 + \theta)\bar{\beta}^* \right] X_0 e^{gt} dt$$

$$W^{coop}(X_0) = \left[f(\bar{\beta}^*) - \kappa(1 + \theta)\bar{\beta}^* \right] X_0 \frac{1}{\rho - g} = X_0 \frac{f(\bar{\beta}^*) - \kappa(1 + \theta)\bar{\beta}^*}{\rho - A + n(1 + \theta)\bar{\beta}^*}$$

where, since $\rho - A > 0$, $\rho - g > 0$.

Now, from (3.104) and (3.105),

$$(\rho - A)\bar{\psi} = f(\bar{\beta}) - \bar{\beta}f'(\bar{\beta}) = f(\bar{\beta}) - \bar{\beta}(1 + \theta)(\kappa + n\bar{\psi}) \quad (3.110)$$

we obtain

$$(\rho - A + n(1 + \theta)\bar{\beta}^*)\bar{\psi}^* = f(\bar{\beta}^*) - \kappa(1 + \theta)\bar{\beta}^*$$

It follows that

$$\frac{f(\bar{\beta}^*) - \kappa(1 + \theta)\bar{\beta}^*}{\rho - A + n(1 + \theta)\bar{\beta}^*} = \bar{\psi}^* = \frac{1}{n} \left[\frac{f'(\bar{\beta}^*)}{(1 + \theta)} - \kappa \right] \quad (3.111)$$

where the last equality comes from (3.103). Therefore

$$W^{coop}(X_0) = \bar{\psi}^* X_0 \quad (3.112)$$

Thus welfare (per person) is the product of the shadow price $\bar{\psi}^*$ and the stock X_0 .

An increase in κ or θ will shift down the curve representing the left-hand side (LHS) of equation (3.106), so the intersection $\bar{\beta}^*$ is moved to the left. Direct computation shows that

$$\frac{\partial \bar{\beta}^*}{\partial \kappa} = \frac{(\rho - A)(1 + \theta)}{\left[\rho - A + n(1 + \theta)\bar{\beta}^* \right] f''(\bar{\beta}^*)} < 0 \quad (3.113)$$

Thus

$$\begin{aligned} \frac{\partial W^{coop}}{\partial \kappa} &= \frac{\partial \bar{\psi}^*}{\partial \kappa} X_0 = \frac{1}{(1 + \theta)n} \left[f''(\bar{\beta}^*) \frac{\partial \bar{\beta}^*}{\partial \kappa} - (1 + \theta) \right] X_0 \\ &= \frac{1}{n} \left[\frac{-n(1 + \theta)\bar{\beta}^*}{\rho - A + n(1 + \theta)\bar{\beta}^*} \right] X_0 < 0 \end{aligned}$$

A similar calculation shows that welfare falls if θ increases. ■

3.4 Non-cooperative resource extraction by envious agents

In this section, we study a differential game involving n identical players. Consider individual i . She faces $n - 1$ rival rent-seekers. Suppose she thinks that each rival j adopts a consumption strategy having a stationary feedback (i.e., stationary Markovian) form

$$c_j(t) = \phi_j(X(t)) \text{ where } \phi_j'(X) > 0 \text{ and } \phi_j(0) = 0$$

That is, at any moment of time, individual j 's consumption depends only on the currently observed stock level $X(t)$. The restriction that $\phi_j(0) = 0$ makes sense: when the resource stock is zero, it is impossible to extract any resource.

Then

$$C_{-i}(t) = \frac{1}{n-1} \sum_{j \neq i} \phi_j(X(t)) \equiv \Phi(X(t))$$

The optimization problem for individual i is then to choose a time path of consumption $c_i(t) \geq 0$ that maximizes her life-time utility

$$\int_0^\infty e^{-\rho t} \left\{ U \left(\frac{c_i(t)}{\Phi(X(t))}, c_i(t), X(t) \right) - \kappa(1 + \theta)c_i(t) \right\} dt$$

subject to

$$\dot{X}(t) = AX(t) - (n-1)(1 + \theta)\Phi(X(t)) - (1 + \theta)c_i(t)$$

and

$$\lim_{t \rightarrow \infty} X(t) \geq 0$$

This problem is a standard optimal control problem. Suppose the problem has a solution: a pair of time paths $(c_i(t), X(t))$ that maximizes the objective function. Then one can express the optimal control $c_i(t)$ as a function of the stock $X(t)$. Denote this function by $g_i(X)$:

$$c_i(t) = g_i(X(t))$$

Such a function $g_i(X)$ is player i 's "optimal Markovian strategy", given $\Phi(X)$. More formally, we say that the function $g_i(\cdot)$ is player i 's Markovian best reply to the $(n-1)$ tuple of Markovian strategies of her rivals, $(\phi_1(\cdot), \phi_2(\cdot), \dots, \phi_{i-1}(\cdot), \phi_{i+1}(\cdot), \dots, \phi_n(\cdot))$.

We are interested in the scenario where all players are facing similar optimization problems. This is a differential game among n players.

Definition: A Markov-perfect Nash equilibrium of the game described above is a n -tuple of Markovian strategies $(\phi_1^*(.), \phi_2^*(.), \dots, \phi_n^*(.))$ such that, for each player i ($i = 1, 2, \dots, n$), the function $\phi_i^*(.)$ is player i 's Markovian best reply to the $(n - 1)$ tuple of Markovian strategies of her rivals, $(\phi_1^*(.), \phi_2^*(.), \dots, \phi_{i-1}^*(.), \phi_{i+1}^*(.), \dots, \phi_n^*(.))$. (For a more precise and more general definition, see Dockner et al., 2000, or Long and Sorger, 2006.)

3.4.1 Finding a Markov-perfect Nash equilibrium: the case of identical agents

In this subsection, we will show that, when agents are identical, the game described above has a symmetric Markov-perfect Nash equilibrium, in which all players adopt the same linear Markovian strategy

$$c_j(t) = \beta X(t)$$

where β is a positive constant.

