Jian-Guang Shen

Models of Currency Crises with Banking Sector and Imperfectly Competitive Labor Markets

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Abstract

This study extends the standard currency crisis theory (especially the second-generation models) by adding and emphasizing strategic interactions of agents in anticipating currency crises. The models in this study have a fairly elaborate and extensive micro-based structure, covering the household, firm, bank and central bank. Domestic interest rates are determined in a Stackelberg game where the bank is the leader and the firm the follower. The central bank's exchange rate decision is a function of private sector expectations on the exchange rate and international interest rates. Under certain world interest rates the pegged exchange rate can be sustained, as domestic fundamentals are compatible with the external monetary environment. Under other world interest rates, varying expectations on exchange rates can result in more than one equilibrium exchange rate. In addition, the higher the world interest rate, the higher the equilibrium devaluation rate.

In the latter part of the study, the wage rate is endogenously determined in a bargaining framework and fiscal policy in the form of infrastructure investment is introduced. The interaction between fiscal policy and the wage bargaining process is incorporated into the basic model framework. The trade union's bargaining power and marginal labor disutility, as well as fiscal expenditure can also play a role in the exchange rate policy. The different time sequence of actions of the trade union and business sector makes a difference in the equilibrium exchange rates. Under certain conditions, the interaction between trade union and fiscal authority can break the 'wage-devaluation' spiral.

Key words: currency crisis, banking sector, Stackelberg game, wage bargaining, the Finnish crisis.

Tiivistelmä

Tässä tutkimuksessa laajennetaan valuuttakriisejä kuvaavia tavanomaisia malleja (erityisesti ns. toisen sukupolven malleja) painottamalla niissä talouden toimijoiden kriisejä ennakoivan strategisen käyttäytymisen osuutta aiempaa enemmän. Tässä tutkimuksessa esitetyissä malleissa on melko pitkälle kehittynyt ja kattava mikro-perusteinen rakenne, joka sisältää edustavan kotitalouden, yrityksen, pankin ja keskuspankin. Kotimaiset korot määräytyvät ns. Stackelberg-pelissä, jossa pankki toimii ensin ja yritys seuraa. Keskuspankin valuuttakurssipäätös riippuu yksityisen sektorin valuuttakurssiodotuksista ja kansainvälisistä koroista. Kiinteä valuuttakurssi voidaan säilyttää tietyn kansainvälisen korkotason vallitessa, jos kotimaiset talouden perustekijät sopivat yhteen rahatalouden ulkoisten olosuhteiden kanssa. Jos korkotaso on jokin muu, erilaiset valuuttakurssiodotukset voivat johtaa tilanteeseen, jossa on useita tasapainovaluuttakursseja. Lisäksi osoittautuu, että devalvoitumisaste on tasapainossa sitä korkeampi, mitä korkeampi kansainvälinen korkotaso on.

Tutkimuksen jälkimmäisessä osassa tarkastellaan tilannetta, jossa palkkataso määräytyy endogeenisesti neuvottelumallissa. Infrastruktuuri-investointien kautta malliin lisätään myös finanssipolitiikka. Perusmalliin siis yhdistetään finanssipolitiikan ja palkkaneuvottelujen riippuvuus toisistaan. Ammattiliiton neuvotteluvoima ja työvoiman rajakustannukset samoin kuin valtion menot voivat myös vaikuttaa valuuttakurssipolitiikkaan. Ammattiliiton ja yityssektorin päätösten eriaikaisuudella on tärkeä merkitys tasapainovaluuttakurssin määräytymisen kannalta. Tietyissä olosuhteissa ammattiliiton ja finanssipolitiikan päätösten riippuvuus toisistaan voi rikkoa toistuvien palkankorotusten ja devalvaatioiden kierteen.

Asiasanat: valuuttakriisit, pankkijärjestelmä, Stackelberg-peli, palkkaneuvottelut, Suomen talouskriisi.

Foreword

Looking at the final manuscript of this study, I feel deeply indebted to my supervisors and official examiners, Professor Erkki Koskela, at the University of Helsinki, and Professor Pertti Haaparanta at the Helsinki School of Economics and Business Administration, who have guided me through the licentiate to the doctoral thesis in the past few years. I have benefited immensely from their constant encouragement, and constructive and insightful comments. They have guided me through many difficulties in the study, and their suggestions are instrumental in shaping the final outcome. I can hardly thank them enough.

The present study is a theoretical enquiry into the issues of currency crises. Based on my licentiate thesis, this study was essentially completed in one and a half year period that, by the goodwill of my superior Dr Pekka Sutela, for whose support and encouragement I am most grateful, at the Bank of Finland Institute for Economies in Transition, BOFIT, I was able to spend in peace in completing the study. I feel very fortunate to have this opportunity, and I am very thankful to the Bank of Finland for allowing me to complete and publish the study. The Bank of Finland in general, and BOFIT in particular, provided excellent work environment and facilities. Inside the bank, Dr Jouko Vilmunen of the research department and Dr Jukka Pirttilä of BOFIT were particularly helpful and gave very supportive and helpful comments and suggestions on various issues.

The root of this study stems from my rewarding stay at the Research Institute of the Finnish Economy, ETLA. My interest in this topic was stimulated by the extensive publications by ETLA on the Finnish crisis. During that period, I was interested in building econometric models to test various aspects of debates arising from the crisis. I was myself surprised by the change in the final outcome of the study. I wish to thank my superiors at ETLA, particularly Dr Pentti Vartia, for the encouragement and support in initiating the research, which led to a licentiate thesis. In addition, Dr Kari Alho, Dr Jukka Lassila and Mr Paavo Suni at ETLA also encouraged my pursuit of academic research and gave valuable suggestions.

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Finally, I would like to thank my wife Qiong Wang for encouraging and sometimes propelling me to make progress in this study. Without her constant support and inspiration, I would have hardly completed the study by now. This thesis is dedicated to her.

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Jian-Guang Shen

Contents

1 Introduction

The world economy has witnessed increasingly frequent currency crises in recent years. In the 1980s several countries in Latin America suffered a wave of currency crises that resulted in economic stagnation for almost a decade.[1] In 1992 some countries in Europe, including Finland, Sweden, Britain and France, were forced to abandon their pegged exchange rate regimes. These economies subsequently experienced a period of uncertainty and distress.[2] At the end of 1994 Mexico suffered a peso crisis, with the currency depreciating rapidly and capital fleeing from the country. Only after a massive injection of capital from the United States did the situation stabilize.[3] The Asian currency and financial crisis of 1997–1998 had devastating consequences for Asia as well as other emerging markets. The sudden shift from 'Asian Miracle' to 'Asian Paper Tigers' has stimulated enormous and continuous interest in currency crises. There is now a growing literature on all aspects of the Asian Crisis.[4]

These currency crises are characterized by large devaluations of currencies that had previously been fairly stable. When a pegged exchange rate regime is abandoned suddenly, the currency often suffers a rapid and pronounced loss of value. Capital rushes out of the country and economic activity slows down sharply, which deals a heavy blow to the improvement of welfare of the country concerned. Kaminsky and Reinhart (1996), Tornell (1999) and Aziz et al (2000) provide more details about empirical facts of these crises. The grave consequences of currency crises make it important to understand the logic of currency crises as well as how government policies may relate to crises.

The purpose of this study is to build theoretical models of currency crises. These models extend the standard currency crisis theory (especially the second-generation models) by adding and emphasizing strategic interactions of agents in anticipating currency crises. The

[1] For example in the Mexico crisis in 1982, it was the default in sovereign debts that caused a currency crisis. A series of articles investigate various aspects of these crises. See eg Edwards (1998) and Bacchetta and Wincoop (1998).

[2] See eg Eichengreen and Wyplosz (1993), Jonung et al (1996), Honkapohja and Koskela (1999), and Jeanne and Masson (2000).

[3] See eg Calvo and Mendoza (1996), Sachs et al (1996), Tornell (1999), and Balino and Ubide (1999) for details.

[4] See eg Aziz et al (2000), Corsetti et al (1998), Radelet and Sachs (1998), Furman and Stiglitz (1998), Tornell (1999), Berg (1999) and Boorman et al (2000).

models focus on the role of the banking sector in determining interest rates, which has important implications for the central bank's decision on the exchange rate. The overall impacts of devaluation on private sector profits depend on a tradeoff between the benefits to the open sector and the costs to the foreign debt bearers. The central bank's exchange rate decision is based on this tradeoff and ultimately is a function of private sector expectations on exchange rates and international interest rates. The nonlinearity of the solutions results in multiple equilibria of the equilibrium exchange rates.

In addition, both the trade union's optimal decisions on wage rates and the government's fiscal policy can also influence the overall profits of the private sector. A centralized wage bargaining system in Finland and the government's participation in this process provide the trade union and fiscal authority with meaningful roles to play in the exchange rate decision. This institutional characteristic is taken account of via two extensions to the basic theoretical model. The wage rate and fiscal expenditure are each a function of the expected exchange rate, and they influence exchange rate determination. The central bank's exchange rate decision is ultimately a function of private sector expectations on exchange rates and international interest rates, as well as wage rates and fiscal spending.

Some institutional features of the Finnish economy and empirical evidence on the Finnish currency crisis are featured in the models in this study. Most importantly, we try to incorporate certain stylized facts in the models: the time lag between deposit and lending interest rate liberalization prior to the currency crisis, price stickiness despite a huge devaluation after the crisis, the widening interest rate spread during the crisis, the orientation of exchange rate policy toward competitiveness, and a highly centralized wage bargaining system. These represent the assumptions made in the models, as well as empirical features emphasized in this study.

However, this study is not an empirical study of the Finnish crisis. It is instead a theoretical study of currency crises, using stylized facts from the Finnish crisis as a starting point for making assumptions. In addition, the Finnish wage bargaining receives particular attention. These particular features and institutional characteristics are incorporated in the theoretical models, where the integration of the self-fulfilling currency crisis theory with the modeling of interest rate setting by a banking sector is the focus. Thus this study has different angels and emphases from many other studies, both theoretical and empirical, on the Finnish currency crisis.