Suppose player i knows that all other players use the strategy $c_j(t) = \beta X(t)$. The optimization problem of agent i is to choose a time path of $c_i \geq 0$ that maximizes

$$\int_0^\infty e^{-\rho t} \left\{ G\left(\frac{c_i}{\beta X}\right) F(c_i, X) - \kappa(1 + \theta)c_i \right\} dt$$

subject to

$$\dot{X} = AX - (n - 1)(1 + \theta)\beta X - (1 + \theta)c_i$$

$$\lim_{t \rightarrow \infty} X(t) \geq 0$$

We may interpret $A - (n - 1)(1 + \theta)\beta$ as player i 's net rate of return on holding the asset.

Let ψ_i be the co-state variable. The Hamiltonian is

$$H_i = G\left(\frac{c_i}{\beta X}\right) F(c_i, X) - \kappa(1 + \theta)c_i + \psi_i [AX - (n - 1)(1 + \theta)\beta X - (1 + \theta)c_i]$$

The optimality conditions are

$$\frac{\partial H_i}{\partial c_i} = G'\left(\frac{c_i}{\beta X}\right) \left(\frac{1}{\beta X}\right) F(c_i, X) + G\left(\frac{c_i}{\beta X}\right) F_{c_i}(c_i, X) - (\kappa + \psi_i)(1 + \theta) = 0 \quad (3.114)$$

$$\dot{\psi}_i = \psi_i [\rho - A + (n - 1)(1 + \theta)\beta] + G'\left(\frac{c_i}{\beta X}\right) \left(\frac{c_i}{\beta}\right) X^{-2} F - G F_X \quad (3.115)$$

$$\dot{X} = \frac{\partial H_i}{\partial \psi_i} = AX - (n - 1)(1 + \theta)\beta X - (1 + \theta)c_i \quad (3.116)$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} \psi_i(t) \geq 0 \text{ and } \lim_{t \rightarrow \infty} e^{-\rho t} \psi_i(t) X(t) = 0 \quad (3.117)$$

Let us try a symmetric equilibrium, with

$$\frac{c_i(t)}{X(t)} = \frac{c_j(t)}{X(t)} = \beta \quad (3.118)$$

We must verify that the optimality conditions (3.114) to (3.117) are satisfied when the strategies described by equation (3.118) are used, for some suitable constant $\beta > 0$.

Using symmetry, equation (3.114) becomes

$$G'(1) \left(\frac{1}{\beta}\right) f(\beta) + G(1) f'(\beta) - \kappa(1 + \theta) - (1 + \theta)\psi_i(t) = 0 \quad (3.119)$$

This equation implies that $\psi_i(t)$ is a constant, i.e. $\dot{\psi}_i = 0$ along the equilibrium play. Hence we must have

$$\psi_i [\rho - A + (n - 1)(1 + \theta)\beta] =$$

$$-G'(1) f(\beta) + G(1) [f(\beta) - f'(\beta) \beta] \quad (3.120)$$

These two equations are satisfied iff there exists some $\hat{\beta} > 0$ which satisfies the following condition

$$\left[\frac{G'(1) f(\beta) \frac{1}{\beta} + G(1) f'(\beta)}{1 + \theta} - \kappa \right] [(\rho - A) + (n - 1)(1 + \theta)\beta] + G'(1) f(\beta) =$$

$$G(1) [f(\beta) - f'(\beta) \beta] \quad (3.121)$$

Proposition 3: *A Markov-perfect Nash equilibrium, where all players play a linear feedback strategy of the form $c = \beta X$, exists iff the equation (3.121) has a solution $\hat{\beta} > 0$.*

Example: The Cobb-Douglas Case

$$U = z_i^\lambda c_i^\mu X^{1-\mu}$$

Here, $G(z) = z^\lambda$, $G'(z) = \lambda z^{\lambda-1}$, $G(1) = 1$, $G'(1) = \lambda$, $f(\beta) = \beta^\mu$, $f'(\beta) = \mu\beta^{\mu-1}$,
 $f(\beta) - f'(\beta)\beta = (1 - \mu)\beta^\mu$

Eq (3.121) becomes

$$\left[\frac{\lambda\beta^{\mu-1} + \mu\beta^{\mu-1}}{1 + \theta} - \kappa \right] [(\rho - A) + (n - 1)(1 + \theta)\beta] =$$

$$-\lambda\beta^\mu + (1 - \mu)\beta^\mu$$

i.e.

$$\left[\frac{\lambda + \mu}{1 + \theta} - \kappa\beta^{1-\mu} \right] = \frac{(1 - \lambda - \mu)}{(\rho - A)\frac{1}{\beta} + (n - 1)(1 + \theta)} \quad (3.122)$$

The LHS of equation (3.122) is decreasing in β . As β varies from zero to infinity, the LHS falls from $(\lambda + \mu)/(1 + \theta)$ to minus infinity if $\kappa > 0$. The RHS is increasing in β , varying

from zero to $(1 - \lambda - \mu) / [(n - 1)(1 + \theta)]$ as β varies from zero to infinity. It follows that if $\kappa > 0$, there exists a unique positive $\hat{\beta}$ that equates the LHS with the RHS. Furthermore, an increase in κ will lower the curve representing the LHS, resulting in a smaller value of $\hat{\beta}$. An increase in λ will shift the curve representing the RHS down, and shift the curve representing the LHS up, resulting in a higher value of $\hat{\beta}$. (If $\kappa = 0$ then a positive $\hat{\beta}$ exists if and only if $n(\lambda + \mu) < 1$.)

Do these results apply to the general case? The answer is yes, provided the equation (3.121) has a unique solution $\hat{\beta} > 0$. Without loss of generality, we set $G(1) = 1$ and treat $G'(1)$ as a parameter: the higher is $G'(1)$, the higher is the degree of status-consciousness of the players. To simplify notation, denote the status consciousness parameter by $\lambda \equiv G'(1)$.

Proposition 4: *(The general case) Assume $\hat{\beta}$ is unique. Then*

(a) A higher degree of status-consciousness will result in a higher equilibrium rate of extraction and a lower public asset growth rate.

(b) An increase in κ or A will reduce the equilibrium rate of extraction, $\hat{\beta}$ and thus increase the growth rate of the public asset.

Proof: An increase in $G'(1)$ will shift upwards the curve representing the LHS of (3.121). Hence the intersection point $\hat{\beta}$ must move to the right. Similarly, an increase in κ or A shift downwards the curve representing the LHS of (3.121), thus moving $\hat{\beta}$ to the left. The growth rate of the public asset in the Markov-perfect equilibrium (*MPE*) is

$$\frac{\dot{X}}{X} = g^{MPE} = A - n(1 + \theta)\hat{\beta}$$

It follows that an increase in κ or A will increase the growth rate of the public asset. ■

Remark: The result (b) above is in sharp contrast to that of Long and Sorger (2006), where an increase in κ (interpreted as an increase in the cost of money laundering) will increase extraction, and reduce the growth rate of the public asset. The reason for the difference is that in Long and Sorger (2006), agents can “store” the amount they extract from the common-property resources by investing it in a private asset. In our model, the quantity extracted must be consumed. Also, for the same reason, our result is different from Tornell and Lane (1999), in that in our model an increase in A , the return of the public asset, will not result in greater appropriation rates.

Proposition 5: *(comparing the cooperative solution with the non-cooperative equilibrium) The cooperative rate of extraction, $\bar{\beta}^*$, is lower than the non-cooperative rate of extraction $\hat{\beta}$, with which a tragedy of the commons occurs.*

Proof: Re-write eq (3.106) as follows

$$\left[\frac{f'(\beta)}{(1+\theta)} - \kappa \right] \left(\frac{\rho - A}{n} \right) = f(\beta) - \beta f'(\beta) \quad (3.123)$$

and compare with

$$\left[\frac{\lambda f(\beta)^{\frac{1}{\beta}} + f'(\beta)}{1+\theta} - \kappa \right] [\rho - A + (n-1)(1+\theta)\beta] + \lambda f(\beta) = f(\beta) - \beta f'(\beta) \quad (3.124)$$

We first prove that when $\lambda = 0$, $\hat{\beta}$ must exceed $\bar{\beta}^*$. Both equations have the same right-hand side, which is an increasing function of β ; as β varies from 0 to infinity, $f(\beta) - \beta f'(\beta)$ rises continuously. The left-hand side of equation (3.123) is downward sloping, and is positive for all $\beta < \beta_H$ where by definition $f'(\beta_H) = (1+\theta)\kappa$. For all $\beta < \beta_H$, the value of the LHS of eq (3.124) is greater than that of equation (3.123). It follows that $\hat{\beta}$ exceeds $\bar{\beta}^*$. Now, if $\lambda > 0$, this will make $\hat{\beta}$ even greater. ■

Proposition 6: *(comparing welfare levels) The cooperative solution yields a higher welfare level than that of the Markov perfect equilibrium.*

Proof:

Recall from the cooperative solution that

$$W^{coop} = \bar{\psi}^* X_0$$

$$\bar{\psi}^* = \frac{f(\bar{\beta}^*) - \kappa(1 + \theta)\bar{\beta}^*}{\rho - A + n(1 + \theta)\bar{\beta}^*} = \frac{1}{(1 + \theta)n} \left[f'(\bar{\beta}^*) - \kappa(1 + \theta) \right]$$

The welfare of the representative agent in the Markov-perfect equilibrium is

$$\begin{aligned} W^{MPE} &= \int_0^\infty e^{-\rho t} \left[f(\hat{\beta}) - \kappa(1 + \theta)\hat{\beta} \right] X_0 e^{gt} dt \\ &= \left[f(\hat{\beta}) - \kappa(1 + \theta)\hat{\beta} \right] X_0 \frac{1}{\rho - g} = X_0 \frac{f(\hat{\beta}) - \kappa(1 + \theta)\hat{\beta}}{(\rho - A + n(1 + \theta)\hat{\beta})} \end{aligned}$$

Now,

$$\begin{aligned} (\rho - A + (1 + \theta)(n - 1)\hat{\beta})\hat{\psi} &= f(\hat{\beta}) - \hat{\beta}f'(\hat{\beta}) - G'(1)f(\hat{\beta}) \\ &= f(\hat{\beta}) - \hat{\beta} \left[f'(\hat{\beta}) + G'(1)\frac{f(\hat{\beta})}{\hat{\beta}} \right] \\ &= f(\hat{\beta}) - \hat{\beta}(1 + \theta)(\kappa + \hat{\psi}) \end{aligned}$$

where the first equality comes from (3.120) and the third one comes from (3.119). Therefore

$$\hat{\psi} = \frac{f(\hat{\beta}) - \kappa(1 + \theta)\hat{\beta}}{\rho - A + n(1 + \theta)\hat{\beta}}$$

$$W^{MPE} = \hat{\psi} X_0 \tag{3.125}$$

Let's denote

$$\psi = \psi(\beta) = \frac{f(\beta) - \kappa(1 + \theta)\beta}{\rho - A + n(1 + \theta)\beta} \tag{3.126}$$

We want to show that

$$\bar{\psi}^* > \hat{\psi}$$

The cooperative equilibrium can be transformed to an equivalent problem:

$$\underset{\beta}{Max} W^{coop} = \psi(\beta)X_0$$

Therefore, the first-order condition of the problem above must yield

$$\psi'(\beta) = 0$$

which gives

$$\frac{\partial \psi(\beta)}{\partial \beta} = \frac{[f'(\beta) - \kappa(1 + \theta)] [\rho - A + n(1 + \theta)\beta] - n(1 + \theta) [f(\beta) - \kappa(1 + \theta)\beta]}{(\rho - A + n(1 + \theta)\beta)^2} = 0$$

Rearrange terms in the numerator, we have

$$\left[\frac{f'(\beta)}{(1 + \theta)} - \kappa \right] = \frac{n [f(\beta) - \beta f'(\beta)]}{\rho - A} \quad (3.127)$$

which is identical to (3.106) used to determine the cooperative equilibrium strategy $\bar{\beta}^*$ in Section 3. The second order condition is satisfied. This implies that the curve $\psi(\beta)$ defined by (3.126) reaches its maximum at $\beta = \bar{\beta}^*$. Therefore the MPE solution $\hat{\beta}$ must yields a smaller ψ , hence a lower welfare. Figure 3.2 depicts the curve $\psi(\beta)$. ■

Remark: Since $\hat{\beta} > \bar{\beta}^*$ as shown in Proposition 5, we must have $\psi'(\hat{\beta}) < 0$, which indicates the welfare in the MPE case is decreasing in β , i.e. $\hat{\beta}$ always lies to the right of $\bar{\beta}^*$ (Fig 3.2 illustrates this situation).