The settings of the basic model used here to analyze monetary policy and currency crises are similar in various aspects to other self-fulfilling currency crisis models, particularly those of Obstfeld (1994), Ozkan and Sutherland (1998) and Edwards and Vegh (1997). However, the basis model in this study differs from the others in some key areas. Most importantly, the model here has a fairly elaborate and extensive micro-based structure, covering the household, firm, bank and central bank. In extensions, the trade union and fiscal authority are included to introduce endogenous wage setting and fiscal decision-making. Thus this study analyzes currency crises by emphasizing strategic interactions among these agents. The intertemporal optimal decision of the household is pursued, which is very important for understanding saving behavior.[5] A game theoretic framework, where the firm and bank interact, is employed. A banking sector is modeled so that interest rates can be determined endogenously. The distinction between international interest rate, domestic deposit rate and lending rate allow detailed descriptions of actual developments in the financial market and facilitate fairly comprehensive analyzes.

The existence of a banking sector has profound implications on monetary policy and economic activity. In macroeconomic theory, the role of financial institutions and variables is often neglected. But recent developments in economic theory highlight an increasingly promising role for financial-related factors. In this study an endogenous banking sector is modeled to maximize its profit in the traditional lending and borrowing business. The emphasis is on the incorporation of the banking sector in the basic currency crisis models and the interest rate channels through which exchange rate policy is conducted. The incorporation of the banking sector in the standard second-generation currency crisis models is a novel feature here, as most second-generation currency crisis models abstract from detailed analysis of agent behavior.

As in normal second-generation currency crisis models, the switch of exchange rate regime is considered the result of an optimizing decision by the central bank. The central bank's decision on the exchange rate is based on the interaction of all other agents as well as their expectations on the future exchange rate. The central bank faces conflicting interests in deciding the exchange rate, which will have different impacts on the open and closed sectors. The model is likely to have multiple solutions, as is often the case in other second-generation currency crisis models.

[5] The intertemporal optimal decision and hence the saving behavior are analyzed in chapter 3, but are abstracted from in chapter 4 and 5, for simplicity.

Under a fixed exchange rate system, the dynamic time-inconsistency problem of the central bank is the root cause of multiple solutions. A simplified version of the model shows that only under certain conditions, can the pegged exchange rate be maintained. Otherwise two equilibria will exist. The first one features no deviation of the private sector's expectations from the fixed exchange rate system. Then it is always in the central bank's interest to maintain the fixed exchange rate. The second one features a currency crisis as the change in expectations validates a change in economic fundamentals, which makes the change in the exchange rate ideal given the central bank's policy preferences. Thus the currency crisis is really self-fulfilling.

The policy implication of the self-fulfilling currency crisis theory is that, under a pegged exchange rate system, central banks are always facing a policy dilemma under severe speculative attacks: whether to defend or abandon the fixed exchange rate system. As long as the fixed exchange rate system is taken as a cornerstone of monetary policy, every effort is taken to insure the maintenance of this policy. Central banks often announce that they will defend the peg under any circumstances. It is rational to do so because private sector expectations are very important in maintaining a fixed exchange rate regime.

In times of adversity, foreign debts are an important reason for not changing a fixed exchange rate policy. The cost of abandoning the policy is enormous, not only due to the loss of credibility,[6] but also due to the blow to domestic agents who accumulated foreign debts without proper hedging. Otherwise the abandonment of the fixed exchange rate is often considered a way of pushing the economy to an export-led recovery when there are external shocks that are too big for the economy to sustain. A big devaluation is particularly welcome to the export sector, as enhanced competitiveness gained from devaluation not only improves the profit margin, but also increases market share abroad. Thus central banks do face a tradeoff between defending or abandoning the pegged exchange rate system. Private sector expectations of future monetary policy (particularly exchange rate policy) become very important.

In summary, some recent currency crises can be partially attributed to the ill preparedness of policymakers for the new phenomenon of

[6] The credibility issue, as well as the interaction between central bank and speculators, is abstracted from in this study.

free capital mobility and its consequences. When the deregulation of capital control is not accompanied by tighter supervision of financial institutions, and when there is a lack of pre-emptive strikes on the ballooning of foreign debts and asset prices, an economy aiming at a fixed exchange rate regime may be vulnerable to speculative attacks. If there are shocks to the economy, eg a surge in the world interest rates, the policymakers may find themselves facing a dilemma regarding defense of the fixed exchange rate regime.[7] As a result, an optimizing policymaker may well abandon the peg when the expectations on this action are strong enough.

In order to maintain successfully the pegged exchange rate system, coordination of other policies is also important. Under the pegged exchange rate system and without capital controls, the monetary authority cannot manipulate interest rates for the purpose of demand management. Thus other policy instruments, particularly fiscal policy and labor market policy, can play an important role.

In an extension to the basic model, where the impacts of interest rate channel are emphasized, endogenous wage determination is introduced in a bargaining framework. The wage rate is endogenously determined in the interaction among the trade union, firm and bank. The trade union's bargaining power and marginal labor disutility can also play a role in exchange rate policy. Generally speaking, the more bargaining power the trade union has and the stronger its marginal disutility, the higher the wage rate it will demand. This will result in a larger devaluation. In addition, the different time sequence of actions of the trade union and business sector has impacts on economic performance and exchange rate policy. More specifically, when the bank is a Stackelberg leader vs the trade union in deciding interest and wage rates, capital investment and the firm's profit are smaller and the equilibrium devaluation rate is higher than is the case when the bank is a Stackelberg follower vs the trade union.

The role of fiscal policy in currency crises is explored in another extension. Fiscal policy is always a focal point in currency crisis models. However, in this study the focus on the interaction of a fiscal authority and a trade union in deciding fiscal policy and the wage bargaining solution is rather unique. The fiscal authority can use fiscal

[7] As Honkapohja and Koskela (1999, p. 402) state: 'At this stage, the alternatives available to the authorities are all bad. If they want to defend the value of the currency, the authorities have to raise domestic interest rates, which hurts the highly indebted private sector. If they want to improve the weakened competitiveness of export sector, a devalued exchange rate hurts whose who have borrowed abroad.'

policy to moderate wage demand, so as to lessen the pressure on devaluation. While devaluation expectations will trigger a 'devaluation expectations-wage-devaluation' spiral, under certain conditions, an expansionary fiscal policy can offset the adverse impact of an increase in wage rates on a firm's profit and thus prevent real devaluation.

The structure of this study is as follows. Chapter 2 is a survey of theoretical and empirical work on currency crises. A review of currency crisis theories and the evolution of theoretical development of the banking sector in economic modeling is carried out in the first two sections. The following section surveys the empirical studies on currency crises. The last section highlights several stylized facts in the Finnish currency crisis.

Chapters 3–5 concentrate on building an integrated currency crisis model. Chapter 3 lays down the basic assumptions and model structures, and reproduces and outlines the mechanism of multiple equilibria for exchange rates. The key contributions are the incorporation of an endogenous banking sector in second-generation currency crisis models, with emphasis on strategic interactions among economic agents and interest rate channels through which exchange rate policy is effected.

The next two chapters relax the assumptions in chapter 3 in turn and add two important institutional aspects. Chapter 4 deals with wage determination in a bargaining framework. The wage rate is endogenously determined in a 'right-to-manage' framework where the trade union has an important role to play in currency crises. The relation between trade union behaviour and currency crisis is, to my knowledge, not analyzed in the literature of currency crises. But this relation could be rather important in the Finnish case. Chapter 5 adds a fiscal authority to the model in Chapter 4. Fiscal policy is always a focus in currency crisis models. However, here the strategic interaction of a fiscal authority and trade union in deciding fiscal policy and wage is highlighted. Chapter 6 summarizes the study.

2 Theory and empirical work on currency crises: a survey

2.1 A review of currency crisis theory

The traditional currency crisis theory emphasises the quantity of limited foreign reserves in causing currency crises. A currency crisis occurs when there is massive speculative selling of domestic currency and the central bank neither has enough foreign exchange reserves nor is willing to borrow.

This 'first-generation' currency crisis model[8] stresses the role of unsustainable monetary and fiscal policy in precipitating a currency crisis. If a government constantly prints money to finance persistent budget deficits, its stock of foreign reserves will fall. Once foreign reserves fall to a critical level, speculators anticipating the collapse of the pegged exchange rate will attack the currency, which will lead to a collapse of the fixed exchange rate system.

This theory of currency crisis initiated by Krugman (1979) is influential because it demonstrates how currency crisis can happen well before the total exhaustion of foreign exchange reserves. The introduction of rational expectations into currency crisis analyzes is a significant contribution. It is the incompatibility of government policy that is the root cause of currency crises. However, the first generation model depends on the dubious assumption that the policymaker always sticks to vulnerable policies. It is not rational to assume that the government will stick to obviously faulty policies.

Corsetti-Pesenti-Roubini (1999) build on the first-generation currency crisis models along the line of Krugman (1979), and show that these types of models are able to explain new phenomena, particularly those of the Asian crisis, once some modifications are made to the basic setting. The logic of speculative attacks is the same as in Krugman, but Corsetti et al (1999) endogenize the rate of money growth by the policymaker. In addition, the paper focuses on so-called 'debt socialization', which means that the implicit guarantee of

[8] It is initially formulated in Krugman (1979), who develops the work on speculative attacks on price-fixing schemes in exhaustible resource markets by Salant and Henderson (1978) and applies it to currency crisis models. For surveys of the currency crisis literature, see Blackbum and Sola (1993) and Garber and Svensson (1995).

foreign debt results in over-indebtedness and subsequently currency crisis when there are shocks.