Combining Propositions 5 and 6, it is interesting to note that the cooperative equilibrium has both higher welfare level and greater resource growth rate. Let's explore some intuition behind these results. In the cooperative equilibrium or the social planner's problem, the agents know *ex ante* that their consumption levels will be equal thus the status-conscious parameter λ doesn't play a role in the equilibrium. In the MPE case, however, the agents will observe the resource stock at the beginning of each period and make her own decision about the extraction rate, each trying not to be behind, even though they know that in the symmetric equilibrium their consumption levels will be equal *ex post*. The "positional externalities" imposed by the status-consciousness can only be eliminated by cooperation.

We have shown in Proposition 2 that a fall in κ leads to a higher welfare in the cooperative equilibrium. We now show that, in contrast, in the case of a non-cooperative equilibrium, a fall in κ can decrease the noncooperative welfare, i.e., technological progress in resource extraction can be welfare-worsening when agents are non-cooperative. Furthermore, the absolute magnitude of the negative impact of technological progress on welfare is an increasing function of the degree of status-consciousness. The next proposition is a formalization of this result.

Proposition 7: *A technological progress in resource extraction can reduce welfare in the non-cooperative case. This fall in welfare is an increasing function of the degree of status-consciousness.*

Proof: By (3.119), and recall that $G(1) = 1$,

$$\hat{\psi} = \frac{1}{1+\theta} \left[G'(1) \frac{f(\hat{\beta})}{\hat{\beta}} + f'(\hat{\beta}) - \kappa(1+\theta) \right] \quad (3.128)$$

Thus, using (3.128) and (3.125),

$$\frac{dW^{MPE}}{d\kappa} = X_0 \frac{d\hat{\psi}}{d\kappa} = \frac{X_0}{1+\theta} \left\{ \left[G'(1) \left(\frac{\hat{\beta} f'(\hat{\beta}) - f(\hat{\beta})}{\hat{\beta}^2} \right) + f''(\hat{\beta}) \right] \frac{d\hat{\beta}}{d\kappa} - (1+\theta) \right\} \quad (3.129)$$

Now, since the term inside the square brackets is negative, and $\frac{d\hat{\beta}}{d\kappa}$ is also negative, the sign of the expression inside the curly brackets is ambiguous. Let us explore the special Cobb-Douglas case.

Implicit differentiation of equation (3.122) shows that, if $\theta = 0$,

$$\frac{d\hat{\beta}}{d\kappa} = \frac{-\hat{\beta}^{1-\mu} [\rho - A + (n-1)\hat{\beta}]}{1 - n(\lambda + \mu) + (n-1)\kappa\hat{\beta}^{1-\mu} + \kappa(1-\mu)\hat{\beta}^{-\mu} [\rho - A + (n-1)\hat{\beta}]} < 0$$

We evaluate this derivative at $\kappa = 0$:

$$\frac{\partial \hat{\beta}}{\partial \kappa} = \frac{-\hat{\beta}^{1-\mu} [\rho - A + (n-1)\hat{\beta}]}{1 - n(\lambda + \mu)} < 0$$

Now, from (3.122), at $\kappa = 0 = \theta$,

$$\rho - A + (n-1)\hat{\beta} = \frac{(1-\lambda-\mu)\hat{\beta}}{\lambda + \mu}$$

So, at $\kappa = 0$

$$\frac{\partial \hat{\beta}}{\partial \kappa} = -\hat{\beta}^{2-\mu} \left[\frac{(1-\lambda-\mu)}{(\lambda + \mu)(1 - n(\lambda + \mu))} \right] \quad (3.130)$$

Substituting (3.130) into (3.129), we see that the effect of an increase in κ on the equilibrium welfare level is positive if and only if

$$(1-\mu)(1-\mu-\lambda) > [1 - n(\mu + \lambda)](1+\theta)$$

For $\theta = 0$, this inequality is equivalent to

$$n > \frac{\mu}{\mu + \lambda} + (1 - \mu)$$

Since the right-hand side is smaller than 2, it follows that the condition is satisfied if $n \geq 2$.

We conclude that for the Cobb-Douglas case, with $\theta = 0$, a marginal increase in κ from a sufficiently small initial value κ_0 will increase the Markov-perfect equilibrium welfare level. The greater is λ , the greater is the magnitude of the increase in welfare, because

$$\frac{d}{d\lambda} \left[\frac{(1 - \mu)(1 - \mu - \lambda)}{[1 - n(\mu + \lambda)]} - (1 + \theta) \right] > 0$$

■

Remark: This result represents the situation that a small increase in κ may be welfare-improving because the benefits from resource stock preserving outweigh the utility loss from less extraction and consumption (see the case in Figure 3.2, $\hat{\beta}$ reduces to $\hat{\beta}'$ but the welfare is greater than before). However, it won't happen in the cooperative equilibrium since the cooperative equilibrium extraction rate $\bar{\beta}^*$ is always the welfare-maximizing extraction rate.

3.4.2 Heterogeneous agents

So far we have focused on the case of homogeneous players. This section examines the effects of heterogeneity among agents on the properties of Markov-perfect Nash equilibria. To simplify the analysis, we focus on the case where there are only two groups of players. More specifically, let us assume that there are $n_1 \geq 2$ players described by the parameters $(\rho_1, \theta_1, \kappa_1)$ with the utility function G_1 and f_1 , and $n_2 \geq 2$ players described by the

parameters $(\rho_2, \theta_2, \kappa_2)$ with the utility function G_2 and f_2 . The total number of players is $n = n_1 + n_2$. We assume that assumptions A1-A3 hold for both group of players, and the agents in each group compare their consumption with other members in the same group only.

Analysis

Following the method used in section 3.4.1, we can set up the maximization problem for each group and solve the Hamiltonians. It is worth to note that the transition equations for each group are now different, i.e., for agent i in group 1:

$$\dot{X} = AX - (n_1 - 1)(1 + \theta_1)\beta_1 X - (1 + \theta_1)c_{i1} - n_2(1 + \theta_2)\beta_2 X$$

For agent i in group 2:

$$\dot{X} = AX - (n_2 - 1)(1 + \theta_2)\beta_2 X - (1 + \theta_2)c_{i2} - n_1(1 + \theta_1)\beta_1 X$$

The Hamiltonians become

$$\begin{aligned} H_{i1} = & G_1 \left(\frac{c_{i1}}{\beta_1 X} \right) F_1(c_{i1}, X) - \kappa_1(1 + \theta_1)c_{i1} + \\ & \psi_{i1} [AX - (n_1 - 1)(1 + \theta_1)\beta_1 X - (1 + \theta_1)c_{i1} - n_2(1 + \theta_2)\beta_2 X] \end{aligned} \quad (3.131)$$

$$\begin{aligned} H_{i2} = & G_2 \left(\frac{c_{i2}}{\beta_2 X} \right) F_2(c_{i2}, X) - \kappa_2(1 + \theta_2)c_{i2} + \\ & \psi_{i2} [AX - (n_2 - 1)(1 + \theta_2)\beta_2 X - (1 + \theta_2)c_{i2} - n_1(1 + \theta_1)\beta_1 X] \end{aligned} \quad (3.132)$$

The optimality conditions are

$$\begin{aligned}\frac{\partial H_{i1}}{\partial c_{i1}} &= G'_1 \left(\frac{c_{i1}}{\beta_1 X} \right) \left(\frac{1}{\beta_1 X} \right) F_1(c_{i1}, X) + G_1 \left(\frac{c_{i1}}{\beta_1 X} \right) F_{c_{i1}}(c_{i1}, X) \\ &\quad - \kappa_1(1 + \theta_1) - (1 + \theta_1)\psi_{i1} \\ &= 0\end{aligned}$$

$$\begin{aligned}\frac{\partial H_{i2}}{\partial c_{i2}} &= G'_2 \left(\frac{c_{i2}}{\beta_2 X} \right) \left(\frac{1}{\beta_2 X} \right) F_2(c_{i2}, X) + G_2 \left(\frac{c_{i2}}{\beta_2 X} \right) F_{c_{i2}}(c_{i2}, X) \\ &\quad - \kappa_2(1 + \theta_2) - (1 + \theta_2)\psi_{i2} \\ &= 0\end{aligned}$$

Each type of agents has the corresponding necessary conditions, for example, for n_1 type of agents:

$$\begin{aligned}\dot{\psi}_{i1} &= \psi_{i1} [\rho_1 - A + (n_1 - 1)(1 + \theta_1)\beta_1 + n_2(1 + \theta_2)\beta_2] \\ &\quad + G' \left(\frac{c_i}{\beta X} \right) \left(\frac{c_i}{\beta} \right) X^{-2} F - G F_X\end{aligned}\tag{3.133}$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} \psi_{i1}(t) \geq 0 \text{ and } \lim_{t \rightarrow \infty} e^{-\rho t} \psi_{i1}(t) X(t) = 0\tag{3.134}$$

Again we assume that there exist two symmetric linear solutions for these two groups:

$$\frac{c_{i1}(t)}{X(t)} = \beta_1, \frac{c_{i2}(t)}{X(t)} = \beta_2 \text{ where } \beta_1 \text{ and } \beta_2 \text{ are constants}\tag{3.135}$$

Substitution yields

$$\begin{aligned}G'_1(1) \left(\frac{1}{\beta_1} \right) f_1(\beta_1) + G_1(1) f'_1(\beta_1) - \kappa_1(1 + \theta_1) - (1 + \theta_1)\psi_{i1} &= 0 \\ G'_2(1) \left(\frac{1}{\beta_2} \right) f_2(\beta_2) + G_2(1) f'_2(\beta_2) - \kappa_2(1 + \theta_2) - (1 + \theta_2)\psi_{i2} &= 0\end{aligned}$$

These two equations imply that ψ_1 and ψ_2 are also constants, i.e. $\dot{\psi} = 0$ along the equilibrium path. Hence we must have

$$\left[\frac{G'_1(1)f_1(\beta_1)\frac{1}{\beta_1} + G_1(1)f'_1(\beta_1)}{1 + \theta_1} - \kappa_1 \right] [\rho_1 - A + (n_1 - 1)(1 + \theta_1)\beta_1 + n_2(1 + \theta_2)\beta_2] =$$

$$-G'_1(1)f_1(\beta_1) + G_1(1)[f_1(\beta_1) - f'_1(\beta_1)\beta_1] \quad (3.136)$$

$$\left[\frac{G'_2(1)f_2(\beta_2)\frac{1}{\beta_2} + G_2(1)f'_2(\beta_2)}{1 + \theta_2} - \kappa_2 \right] [\rho_2 - A + (n_2 - 1)(1 + \theta_2)\beta_2 + n_1(1 + \theta_1)\beta_1] =$$

$$-G'_2(1)f_2(\beta_2) + G_2(1)[f_2(\beta_2) - f'_2(\beta_2)\beta_2] \quad (3.137)$$

The growth rate of the public asset is therefore given by

$$g = A - n_1(1 + \theta_1)\beta_1 - n_2(1 + \theta_2)\beta_2 \quad (3.138)$$

We use the previous Cobb-Douglas example to show some analytical results. The equations analog to (3.136) and (3.137) are

$$\left[\frac{\lambda_1\beta_1^{\mu_1-1} + \mu_1\beta_1^{\mu_1-1}}{1 + \theta_1} - \kappa_1 \right] [\rho_1 - A + (n_1 - 1)(1 + \theta_1)\beta_1 + n_2(1 + \theta_2)\beta_2] =$$

$$-\lambda_1\beta_1^{\mu_1} + (1 - \mu_1)\beta_1^{\mu_1} \quad (3.139)$$

$$\left[\frac{\lambda_2\beta_2^{\mu_2-1} + \mu_2\beta_2^{\mu_2-1}}{1 + \theta_2} - \kappa_2 \right] [\rho_2 - A + (n_2 - 1)(1 + \theta_2)\beta_2 + n_1(1 + \theta_1)\beta_1] =$$

$$-\lambda_2\beta_2^{\mu_2} + (1 - \mu_2)\beta_2^{\mu_2} \quad (3.140)$$

To solve the system of two equations analytically, we assume that $\kappa_1 = \kappa_2 = 0$. There are two equations for two unknowns, the solutions are:

$$\hat{\beta}_1 = \frac{1}{1 + \theta_1} \frac{(\lambda_1 + \mu_1)[\rho_1 - n_2(\rho_1 - \rho_2)(\lambda_2 + \mu_2) - A]}{1 - n_1(\lambda_1 + \mu_1) - n_2(\lambda_2 + \mu_2)} \quad (3.141)$$

$$\hat{\beta}_2 = \frac{1}{1 + \theta_2} \frac{(\lambda_2 + \mu_2)[\rho_2 - n_1(\rho_2 - \rho_1)(\lambda_1 + \mu_1) - A]}{1 - n_1(\lambda_1 + \mu_1) - n_2(\lambda_2 + \mu_2)} \quad (3.142)$$