The increasingly significant global trade and capital flow stimulated new thinking on currency crises in the 1990s. This 'first-generation' currency crisis model in its original version seems to be unable to account fully for the crisis in Finland in 1991–1992, the EMS crisis of 1992, or the Asian crisis of 1997–1998. Thus the effect of self-fulfilling expectations has gained more prominence in research on currency crises.

The 'second generation' currency crisis model[9] stresses the consequences of rational expectations for the potential downfall of a fixed exchange rate regime. Stimulated by Flood and Garber (1984), Obstfeld (1986) develops this theory and makes it widely known. Later models add an optimizing government that follows certain kinds of contingent policies. Keeping the exchange rate fixed is not the sole aim of the government, and an exchange rate escape clause is incorporated.[10] Speculation will become a self-fulfilling process, and even a currency at its equilibrium value can suffer a drastic depreciation. It is the time inconsistency of policymaking that is the root cause of currency crises. This type of model has now gained wide acceptance. See for example De Kock and Grilli (1993), Dellas and Stockman (1993), Obstfeld (1994, 1996, 1997), Bensaid and Jeanne (1994) and Ozkan and Sutherland (1998).

Obstfeld (1994) is a classic paper that provides two self-fulfilling currency crisis models, in which the crisis and realignment of exchange rates result from interaction between rational private agents and a policymaker with well-defined goals. In the first model, high interest rates associated with devaluation expectations can force a government to abandon the fixed exchange rate policy even though the peg itself can be sustained if private agents have different expectations. In the second model the policymaker may devalue the currency out of a desire to offset external shocks to the economy. Both models are subject to multiple equilibria because: 'Speculative anticipations depend on conjectured government responses, which in turn depend on how price changes that are themselves fuelled by expectations affect the government's economic and political positions.

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[9] Krugman (1998) comments, "The quick review of the main episodes in the decade to date indicates pretty clearly that crises in the 90s are best described by 'second-generation' models – that is, the motives for devaluation lie in the perceived need for more expansionary monetary policies rather than in budget deficits and inflation."

[10] For the rationale behind the escape clause, see Drazen and Masson (1994).

This circular dynamic implies a potential for crises that need not have occurred, but that do occur because market participants expect them to'.[11]

Bensaid and Jeanne (1994) extend the findings of Obstfeld (1994) by emphasizing the role of nominal interest rates as well as dynamic aspects of the crisis. They point out that there is a contradiction in the use of nominal interest rates to defend the fixed exchange rate. Modeling currency crises as a dynamic process, and they show how the nominal interest rate and the probability of devaluation can increase together until a devaluation occurs. A fixed exchange rate system is vulnerable because: 'raising the nominal interest rate does not only help to maintain the parity; it may also be costly for the economy. Foreign exchange market participants are aware that this cost creates incentives for the government to stop defending the parity, which in turn increases their expectations of devaluation. This makes possible vicious circles in which the nominal interest rate and probability of devaluation grow together, until the cost becomes too large and devaluation actually occurs.'

Ozkan and Sutherland (1998) are similar in many ways to Obstfeld (1994), but they place emphasis on trigger points in currency crises. In their model, the policymaker's optimizing problem is to choose the trigger level of the demand shock at which to abandon the fixed exchange rate regime and make way for looser monetary policy and a boost to aggregate demand. Agents know the policymaker's optimization problem and build their expectations of a regime switch into interest rate differentials as the demand shock progresses, which in turn affects the policymaker's decision to devalue.

It should be emphasized that the distinction between first and second generation crisis models does not lie in whether crises are due to 'fundamentals' or 'purely' self-fulfilling expectations. 'The fundamental factors in these (second generation) models are the dynamic-consistency problems implied by the preferences and constraints of government. The constraints themselves are endogenous through their dependence on market expectations, and this critical endogeneity, combined with the authority's inability to adhere to preordained rules, leads to multiplicity.'[12] In most cases, weak economic fundamentals induce self-fulfilling speculative attacks. Although it cannot be ruled out that even economies with sound

[11] Obstfeld (1994, p. 190).
[12] Obstfeld (1994, p. 211).

economic fundamentals are vulnerable to self-fulfilling attacks, attacks on a certain currency are often initiated by certain shortcomings in the country's economic fundamentals. The ERM crisis in 1992 and the Asian crisis in 1997–1998 showed that speculators often attacked first the currencies of economies with weak fundamentals.[13]

The shortcomings with the second generation or self-fulfilling currency crisis models are threefold. Firstly, all these models generally depend on a 'sunspot' to initiate a currency attack. This method adds an exogenous noneconomic element into the model and makes the onset of currency crises unexplainable and impossible to test empirically. Secondly, these crisis models leave open the policy issues associated with curbing speculative attacks. These models imply that, since currency crises are self-fulfilling, governments must be able to influence private sector expectations in order to prevent a currency crisis. Thirdly, these models assume that agents have common knowledge of all aspects of the economy. There is no asymmetrical information structure.

The latest development in currency crises focuses on remedying these shortcomings of the second-generation models. Models incorporating more elaborate behaviors of speculators, information structure, and the onset of currency crises are emphasized. In addition, the role of firms' and banks' balance sheet constraints in crises is receiving more and more attention.[14]

Morris and Shin (1997) argue that the apparent multiplicity of equilibria in the conventional second-generation currency crisis theory is the consequence of rather strong informational assumptions on the common knowledge of the fundamentals. In their more realistic modeling of the informational structure underlying speculative attacks, the multiplicity of equilibria can disappear. How the unique outcome may turn out depends on the parameters of the problem, such as the cost of speculation, the underlying fundamentals of the economy, as well as the amount of speculative capital. Thus the assumptions on the information structures play a key role in studying

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[13] In Europe in 1992, Finland was the first country to abandon the pegged exchange rate. This may be partially attributable to the fact that Finland had been hit particularly hard by the collapse of Soviet trade. In southeast Asia in 1997, it was Thailand that had the largest current account deficit.

[14] Some refer to these newer types of models as well as others that focus on the fragility of financial sectors as third-generation currency crisis models. But others, for example, Jeanne (1999), argue that these models are mere extensions of the second-generation models.

currency crises. In particular, it is not the amount of information per se that matters, but rather how public and transparent this information is.

Kasa (1999) develops a learning model of currency crises. Informal reasoning about the unemployment 'escape-clause' model suggests that, under a plausible learning process, the middle equilibrium is unstable and the other two extreme equilibria are stable. The advantage of this model is that there is no sunspot, and actual data from currency crises are described by a two-state Markov switching model of the type that has been applied to the sunspot model. The disadvantages of the model are that expectations are not rational and there is no government policy rule.

Currency crises tend to spread from one country to another. Often a number of countries in the same region fall victim virtually at the same time. This contagion phenomenon is taken into account in some papers that investigate how currency crises can spread across borders. Usually links through trade or competitiveness are among the primary focuses. Gerlach and Smets (1995) demonstrate that close trade and import-export price links make the currency of one country vulnerable once a close trade partner devalues its currency. In the Nordic financial crisis in 1992, attacks on the Swedish krona followed immediately after the collapse of the Finnish markka. An earlier paper, Willman (1988), shows that events abroad can influence the real exchange rate and domestic competitiveness once relative prices are endogenously determined under sticky wages and imperfect substitutability between domestic and foreign assets.

The second line of investigating contagion is to employ the concepts of multiple equilibria and self-fulfilling expectations, in which sentiment in one country changes purely because of a crisis in another country. To some extent this method of modeling contagion can be regarded as an extension to the 'second-generation' models. Masson (1999) presents a simple balance of payments model in which a currency crisis may occur via plausible channels such as the world interest rate, competitor's exchange rate, or expectations.

The further globalization and liberalization of both goods and capital markets have made contagion currency crises more relevant and interesting amid new developments in the world economy. The recent Asian crisis has stimulated tremendous interest and discussion on contagious currency crises. See the discussion by Krugman (1998).

2.2 Banking sector and currency crisis models

The existence of a banking sector has profound implications on monetary policy and economic activity. However, in macroeconomic theory, the role of financial institutions and variables is often neglected. The rationale behind this thinking was first provided by Modigliani and Miller (1958), which introduced the famous view that 'finance is a veil'.

Bernanke (1983) is among the earlier papers that challenge the orthodox teaching of that time. Base on data from the US Great Depression at the end of 1920s, Bernanke (1983) points out that the money stock alone is not sufficient to explain the depth of the depression. Financial variables, particularly bank credits, are also important in explaining the collapse of economic activity. Thus finance is not a 'veil'.

Farmer (1984) makes an important contribution by pointing out the truly complex effects of financial contracting. Using an overlapping generations model under the assumption of asymmetric information, Farmer (1984) shows that productivity shocks today can affect interest rates in the future.

Based on the importance of intermediaries in the provision of credit and the special nature of bank loans, Bernanke and Blinder (1988) develop models of aggregate demand which allow roles for both money and bank loans. This new framework breaks out of the traditional money-only framework and opens up a new research area that emphasizes the role of credit in economic activity. As they later point out,[15] 'There we develop an analogue to the simple IS-LM model which embodied an unconventional view of the monetary transmission mechanism: that central bank policy works by affecting bank assets (loans) as well as bank liabilities (deposits).'

Honkapohja-Koskela-Paunio (1996) extend the Bernanke and Blinder (1988) framework to an open economy by including a banking sector and the availability of credit in the model and by assuming foreign borrowing by the public. They then use this theoretical framework to discuss the fiscal and monetary polices conducted during the Finnish currency crisis, paying special attention to the macroeconomic implications of high foreign debt and the banking system.

[15] Bernanke and Blinder (1992).

An important contribution to the research on the role of banks in economic modeling is made by Diamond and Dybvig (1983). The model they provide offers a useful framework for studying the economics of banking and associated policy issues. Kiyotaki and Moore (1997) show that a small productivity shock can trigger a credit cycle if firms have to use their productive assets (land in their paper) as collateral for borrowing in a constrained capital market. Holmström and Tirole (1994) investigate the links between wealth-constrained financing and the liquidity services offered by the financial market and between liquidity and capital formation. Repullo and Suarez (2000) develop a model of the choice between bank and market finance by entrepreneurial firms to show that the monitoring associated with bank finance ameliorates a moral hazard problem between entrepreneurs and their lenders.

Recent developments in economic theory highlight an increasingly promising role for financial-related factors.[16] The vital job of channeling funds from institutions with surplus funds to firms that have investment opportunities is performed by the financial system. The system itself is not frictionless, as asymmetric information results in adverse selection, moral hazard and cost verification.

Edwards and Vegh (1997) develop macroeconomic models of open economies in which banks play a meaningful role in the transmission mechanism. They use an optimizing model of a small open economy with a fixed exchange rate regime to illustrate how the introduction of a costly bank activity into an otherwise standard open-economy model may dramatically alter the real effects of macroeconomic disturbances. The result is that when banking is costly, exchange rate stabilization cycles will lead to variation in economic activity through changes in interest rate spreads and bank credit. Thus the magnification role played by the banking sector is illustrated.

The fragility of the banking sector is often highlighted as a cause of the recent currency crises. Burnside-Eichenbaum-Rebelo (1999) shows that government guarantees to domestic and foreign lenders tend to lower interest rates and generate an economic boom, which may eventually lead to fragility of the banking sector. Foreign debts thus could drive the banking sector into difficulty if the fixed exchange rate is abandoned.

[16] Freixas and Rochet (1997) provide an excellent overview.

The setup for Chang and Velasco (1998) is fundamentally similar to that for Diamond and Dybvig (1983), as the types of the agents are not known in advance. However, Chang and Velasco (1998) add currency demand to the utility function, which makes a distinction among different exchange rate-monetary regimes necessary. They provide a detailed account of interactions between bank fragility and exchange rates under different monetary regimes. When banks act as maturity transformers in the economy, as in Diamond and Dybvig (1983), different monetary regimes induce different consumption allocations and have different implications for financial fragility, which are particularly evident under a fixed exchange rate system.

Caballero and Krishnamuthy (1999) are similar in structure to models of liquidity in the banking literature. However, they give central roles to credit market constraints arising from macroeconomic contractual problems in international collateral. The response of the economy to a shock to its international collateral can be highly nonlinear (multiple equilibria as a result), depending on the balance sheet condition.

These types of liquidity crisis models focus on the micro-aspects of the liquidity crisis and are less concerned about macroeconomic phenomena. They rely crucially on the existence of many uncoordinated agents and the principle of sequential fund withdrawals.

The model in this study focuses mainly on macro-level variables, such as aggravate lending, investment, and profitability, even though it has fairly elaborate micro-foundations. An endogenous banking sector is modeled to maximize its profit in the traditional lending and borrowing business. The bank, as a strategic player, interacts with all other private agents. It is the lending interest rate, which is endogenously determined by the bank, that has important implications for the central bank's decision on the exchange rate. The mechanism of the currency crises is explained by the benefit-cost analysis of the central bank, not the liquidity crises due to the lack of coordination between private agents. This is the fundamental difference between the model in this study and the other currency crisis models with a banking sector, which are in the spirit of Chang and Velasco (1999) or Caballero and Krishnamuthy (1999).

2.3 Empirical work on currency crises

There is a growing literature on empirical research on currency crises, since Blanco and Garber (1986) first applied the first generation currency crisis framework. They produced empirical evidence in support of the theory that the collapse of a fixed exchange rate regime is linked to lax monetary and fiscal policies. Now there are three main groups of empirical papers on currency crises.

The first group follows Blanco and Garber (1986) and tries to provide evidence on the causes of currency crises. Blanco and Garber (1986) use monetary models with estimated parameters to calculate the shadow floating exchange rate. Then this shadow exchange rate is compared with the real pegged exchange rate to determine the likelihood of a speculative attack.

Eichengreen et al (1994, 1995) analyze the experience of some two dozen OECD countries since 1959 by constructing empirical measures[17] of speculative attacks, and discuss certain causes and consequences of devaluation and revaluation that are consistent with their main theoretical framework.

Sachs et al (1996a) identifies a large appreciation of the real exchange rate, a weak banking system, and low levels of foreign exchange reserves as three key fundamentals explaining the different experiences of twenty developing countries during the Mexican crisis in 1995. The finding is that countries with weak fundamentals and low reserve-liability ratios are vulnerable to self-fulfilling investor panic.

Jeanne and Masson (2000) study the French franc crisis of 1992 using a regime-switching model with two different states of realignment expectations. They conclude that the French franc crisis can be interpreted as self-fulfilling jumps between different states in a sunspot equilibrium.

Kaminsky and Reinhart (1996) investigate the connection between currency crises and banking crises by focusing on 20 countries that experienced currency and banking crises during 1970–1995. The conclusions are that a banking crisis may well explain the onset of a currency crisis, and financial liberalization often precedes a banking crisis. Both domestic and external shocks may trigger currency crises.

[17] They measure speculative pressure by a weighted average of changes in exchange rates, interest rates and reserves, where all variables are measured relative to those of a key country.

Kajanoja (2000) studies the Finnish currency crisis using an empirical speculative attack model based on the first-generation currency crisis model. By incorporating partially sterilised interventions and sticky prices, Kajanoja (2000) abandons the assumptions of short-run PPP and zero sterilization, which are common for this type of model. The empirical results reveal that changes in economic activity, unemployment and domestic credit may render the fixed exchange rate vulnerable to speculative attacks in the Finnish case.

The second group focuses on the predictability of currency crises.[18] These identify certain macroeconomic variables – such as exports, deviation of real exchange rate from trend, ratio of broad money to gross international reserves, output, equity prices, and composition and level of debt – which behave abnormally and are linked to crises. Frankel and Rose (1996) compare the evolution of these variables in tranquil and crisis times and then estimate the k-step -ahead likelihood of a crisis. Frankel and Rose (1996) find that currency crashes tend to occur when output growth is low; the growth of domestic credit is high; and the level of foreign interest rates is high. In particular, a low ratio of foreign direct investment to debt is consistently associated with a high likelihood of a crash.

Kaminsky-Lizondo-Reinhart (1997) use these macroeconomic variables to construct a signaling (or warning) system that may predict currency crises. When an indicator in the monitoring system exceeds a certain threshold value, this is interpreted as a warning signal that a currency crisis may take place within the next 24 months.

However, both the Frankel and Ross (1996) and Kaminsky-Lizondo-Reinhart (1997) approaches have so far generated mixed results in predicting out-of-sample crises. Although the Kaminsky-Lizondo-Reinhart (1997) approach is found to be better than pure guessing for predicting the Asian crisis, neither of these models reliably predicts the timing of the Asian crisis in 1997. False alarms almost always outnumber appropriate warnings.

Rose and Svensson (1994) using daily financial data, find that the ERM exchange rates were credible from the inception of the EMS until shortly before September 1992. No economically meaningful relationships between realignment expectations and macroeconomic variables are found, although lower inflation may improve credibility.

[18] See Berg et al (1999) for a survey.

Goldfajn and Valdes (1997) look at direct survey data on expected exchange rates and find that, although overvaluation has predictive power in explaining crises, expectations fail to anticipate currency crises.

The third group concentrates on cross-border contagion. Sachs et al (1996b) investigate the contagion phenomena in the Tequila crisis. Corsetti et al (1998) and Furman and Stiglitz (1998) try to explain what caused a wild spread of the Asian crisis and what are the factors that contributed to the contagious consequences of an initial shock.

Glick and Rose (1999) provide empirical evidence to support the argument that patterns of international trade are more important in the spread of currency crises than other macroeconomic phenomena.

Tornell (1999) finds that the Tequila crisis in 1995 and the Asian crisis in 1997 did not spread randomly. The cross-country variation in the severity of crisis can be largely explained by three fundamentals: the strength of the banking system, the real appreciation, and the country's international liquidity. Most significantly, Tornell (1999) finds that the rule that links fundamentals to crisis severity has been the same in both crises.

Empirical work on currency crises finds that economic fundamentals are important for the onset of currency crises. More specifically, the slowing of economic activity, real appreciation, rapid credit expansion, and strength of the bank system are the main reasons for anticipating a currency crash in connection with many currency crises. The pre-crisis vulnerability of these economies to speculative attack is well established.

On the other hand, in other crises, particularly for some countries involved in the EMS crisis (most notably, Britain and France), the economies were fairly robust, and not particularly vulnerable. It is the self-fulfilling nature of expectations of devaluation that result in a currency crisis.

The Finnish economy was clearly quite vulnerable prior to the currency crisis in 1991–1992. The financial deregulation led to rapid expansion of credits and over-borrowing before the crisis; the unfavourable development of external trade squeezed firms' profit margins; and rising interest rates in Europe weakened the balance sheets of Finnish banks and led to a collapse of asset prices. Thus the Finnish economic fundamentals were rather fragile prior to the collapse of the pegged exchange rate system. As empirical work by Kajanoja (2000) shows, slowing GDP growth and rising unemployment, as well as domestic credit growth and a rising real exchange rate, may have made the pegged exchange rate vulnerable to speculative attacks in the Finnish case.

The weakness in fundaments, however, cannot account fully for the Finnish currency crisis. Pre-crisis private sector expectations also played a significant part. There was an export slump and a slowdown in economic activity already in 1990, but the pegged exchange rate continued. Strong support for the pegged exchange rate system and determination on the part of the Bank of Finland in 1990 and early 1991 made the peg seemingly unbreakable. Continuous speculation on the eventual abandonment of the peg nevertheless eroded private agents' confidence. Expectations of devaluation worsened the economic fundaments, partly through the increase in domestic interest rates. Finally, the Bank of Finland had to devaluate the currency.