(Note that if $\theta_1 = \theta_2$, $\lambda_1 + \mu_1 = \lambda_2 + \mu_2 < 1/n$ and $n_1 = n_2 = n/2$, then $\hat{\beta}_1 > \hat{\beta}_2$ if and only if $\rho_1 > \rho_2$, i.e., the more impatient group extracts the resource stock at a faster rate.)

Since this model is featured by relative consumption appearing in the agents' utility function, we are especially interested in the effect of heterogeneity in the status-conscious parameter λ on the equilibrium outcome. For example, if we assume there is a mean-preserving spread of λ among agents, i.e., $\lambda_1 = \lambda + \frac{\eta}{n_1}$, $\lambda_2 = \lambda - \frac{\eta}{n_2}$ with $\eta > 0$, how are the growth rate of public assets and welfare affected by an increase in η ? The following proposition explains this effect.

Proposition 8: *In the Cobb-Douglas case with $\kappa_1 = \kappa_2 = 0$,*

(a) *A mean-preserving spread in the distribution of the status-conscious parameter λ leads to an increase of the public asset growth rate iff $\rho_2 > \rho_1$, i.e., iff the members of the group with stronger status-consciousness are more patient.*

(b) *If the status-conscious parameter λ is the only source of heterogeneity, a mean-preserving spread in the distribution of λ across agents leads to a decrease of the social welfare.*

Proof:

(a) Substitute $\hat{\beta}_1$ and $\hat{\beta}_2$ into (3.138) and take derivative with respect to η will yield

$$\frac{\partial g}{\partial \eta} = \frac{\rho_2 - \rho_1}{1 - n_1(\lambda_1 + \mu_1) - n_2(\lambda_2 + \mu_2)}$$

by definition, $1 - n_1(\lambda_1 + \mu_1) - n_2(\lambda_2 + \mu_2) > 0$, therefore $\frac{\partial g}{\partial \eta} > 0$ iff $\rho_2 > \rho_1$.

(b) The social welfare is the total sum of individual welfare and is given by

$$SW = n_1 W_1 + n_2 W_2 = \frac{n_1 \beta_1^{\mu_1} X_0}{\rho_1 - g} + \frac{n_2 \beta_2^{\mu_2} X_0}{\rho_2 - g} \quad (3.143)$$

If $\lambda_1 = \lambda + \frac{\eta}{n_1}$, $\lambda_2 = \lambda - \frac{\eta}{n_2}$ and all other parameters are equal across two groups,

we have

$$\begin{aligned} \frac{\partial SW}{\partial \eta} &= 0 \Rightarrow \left(\frac{n\lambda - \eta + n\mu}{n(1 + \theta)} \right)^{\mu-1} = \left(\frac{\eta + n\lambda + n\mu}{n(1 + \theta)} \right)^{\mu-1} \\ &\Rightarrow \eta^* = 0 \end{aligned}$$

$$\frac{\partial^2 SW}{\partial \eta^2} < 0 \text{ at } \eta^* = 0$$

■

The above proposition shows that if λ differs across the two groups, the social welfare will be lower than in the case of homogeneous agents. If the policy maker observes this and looks for some policy to improve this situation, the government could impose two different costs θ_1 and θ_2 to each group. In fact, this policy can achieve a second-best outcome and it will not affect the public asset growth. The next section illustrates this and the proof is given in the Appendix (See Appendix 3.A, Proposition A.1).

Simulation results: the joint effects of λ and θ on social welfare

In this section the joint effects of λ and θ on social welfare are given by simulation. Again, suppose $\theta_1 = \theta + \frac{\varepsilon}{n_1}$, $\theta_2 = \theta - \frac{\varepsilon}{n_2}$ and $\lambda_1 = \lambda + \frac{\eta}{n_1}$, $\lambda_2 = \lambda - \frac{\eta}{n_2}$. Substituting them into the social welfare function in (3.143) we can express social welfare as a function of ε and η . The plot of social welfare is given in Figure 3.3 (assuming $X_0 = 1$, $\rho = 0.2$, $A = 0.1$, $\lambda = 0.2$, $n_1 = 10$, $n_2 = 10$, $\mu = 0.2$, $\theta = 0.1$).

The saddle-shape diagram allows us to confirm our findings in previous section that a mean-preserving spread in the distribution of λ across agents leads to an decrease of the social welfare, while a mean-preserving spread in the appropriation cost θ will increase the social welfare, *ceteris paribus*. Therefore, if the agents are different in the degree of status consciousness, which reduces the social welfare, the policy maker can apply two tax rates to these agents and can still achieve a second-best outcome.

3.5 Concluding remarks

This paper explores the role of status-consciousness in rent-seeking in a dynamic setting. The agents in the economy are concerned with not only their absolute level of consumption, but also the relative consumption level within their groups. In the cooperative equilibrium, or equivalently the social planner's problem, the outcome is not affected by the concern for relative consumption. If agents behave non-cooperatively, we show that the status-consciousness parameter λ indeed plays an important role in the model. A higher degree of λ leads to more aggressive extraction efforts, therefore the social welfare and the growth

rate of the public resource are lower. This effect has not been explored in the previous literature on rent-seeking models. We have therefore shown that “positional externalities” worsen the “tragedy of the commons” problem.