The Finnish crisis shared some common features with many other currency crises, particularly a decline in economic activity, excess credit growth and foreign liabilities. Moreover, self-fulfilling expectations of devaluation were significant for the eventual abandonment of the pegged exchange rate system. However, the Finnish crisis had some special features as well: unique institutional aspects of the Finnish economy, which are not usually taken into account in the theoretical models of currency crises in the literature. In the following section we will discus in detail some important features of the Finnish economy and currency crisis.

2.4 Stylized facts concerning the Finnish economy and currency crisis

The following stylized facts characterize the Finnish crisis during 1991–1993.[19] These stylized facts are later incorporated into the theoretical models.

[19] For the details on the Finnish crisis and depression, Shen (1999) and Honkapohja and Koskela (1999) are the most relevant to this study. The Finnish depression is also dealt with, with varying focuses, in eg Ahtiala (1997), Bordes et al (1993), Haaparanta et al (1992), Honkapohja et al (1996), Kiander and Vartia (1996, 1998), Tarkka (1994) and Vihriälä (1997).

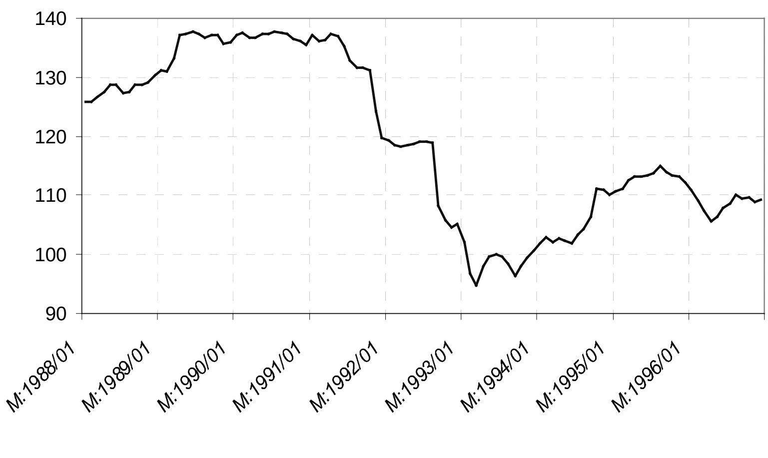
2.4.1 Sticky prices despite large devaluation

Although Finland is a small open economy, its price level did not change much even after large devaluations during and after the currency crisis. Finland's inflation was extremely subdued even after the huge devaluation in 1992.

To answer this puzzle, Honkapohja-Koskela-Paunio (1996) estimates equations for the Finnish manufacturing prices. They find that Finnish producer prices adjust slowly, and only roughly 20% of changes in the sum of domestic cost factors and prices of imported inputs as well as the domestic price of foreign manufacturing goods are immediately passed through to manufacturing prices. Thus domestic firms used profit margins to cushion the impacts of input price changes in the short run during the currency crisis.

This empirical evidence supports the assumption made in the model that the domestic price level is unchanged after the devaluation in 1992. Figure 2.1 shows that the Finnish price level relative to the OECD average actually ***declined*** after devaluation in November 1991 and September 1992. Thus the normal assumption of the law of one price, which would require a rise in the Finnish price level matching the devaluation, does not hold. The law of one price clearly does not hold in the Finnish crisis. Some other recent papers also notice this divergence in theoretical assumptions and empirical evidence, such as Aghion-Bacchetta-Banerjee (2000).

Figure 2.1 **Price level, Finland/OECD (OECD=100)**



Source: OECD.

There are three other factors that support the assumption of sticky prices made in the model in this study. Firstly, the model in this study is of a short-term nature, while the law of one price usually applies in the long term. It is rather common to assume price stickiness in a short-term model. Moreover, empirical evidence tends to reject the law of one price for a variety of products and countries, even in the fairly long run. Frood and Rogoff (1995) and Rogoff (1996) provide an overview of the literature.

Secondly, the exchange rate pass-through literature[20] discusses the extent to which domestic currency prices of imported goods are affected by exchange rate movements. Often it is found that movements in the exchange rate do not fully translate into domestic prices.[21] Using aggregated commodity data, Kreinin (1977) estimates that only about a half of an exchange rate change is likely to be translated into import prices to the US. Feenstra (1989) uses unit import automobile values from Japan to the US to estimate exchange rate pass-through in this industry. Again the pass-through is incomplete.

Finally, export prices of the same goods can differ across destination markets, when exporters adjust their markup to compensate for the change in exchange rate movements. This phenomenon of price discrimination in international markets due to exchange rate movements is labeled ‘pricing-to-market’ by Krugman (1987). Empirical evidence shows that unit export prices are often sensitive to specific exchange rate movements. Gagnon and Knetter (1995) find that Japanese automobile exports are characterized by a high degree of markup adjustment designed to stabilize the price measured in the buyer’s currency. This markup adjustment is highly persistent. See Haskel and Wolf (1999), Cumby (1996), Ghosh and Wolf (1997), and Knetter (1998) for more empirical evidence.[22]

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[20] See Goldberg and Knetter (1996) for a survey.

[21] Imperfect competition and strategic trade theory can be the main causes for the incomplete pass-through (see eg Dornbusch 1987).

[22] Haskel and Wolf (1999) examine the catalogue prices in 25 countries of 119 goods sold by the Swedish household furniture retailers, IKEA. The goods are identical in terms of both design and country of origin and are widely traded. Converting prices of 25 different countries into a common currency, the median deviations of relative prices can be as high as 50%. Thus the simple law of one price is convincingly rejected. To examine the pattern of actual prices, instead of a price index, Cumby (1996) examines the prices of hamburgers across countries; Ghosh and Wolf (1997), Knetter (1998) examine the price of magazines. They find substantial violations of law of one price at a point in time.

2.4.2 A tradition of competitiveness-oriented exchange rate policy

The Finnish economy was characterized by a competitiveness-oriented monetary policy after the Second World War. The Bank of Finland had a tradition of targeting the international competitiveness of the Finnish economy as a vital objective for monetary policy. Pekkarinen and Vartiainen (1993) point out that Finland had devalued rather frequently after the Second World War (major devaluations occurred roughly once every ten years[23]). One of the main reasons for devaluation was to enhance the competitiveness of Finnish industries. Heinonen et al (1997) also stresses the importance of competitiveness in Finnish economic policymaking. As Eriksson-Suvanto-Vartia (1989) states:

> 'The large devaluation in 1957 and 1967 (28.1 and 23.8 per cent, respectively) seems to have had long-lasting effects on expectations. Although both were carried out in a situation of deteriorating competitiveness, they were offensive in nature. In neither case was the size of the exchange rate adjustment justifiable by purchasing-power-parity considerations alone (Suvanto 1978). The 1957 devaluation aimed at helping the previously protected manufacturing industries to enter the free trading system. The 1967 devaluation, in turn, aimed at encouraging structural change and diversification of exports.'

After the Bretton Woods system ended, Finland adopted a basket-peg system. The Bank of Finland was designated to keep the effective exchange rate (defined by a currency index) within a band. The effective exchange rate was calculated on the basis of bilateral trade weights.[24] Because of extensive capital controls, the Bank of Finland was able to insulate the exchange rate from spreads between domestic and international interest rates. The central bank adjusted the Finnish markka's exchange rate repeatedly to achieve high economic growth and full employment. Interest rates were also kept at low levels, with real interest rates negative at times during 1970–1980.

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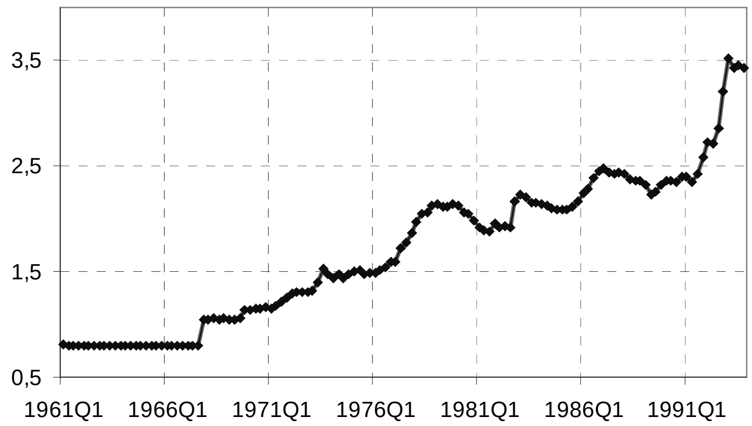
[23] For a discussion on the ten-year devaluation cycle, see Korkman (1978).

[24] After 1984 the currency index was calculated only on the basis of convertible currencies. Thus the Soviet rouble was excluded from the index, although the Soviet Union was one of Finland's biggest trade partners.

Figure 2.2 **Finnish markaa per German mark**



Source: OECD.

Thus the profitability of industries was traditionally an important factor in determining exchange rate policy. Actually the deterioration of corporate profitability threatened massive bankruptcy in the early 1990s in Finland, which is one of the main reasons the Bank of Finland abandoned the fixed exchange rate regime. See Haaparanta et al (1992) for details.

This institutional feature is incorporated into the theoretical models in this study. The aim of keeping the profit of the private sector close to a target level becomes a key target in the central bank's optimization problem in the latter chapters.

2.4.3 Time lag between deposit and lending interest rate liberalization prior to the crisis

After the early 1980s, Finland started the deregulation process in the domestic financial market.[25] Prior to financial deregulation, the control of interest rates by the Bank of Finland resulted in credit rationing in the domestic financial sector.[26] The quotas that the Bank of Finland placed on financial institutions' central bank financing had

[25] See Vihriälä (1997) and Bordes-Currie-Söderström (1993) for a more detailed discussion on the deregulation of Finnish financial markets.
[26] See Koskela et al (1992).

the effect of limiting the growth of commercial loans. The Bank of Finland also exercised tight control on foreign exchange transactions. With this framework, the Bank of Finland was able to separate the domestic financial market from the international capital market and keep domestic interest rates at a low level. The exchange rate was adjusted to achieve international competitiveness and also to insulate the domestic market from inflationary pressures from abroad.[27]

The financial market deregulation started with the forward currency market in 1980. Significant steps were taken in 1986, when the central bank dismantled the average lending rate controls so that banks could decide their own lending rates. In May 1987, the Helibor[28] rates were introduced, and the central bank's credit guidelines were discontinued. At the start of 1988, restrictions on bank lending rates were completely removed. However, restrictions on deposit rates were left in place due to a long-standing deposit rate cartel among Finnish banks. Only after more than two years were banks allowed to set deposit rates. Thus in the model, I assume the deposit rate is fixed by the central bank at the start of the first period, while the lending rate is determined by the bank's optimization process.

Financial market deregulation was strongly believed to have a profound impact on saving and investment behavior in Finland. The deregulation process unleashed rapid credit extension. Figure 2.3 shows that banks lent an increasingly large amount of loans denominated in foreign currencies to the public during 1985–1992.

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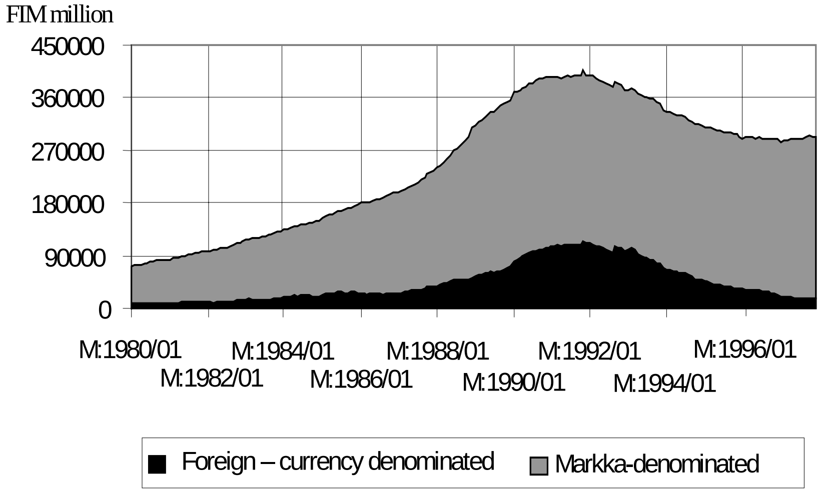
[27] See Pekkarinen and Vartiainen (1993) and Jonung et al (1996).

[28] Helibor refers to the Helsinki Inter-bank Offer Rate. There are six Helibor rates with maturities of one, two, three, six, nine and twelve months.

Figure 2.3 **Banking sector lending**



Source: OECD.

2.4.4 Widening interest rate differentials

The surge in interest rates across Western Europe due to German unification was a shock to the Finnish economy, as were the terms of trade shock and collapse of the Soviet Union.

After German unification in 1990, German interest rates rose significantly between the end of 1988 and 1993, reflecting the growing demand for capital in Germany and the Bundesbank's efforts to fend off inflationary pressure. The German official three-month discount rate rose from 2.5% at the start of 1988 to nearly 9% in mid-1992. The other European countries had to raise their interest rates in order to maintain the European Monetary System (EMS).

Finnish monetary policy was also tightened in 1988, but most noticeably in 1989, when short-term interest rates were raised and the special noninterest bearing cash reserve requirement was introduced. The tightening lasted until 1992, a year that saw the strictest monetary policy and also the abandonment of the pegged exchange rate system. The base rate[29] was raised from a low of 7% in the first quarter of

[29] The movement of the base rate reflected the general condition of the monetary policy. However, the base rate was not anymore as significant a monetary policy instrument as before because it only affected the funding and lending costs on the average but not on the margin.

1988 to 9.5% at the start of 1992.[30] The initial increase in interest rates in 1989 was a response to rising inflationary pressures and uncertainty related to wage bargaining. During 1990–1992, the central bank raised interest rates primarily to defend the currency as German interest rates rose substantially during that period.

In retrospect the Finnish currency and banking crisis highlights the credit view of the monetary transmission mechanism.[31] The rise in interest rates, falling asset prices and partially unexpected devaluation weakened the balanced sheets of banks, firms and households in Finland in the early phase of the crisis. Bank lending declined sharply after 1991–1992. The resulting credit crunch led to a big drop in both business and housing investment during the depression. In addition, during the crisis, the margin between lending and deposit rates widened, from 4.5% in 1988 to 7.5% at the start of 1992. The widening of the margin reflected the risk in financial intermediation and rising cost of investment. Thus two channels of the credit view played important roles during the depression.

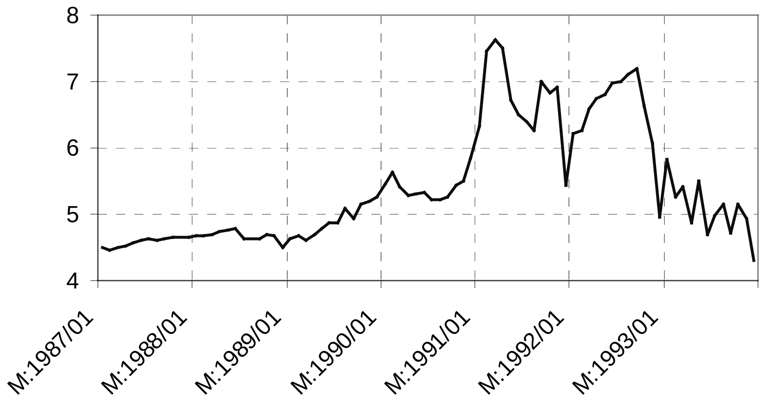
Brunila (1994) and Honkapohja and Koskela (1999) provide empirical evidence that the deterioration of borrowers' balance sheets had a negative effect on investment in the early 1990s. Kinnunen and Vihriälä (1999) find that the customers of the weakest banks terminated their operations more probably than those of the stronger banks in 1992, even if adjustment is made for borrower quality. This

[30] Actually the base rate was lowered from 8% to 7.5% for a while in the late 1988 due to political pressures. The main increase in the base rate took place in 1989.

[31] According to the credit view of the monetary transmission mechanism, financial intermediaries play an important role in the transmission of monetary policy. As Bernanke and Gertler (1995) state, "The direct effects of the monetary policy on interest rates are amplified by endogenous changes in the external financial premium, which is the difference in cost between funds raised externally (by issuing equity or debt) and funds generated internally (retained earning). The size of the external finance premium reflects imperfections in the credit markets that drive a wedge between the expected return received by lenders and the costs faced by potential borrowers. According to the credit view, a change in monetary policy that raises or lowers open market interest rates tends to change the external finance premium in the same direction. …The impacts on the cost of borrowing broadly defined – and, consequently, on the real spending and real activity is magnified." The balance sheet and bank lending are two sub-channels of the credit view (see Bernanke and Gertler 1995 for details).

evidence also supports at least some sort of credit crunch in the early 1990s.[32]

Figure 2.4 **Lending – deposit rate spread in Finland**



Source: OECD.

2.4.5 Imperfectly competitive labor markets

The Finnish economy is characterized by highly centralized trade unions and wage bargaining structures. Wage determination is an important decision in the Finnish economy. The wage bargaining system in Finland is relatively complicated and can involve highly centralized wage determination. Union membership is almost universal, and the coverage of the centralized bargaining outcome is very comprehensive. Therefore, the influence of trade unions is quite pronounced in Finnish economic policymaking in general and wage negotiations in particular. As Eriksson-Suvanto-Vartia (1989) point out:

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[32] But as far as bank behavior is concerned, it is still subject to debate whether the collapse in both housing and business investment were mostly due to a credit crunch or a decline in credit demand itself. In a comprehensive study on the role of banks in the Finnish credit circle during 1986–1995, Vihriälä (1997) draws the conclusion that although banks really played a major role in the creation of the lending boom in the end of the 1980s, the collapse of lending stocks in the early 1990s reflected more a decline in credit demand due to a combination of higher interest rates, excessive capacity and low profitability, as well as weakened creditworthiness of borrowers, than a collapse in credit supply.

> ‘In the discussion about Finnish economic policy, wage movements have traditionally been considered essential for growth, price stability and external balance. This is because wages relative to those in other countries have been seen as the most important determinant of profitability and investment in the traded-goods sector.’

In the Finnish wage bargaining process, the government sometimes plays an active role. The fiscal authority mainly uses tax policy and government expenditure to achieve its objectives, such as the maximization of output and employment in the economy. Sometimes the fiscal authority is able to moderate the trade union’s wage demands by agreeing to cut income taxes or increase transfer payments, so as to increase real after-tax income even if the wage increase is modest. This strategic interaction between fiscal authority and trade union has important implications for the conduct of monetary policy. This institutional characteristic is taken into account when analysing exchange rate policy in two extensions to the basic theoretical model.

In sum, these institutional features of the Finnish economy, as well as empirical evidence of the Finnish currency crisis, are stressed in the theoretical models in this study. Most importantly, the price stickiness despite the huge devaluation after the crisis, and the widening interest rate differential during the crisis, and the central bank’s emphasis on competitiveness of industry (profits), and highly centralized trade union and wage bargaining structures are highlighted as the main stylized facts. These particular features and institutional characteristics are incorporated into the theoretical models. The integration of the self-fulfilling currency crisis theory with the modeling of interest rate setting by a banking sector is the focus in the next chapter. The incorporation of wage bargaining, as well as the interaction between fiscal policy and wage bargaining in currency crisis models, are dealt with in chapters 4 and 5.