Another feature of our model is that we introduce two types of cost within the rent-seeking process, a “wastage-cost” θ and an “effort-cost” κ . In contrast with Long and Sorger (2006), we show that an increase in κ will reduce the equilibrium rate of extraction and increase the growth rate of the public asset. Thus if the policy maker’s primary objective is to protect the public asset from over-extraction, imposing a higher effort-cost (stricter policing of money-laundering) is preferred. We also show that a technological progress, i.e., a smaller κ , can worsen welfare in a rent-seeking equilibrium. The magnitude of this welfare-worsening effect is an increasing function of the degree of status-consciousness. In the analysis for heterogeneous agents, we show that the heterogeneity in the status-conscious parameter λ will reduce social welfare. However, if the agents are different in both θ and λ , we show that positional externalities caused by λ can be mitigated by different wastage-costs, which can be achieved by discriminatory tax rates.

There are several ways our model can be extended. First, one may suppose there exist some external limits for the extraction of the public asset. Thus the agents will optimize their extraction in a constrained problem. Second, with the use of a Cobb-Douglas utility function, one can derive all results in closed form and obtain linear or log-linear equations that are readily adaptable for empirical tests. These extensions are parts of our future research plans.

An Appendix to Chapter 3

3.A The effect of heterogeneity in production costs on the public asset growth and welfare

Proposition A.1: *In the Cobb-Douglas case with $\kappa_1 = \kappa_2 = 0$*

(a) *The growth rate of the public asset is not related to the production costs, θ_1, θ_2 .*

(b) *If the appropriation cost θ is the only source of heterogeneity, a mean-preserving spread in the distribution of this cost across agents leads to an increase of the social welfare.*

Proof:

(a) Denote

$$B_1 = \frac{(\lambda_1 + \mu_1)(\rho_1 - n_2(\rho_1 - \rho_2)(\lambda_2 + \mu_2) - A)}{1 - n_1(\lambda_1 + \mu_1) - n_2(\lambda_2 + \mu_2)}$$

$$B_2 = \frac{(\lambda_2 + \mu_2)(\rho_2 - n_1(\rho_2 - \rho_1)(\lambda_1 + \mu_1) - A)}{1 - n_1(\lambda_1 + \mu_1) - n_2(\lambda_2 + \mu_2)}$$

Substitution yields

$$g = A - n_1(1 + \theta_1)\hat{\beta}_1 - n_2(1 + \theta_2)\hat{\beta}_2 = A - n_1B_1 - n_2B_2 \quad (3.A1)$$

where it is clear that g is not affected by θ_1 and θ_2 .

(b) Let's consider the social welfare under heterogeneity,

$$SW = n_1W_1 + n_2W_2 = \frac{n_1\beta_1^{\mu_1}X_0}{\rho_1 - g} + \frac{n_2\beta_2^{\mu_2}X_0}{\rho_2 - g}$$

Suppose $\theta_1 = \theta + \frac{\varepsilon}{n_1}$, $\theta_2 = \theta - \frac{\varepsilon}{n_2}$,

Let's assume that $\mu_1 = \mu_2 = \mu$ and denote $f(\varepsilon) = (\rho_2 - g)n_1\beta_1^\mu + (\rho_1 - g)n_2\beta_2^\mu$,

We have,

$$\begin{aligned} f'(\varepsilon) &= -\frac{(\rho_2 - g)\mu\beta_1^{\mu-1}}{(1 + \theta_1)^2} B_1 + \frac{(\rho_1 - g)\mu\beta_2^{\mu-1}}{(1 + \theta_2)^2} B_2 = 0 \\ \Rightarrow \varepsilon^* &= \frac{(\theta + 1)(1 - C)}{\frac{1}{n_1}C + \frac{1}{n_2}} \end{aligned}$$

Where

$$C = \left(\frac{B_2^\mu g - \rho_1}{B_1^\mu g - \rho_2} \right)^{\frac{1}{\mu+1}}$$

and

$$f''(\varepsilon^*) = \frac{(\mu + 1)}{n_1 n_2} \left(\frac{(\rho_1 - g)B_2^\mu n_1}{(1 + \theta_2)^{\mu+2}} + \frac{(\rho_2 - g)B_1^\mu n_2}{(1 + \theta_1)^{\mu+2}} \right) > 0$$

If $\rho_1 = \rho_2$, $\lambda_1 = \lambda_2$, then we have,

$$\varepsilon^* = \frac{(\theta + 1)(1 - 1)}{\frac{1}{n_1} + \frac{1}{n_2}} = 0 \quad (3.A2)$$

■

Fig. 3.12. The determination of the equilibrium extraction rate

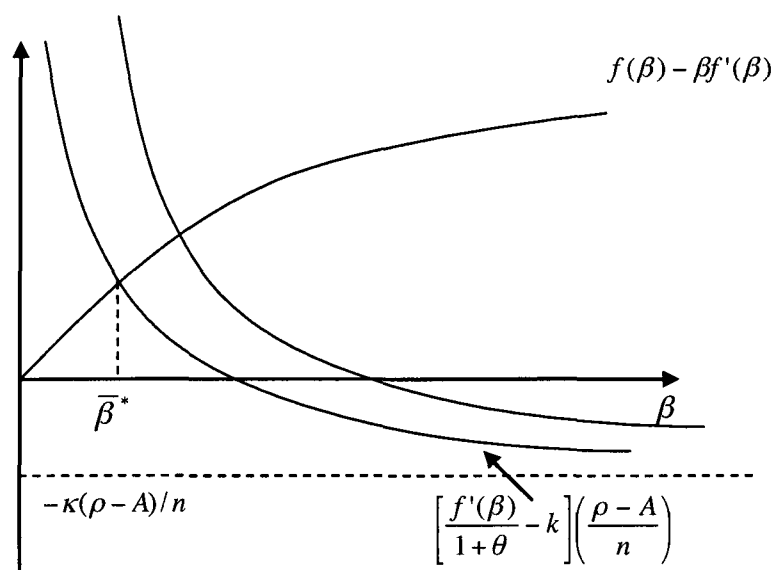
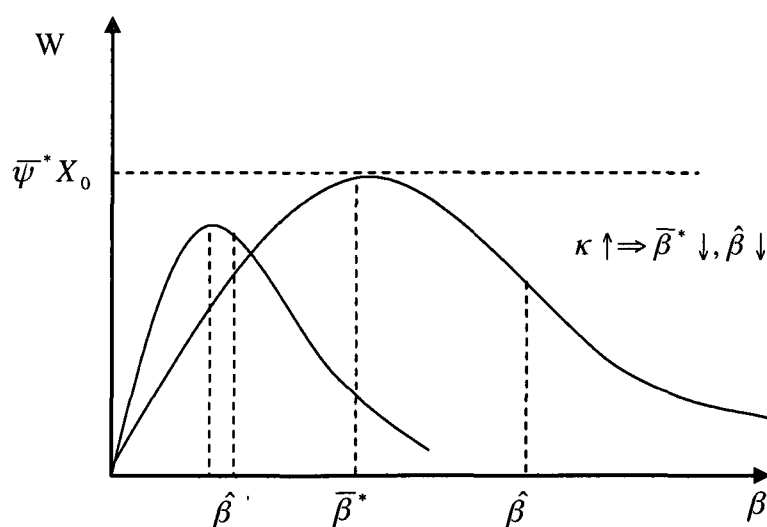
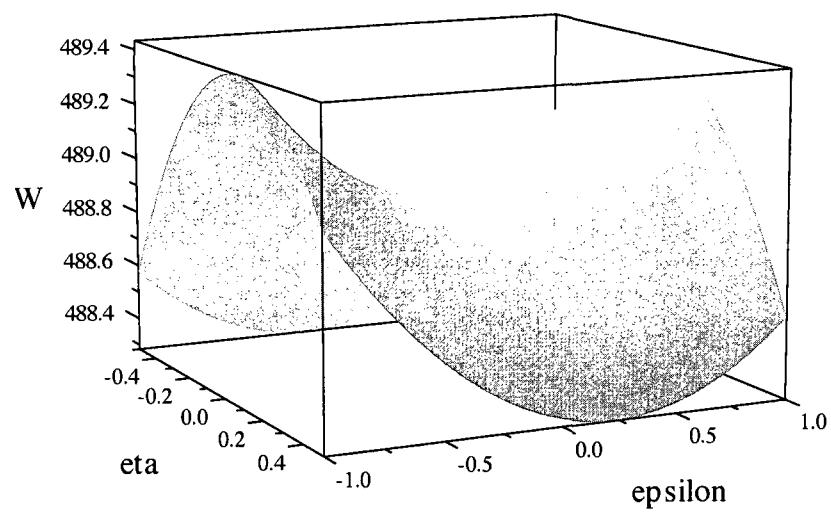
Fig. 3.13. The effect of an increase in κ on welfare and extraction rates

Fig. 3.14. The joint effect of heterogeneity in λ and θ on social welfare

Conclusion

Economic policies in developing countries have a distinctive nature. For low-income countries and emerging market ones which are undergoing significant structural changes and economic growth, they have not reached steady states as industrialized countries did two decades ago thus policies in these countries should be carefully designed and conducted to meet their unique circumstances, sometimes there were even lessons and tragedies.

The thesis reviewed several policy issues in developing and emerging market economies, including exchange rate and monetary policies, FDI policy and policies towards rent-seeking of status-conscious agents. The first chapter examines exchange rate volatility in the content of monetary policy credibility and the central bank's policy target. It shows that exchange rate volatility is lower when central banks adhere to a commitment-of-rule based monetary policy (thus establishing credibility) vis-a-vis a discretion-based policy (when the market is left to guess the central bank's reaction to a shock). The results from this essay may provide a guideline for promoting independent monetary institutions in developing countries. Transparent, responsible and credible monetary policy has been proved to be the best stabilization tool in advanced economies and it is highly possible that this applies to developing ones. The model in this chapter can be further modified to suit special needs, i.e., capital account openness, endogenous price flexibility and further empirical studies for individual countries.

The second essay considers entry modes FDI inflows together with government policies and welfare implication. Essentially it answers the following two questions: why do

FDI flows enter so differently into developing and developed countries? How can the government policy of FDI be modeled into this process given plenty of evidence that these policies do exist? The answers to questions above are that, if the cost-saving effect is large and the government sets up the profit sharing rule for mergers, the foreign firm will consider the FDI investment through either Greenfield or Brownfield, which corresponds to the situation for FDI flows into developing countries. Otherwise, the foreign firm will only consider merger or staying outside, which stands for the developed economy case. Policies such as capital share limitations have not been very successful since sometimes the outcome is not what the government prefers due to the market or bargaining power and fixed cost of entry (the entry barrier). On the other hands, the results from the essay imply that technology advances or R&D efforts may improve the competitiveness of the firms more significantly. The model can be extended into a dynamic and repeating game setup to capture other factors that affect FDI flows, including trade policies, forward-looking behavior of the government and firms.

The last essay focuses on a dynamic resource-grabbing process by status-conscious agents and its social welfare consequence. It is commonly known that there always exist powerful groups in the economy and rent-seeking is frequently seen in those underdeveloped countries. In many cases property rights are not well defined and regulated thus the point of the essay is that more aggressive behavior by status-conscious agents exacerbate "the tragedy of the commons" problem. An important feature of the model is that two types of cost within the rent-seeking process are introduced, a "wastage-cost" and an "effort-cost". We show that if the policy maker's primary objective is to protect the pub-

lic asset from over-extraction, imposing a higher effort-cost (stricter policing of money-laundering) is preferred. We also show that a technological progress can worsen welfare in a rent-seeking equilibrium. The magnitude of this welfare-worsening effect is an increasing function of the degree of status-consciousness. In the analysis for heterogeneous agents, we show that positional externalities caused by status-consciousness can be mitigated by different wastage-costs, which can be achieved by discriminatory tax rates. The future research agenda on this topic includes using of a Cobb-Douglas utility function to derive all results in closed form solutions and to obtain linear or log-linear equations that are readily adaptable for empirical tests.

To my best of knowledge, the dream of economists consists of finding good policies which promotes growth and have greater benefits than their costs, and they could compensate the losers and still have benefits left over. In other words, we always look for welfare improving but Pareto efficient policies. However, this dream might not generally be realized. In real world, it is often too difficult to identify potential losers, evaluate the total gains, and avoid mistakes. Therefore, with only a few exceptions, we have to live with the fact that there is no first-best outcome from most real world policy changes—even good ones. The hope, and I believe it is justified, is that when good policies are the general rule, the losers from one policy will end up gaining from a number of others, and thus few will be net long-term losers. The challenging world of economic development, integration and coordination, needs us to do much more, even beyond economics.

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