3 Currency crisis model with banking sector

3.1 Introduction

In this chapter a currency crisis model with an endogenous banking sector is built. The financial institution's lending behavior, as well as the widening in interest rate differential, is given a prominent role in describing the currency crises in the model. The central bank's decision on the exchange rate and the private sector expectation of the effect of that decision on the future exchange rate interact with world interest rates, domestic bank lending rates, foreign borrowings, output and private sector profits,[33] as well as consumption and saving behavior. Currency crises are fundamentally related to these variables.

This chapter provides a formal framework showing how currency crises and exchange rate decisions are related to these variables. The model does not, however, consider the detailed process of speculative attacks and the role of foreign exchange reserves. Unlike the first generation currency crisis models, the decision-making of the central bank and its impacts on economic activity are emphasized. A change in exchange rate regime is considered the result of an optimizing decision by the policymaker. Thus this model is more in line with second-generation currency crisis theory, in which dynamic-consistency problems implied by preferences and constraints of government lead to multiple solutions for equilibrium exchange rates.

The settings of the basic model are similar in various aspects to Obstfeld (1994), Ozkan and Sutherland (1998), and Edwards and Vegh (1997). However, the model in this study is different from the others in some key areas. Obstfeld (1994) is a classic paper that provides two models of self-fulfilling currency crises. But the models are not micro-based. Ozkan and Sutherland (1998) is similar in many ways to Obstfeld (1994), but it places emphasis on trigger points in currency crises. Edwards and Vegh (1997) model detailed agent behavior but with the emphasis on the role of the banking sector. The

[33] In this chapter, we abstract from the labor factor. Thus unemployment is not analyzed. Overall aggregate economic activity is represented by output. In the next chapter, we will introduce the labor factor and discuss labor demand and wages. As labor supply is assumed to be greater than labor demand, labor demand determines the development of unemployment.

decision-making of the central bank is sidelined. All markets are competitive, and there is no role for expectations. In addition the model does not deal with currency crises explicitly.

One of the main features of the model in this study is the extensive coverage of agents in the economy, including the household, bank, firm and central bank, and the focus on strategic interactions among agents. A banking sector is modeled so that interest rates can be determined endogenously. As the bank is assumed to be a monopoly, it can choose its optimal lending rate, which is higher than the cost of capital. The optimal behavior of the consumer and the firm are also taken into account. Here the interaction between bank and firm is set in a Stackelberg game framework. The bank, being the Stackelberg leader, first sets a lending rate. The firm reacts by choosing its level of bank loans. Finally, optimal levels of bank lending and lending rate are found, given certain expectations of the future exchange rate (set by the central bank). The decision of each of these agents has an impact on the rest of the economy. The central bank's decision on the exchange rate, in particular is based on the interaction of all other agents. The central bank faces conflicting interests in deciding the exchange rate, which will have different impacts on the open and sheltered sectors of the economy.

The second important feature of the model is that the model setup follows the stylized facts of the Finnish crisis, which are summarized in section 2.4. These facts are incorporated in the assumptions of the model. Thus the model in this study has strong empirical features. Some institutional features of the Finnish economy as well as its actual developments before and after the currency crisis are stressed. Although currency crises share many common features, and are worldwide phenomena, every currency crisis has some unique features based on the institutional characteristics of the economy. As regards the Finnish crisis, the way the financial market was liberalized, the competitiveness-oriented exchange rate policy, as well as the response of domestic price levels to devaluation differ from conventional assumptions made in other currency crisis models.[34] In this model, assumptions are made according to the actual institutional facts of the Finnish economy.

[34] The other institutional characteristics of the Finnish economy lie in its centralized wage bargaining system and the government role in wage bargaining. These unique features may have important implications for the currency crisis. These are analyzed in chapters 4 and 5.

Another important feature here is the modeling of firm behavior. Although the economy has only one representative firm with one production function, the firm's profit function, which incorporates domestic sales and exports, implicitly distinguishes between the open and sheltered sectors of the economy.

The existence of a banking sector has profound implications for monetary policy and economic activity. An endogenous banking sector is modeled to maximize its profit in the traditional lending and borrowing business. The domestic banking sector lends to the firm at a premium on both the international capital cost and domestic deposit rates. It is assumed that the domestic banking sector has certain advantages such as loan enforcement and information access so that international financial institutions cannot lend directly to domestic firms.[35] The indebtedness of the banking sector that is stressed in the model is empirically very important in anticipating currency crises.[36]

In this model, the exchange rate plays an important role. The usual channel for the exchange rate to affect the economy is through the trade link. An appreciation depresses exports and encourages imports, which reduces the contribution of net exports to the economy. The effect is a medium-term effect, as trade contracts take time to adjust and switching suppliers is a slow process.

However, in this study another channel is also emphasized: the asset allocation channel. Unexpected exchange rate movements will change the debt burden of domestic residents, especially when they are significant borrowers of foreign capital. Typically, after credit market liberalization, the domestic sectors are heavily indebted. Under these circumstances, unexpected drastic movements in exchange rates will immediately cause significant changes in the net wealth of the economy, thus having big and immediate impacts on the economy.[37]

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[35] In Finland in the late 1980s, firms obtained most of their loans from domestic banks. Foreign banks were not active and didn't play a significant role in the Finnish capital market. Even big Finnish firms borrowed from abroad using domestic banks as intermediaries. See Vihriälä (1997) for details.

[36] The indebtedness of the banking sector is also a key cause of the Asian crisis. This theme is gaining increasing attention (see Chang and Velasco 1999). However, the model here focuses on macro-level variables, whereas in Chang and Velasco (1999), the focus is on the liquidity crisis in a micro-based structure.

[37] A currency crisis may deepen precipitously if domestic borrowers are constrained by liquidity problems. The damage is especially severe if domestic borrowers have to liquidate their domestic asset holdings to pay for overdue foreign debts, which will result in a further weakening of the currency and decline in domestic asset prices. Thus a currency crisis may cause a self-fulfilling spiral of depreciation and decline in domestic asset prices.

3.2 Setup

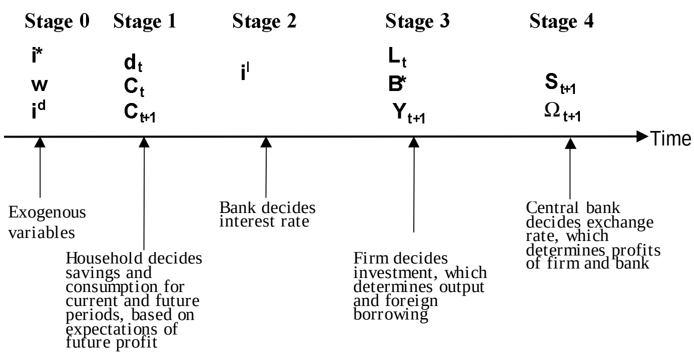
In this section we model a small open economy that is perfectly integrated with the rest of the world in the capital market. The bank can borrow as much as it desires from the international capital market at an exogenous interest rate. There is a single good, which is produced with capital as the only input. The firm has to satisfy domestic consumers first, after which it can sell all surplus output to the international market. The price of the product is sticky in both the domestic and international markets. It is a two-period (t and t+1) model. There is a representative household, bank and firm, and each of them tries to optimize its behavior. The household is the ultimate owner of the bank and firm. The bank conducts normal borrowing and lending business, and the firm produces one product, which the household consumes. The firm relies totally on bank loans for capital investment. In period t+1, the bank and firm distribute all their profits to the household, which then consumes all its wealth.

Before the start of the first period t, the central bank sets the period t exchange rate, S_t, and deposit rate, i^d. It also announces its desire to peg the exchange rate. The household has an initial wealth of ω_t. In addition, the interest rate in the international market, i*, is observable.

Then during the first period, t, the household decides to consume part of its initial wealth and deposit the rest in the bank so as to maximize its intertemporal utility function. The amount of deposits, d_t, is the key decision variable of the household.

Figure 3.1 summarizes the sequence of decisions in the economy.

Figure 3.1 **Time sequence of decisions**



Source: OECD.

The private sector, which consists of the bank and firm, makes an optimizing decision based on the expected values of policy variables set by the central bank. Within the private sector, the firm and bank interact in a Stackelberg game framework. The bank is the Stackelberg leader, which first sets a lending rate. The bank also borrows B* (which is denominated in foreign currency) from the international market at the interest rate i*. The decision on B* depends on the difference between domestic borrowing requirement and deposits. Then the firm reacts by choosing its level of borrowing. The optimal levels of bank lending and lending rate can be found, given certain expectations of the future exchange rate.

In the second period, t+1, after all private agents have made decisions and commitments, the central bank decides the next period exchange rate, S_{t+1}, so as to minimize the value of its loss function. The central bank's decision on the exchange rate is based on the interaction of all other agents. The central bank faces conflicting interests in deciding the exchange rate, which will have different impacts on the open and sheltered sectors.

After the exchange rate S_{t+1} is determined by the central bank, the commercial bank will apply this exchange rate to pay back its foreign loans. The bank will also pay back deposits plus interest to the household. The firm will sell its product to the household and export the surplus to the world market. The bank and firm realize their profits and distribute dividends to the household, which then consumes all of its wealth.

The central bank is not a Stackelberg leader vs private agents. The central bank sets the first-period exchange rate. Then the bank and firm make their optimal decisions based on the expectations of the future exchange rate. After the private agents make their, the central bank decides its optimal exchange rate for the next period. Thus the central bank is not a Stackelberg leader, because it does not commit itself to its previous decision, as in Barro and Gordon (1983).

The reason for this sequence of actions in the model is to view at the whole process in a game theoretic framework. Agents behave in accord with decisions that have to be made in a certain order depending on market position. Once a decision is made, it is costly to reverse it, and so the agent commits to it.

3.3 Agents' optimization problems

In this section agents' behavior and optimization problems are analyzed.

3.3.1 Household

The household has the utility function[38]

$$U = \lg C_t + \beta * \lg(C_{t+1}) \tag{3.1}$$

where C_t is consumption in period t, β ($1>\beta>0$) is the discount factor. For simplicity, I assume that the price of the good is fixed at 1 in both periods. Further, for simplicity but without loss of generality, the exchange rate, which is defined as domestic currency per unit of foreign currency in period t is taken to be 1, so that S_{t+1} greater than 1 indicates a depreciation.

The household is subject to the following constraints

$$C_t = \omega_t - d_t \tag{3.2}$$

$$C_{t+1} = \Omega_f + \Omega_b + d_t(1+i^d) \tag{3.3}$$

where ω_t is initial wealth and d_t is household savings, ie deposits. I assume that the household is the net saver in the economy, and therefore $\omega_t \geq d_t$. Thus first period consumption is equal to initial wealth minus savings. In the second period, t+1, the household spends all of its wealth. Ω_f and Ω_b are the profits of the firm and bank, respectively, and i^d is the deposit rate, which is set by the central bank at the start of period t.

In the first period, t, the household must make its intertemporal optimization decision. Thus it has to rely on its expectations of firm and bank profits to estimate its future income. Expected firm and bank profits are $E_t(\Omega_f)$ and $E_t(\Omega_b)$, respectively. Assuming the household is risk-neutral, we can adopt Selden's ordinal certainty equivalent preference formulation in risk neutral form.[39] As ω_t and i^d are given,

[38] The utility function adopted here is a special case.
[39] See Selden (1978).

the household chooses d_t to maximize its utility function. Then the household's utility function perceived at the start of period t is

$$U = \lg(\omega_t - d_t) + \beta \lg\left[E_t(\Omega_f + \Omega_b) + d_t(1 + i^d)\right] \tag{3.4}$$

Taking the derivative of U with respect to d_t, we get

$$\frac{\partial U}{\partial D_t} = \frac{-1}{\varpi_t - d_t} + \beta \frac{1 + i^d}{E_t(\Omega_f + \Omega_b) + d_t(1 + i^d)} = 0 \tag{3.5}$$

Thus[40]

$$d_t = \frac{\beta \omega_t}{1 + \beta} - \frac{E_t(\Omega_b + \Omega_f)}{(1 + \beta)(1 + i^d)} \tag{3.6}$$

The household's optimal decision does not depend directly on the future exchange rate because we assume in the model that prices are sticky in both periods.[41] Depreciation does not have any impact on the price of domestically produced products. If this assumption is relaxed, depreciation will have a direct impact on the consumption-savings decision due to the substitution effect.

Saving is positively related to the household's initial wealth. A rise in initial wealth will induce more savings in the first period. An increase in savings will reduce the need for foreign borrowing and lessen the risk of an exchange rate movement. The deposit rate, which is very important for the economy, is exogenized in the model. Saving is positively related to its yield, i^d. A rise in i^d will induce more savings and less consumption in period t.

The household's saving decision depends on the expected profitability of the bank and firm. Since the realization of profit depends on other variables, such as investment, bank lending rate, which are determined only afterwards, the household decision on consumption-saving must rely on expectations. In this model, we

[40] The second derivative is negative, which ensures maximization.

$$\frac{\partial^2 U}{\partial d_t^2} = \frac{-1}{(\varpi_t - d_t)^2} + \beta \frac{-(1 + i^d)^2}{\left[E_t(\Omega_f + \Omega_b) + d_t(1 + i^d)\right]^2} < 0$$

[41] However, the future exchange rate will affect the household's optimal decision indirectly, as it affects the profits of the firm and bank.

assume that all agents act in accord with rational expectations and are risk-neutral. The rise of expected combined profits has a negative impact on deposits. Thus if the household expects healthier profits and thus higher income in the next period, it reduces savings and consume more in the current period. As later sections will show, smaller deposits will lead to more foreign borrowing and thus to higher exchange rate risk.

3.3.2 Firm

The firm has a production function of the form:[42]

$$Y_{t+1} = A \cdot k_t^a \tag{3.7}$$

where A represents technological progress, k_t is capital in period t, and $0 < a < 1$.[43]

We assume that capital is completely depreciated in one period and the firm relies totally on the bank loan to finance its investment. This simplification is based on the credit view of the monetary transmission channel, which views a bank loan as not being a substitute for other categories of assets, such as corporate bonds. This assumption is more relevant for small and medium sized firms (see eg Gertler 1993, Edwards and Vegh 1997). Then we can replace K_t in the above equation with L_t, which is bank lending to the firm in period t.

The firm's cost function is

$$C_t = L_t \left(1 + i^l\right) \tag{3.8}$$

where i^l is the bank lending rate, and the firm's ex ante profit function is

$$\Omega_f^e = \lambda \cdot A \cdot L_t^a + (1-\lambda) \cdot E_t(S_{t+1}) \cdot A \cdot L_t^a - L_t \cdot \left(1 + i^l\right) \tag{3.9}$$

where $0 \le \lambda \le 1$.

λ represents the percentage share of output sold in the domestic market in period t+1. At the end of period t, the firm's output is

[42] The production function adopted here is a special case.
[43] Thus we assume that production is subject to diminishing returns to scale.

determined, but household consumption demand is dependent on realized profits.

The domestic price is always 1, but the export price is S_{t+1}. The sum of the first two terms on the right hand of equation 3.9 is the firm's total revenue. Since the consumer plans his last period consumption in period t, any output beyond that will be surplus and will be exported to the international market at a price of S_{t+1}. We have discussed earlier the fact that devaluation produced a wedge between domestic and international price levels in Finland that lasted for several years after the devaluation.[44]

If possible, the firm always wants to export its products to the international market when there is devaluation, as the firm will reap extra profits by taking advantage of the higher prices abroad. However, a country's ability to export also depends on the size and (short-run) competitiveness of its open sector. Thus in the model, the amount the firm is able to export (ie the smallness of λ) is determined by

$$\lambda = \lambda^* - \phi S_{t+1} \tag{3.10}$$

where λ^* is the average share of the country's closed sector and $0 \leq \lambda^* \leq 1$. We can also interpret λ^* as reflecting the (short-run) institutional fact of how much of the country's resource is devoted to its own consumption. $\phi \geq 0$ measures how sensitive the response of λ is to an exchange rate movement. The exchange rate has an impact on the economy because the weaker currency, the easier it is for the firm to export. Devaluation tends to increase a country's exports and reduce sales in the closed sector. Devaluation will also improve the firm's profitability.

We can rewrite the firm's ex ante profits as

$$\begin{aligned}\Omega_f^e &= \left(\lambda^* - \phi E_t\left(S_{t+1}\right)\right) \cdot A \cdot L_t^a \\ &\quad + \left(1 - \lambda^* + \phi E_t\left(S_{t+1}\right)\right) \cdot E_t\left(S_{t+1}\right) \cdot A \cdot L_t^a - L_t \cdot \left(1 + i^1\right)\end{aligned} \tag{3.11}$$

Since the firm is the follower in a Stackelberg game, the firm maximizes its profits by choosing its level of investment given the

[44] If instead we assume the law of one price, then the firm is indifferent about selling abroad or to domestic consumers. Thus the model loses one of the vital channels through which devaluation affects the profitability of the firm. It is widely known that the Finnish devaluation in 1992 helped Finnish firms to increase exports and improve profitability.

lending rate and expectations of the future exchange rate. Taking the derivative of Ω_f^e with respect to L_t, we obtain

$$L_t = \left[\frac{aA \cdot X^{ex}}{\left(1+i^l\right)}\right]^{\frac{1}{1-a}} \Leftrightarrow L_t = \left(aA \cdot X^{ex}\right)^{\eta} \cdot \left(1+i^l\right)^{-\eta} \qquad (3.12)$$

where

$$X^{ex} = \phi \cdot E_t\left(S_{t+1}\right)^2 + \left(1-\phi-\lambda^*\right) \cdot E_t\left(S_{t+1}\right) + \lambda^* \qquad (3.13)$$[45]

and

$$-\eta = -\frac{1}{1-a}$$

is the elasticity of capital investment with respect to the lending interest rate.

Equation 3.12 defines the firm's capital demand (investment) function, which depends on the cost of capital and expected exchange rate. It is obvious that

$$\frac{\partial L_t}{\partial i^l} < 0, \quad \text{and} \quad \frac{\partial L_t}{\partial E_t\left(S_{t+1}\right)} > 0$$

To the firm, the cost of capital, ie the lending rate, is known, as the bank sets it beforehand. The elasticity is constant, and its absolute value is greater than 1. The fact that the firm decides the investment level through the expected future exchange rate reflects the normal time lag between production and marketing. When the firm decides its production level, the final price of its product in the market, as well as the quantity it can sell to the domestic or international market, is not certain. The firm's decisions are based partly on its expectations of these variables.

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[45] As Var(S) is supposed to be zero, we have $E(S^2) = E(S)^2$. The second derivative is negative, which ensures maximization:

$$\frac{\partial^2 \Omega_f^e}{\partial L_t^2} = a \cdot (a-1) \cdot A \cdot X^{ex} \cdot L_t^{a-2} < 0.$$

We can thus get the firm's product supply function and ex ante profit function:

$$Y_{t+1} = a^{\eta-1} \cdot A^{\eta} \cdot \left(X^{ex}\right)^{\eta-1} \cdot \left(1+i^{l}\right)^{-(\eta-1)} \tag{3.14}$$

$$\Omega_f^e = (1-a) \cdot a^{\eta-1} \cdot A^{\eta} \cdot \left(X^{ex}\right)^{\eta} \cdot \left(1+i^{l}\right)^{-(\eta-1)} \tag{3.15}$$

where

$$-(\eta-1) = -\frac{a}{1-a}$$

is the elasticity of output and profit with respect to the lending interest rate.

We can interpret λ or X as such that the economy includes both the open and sheltered sectors. The firm's investment and output are related to the expected exchange rate and the openness of the economy. Devaluation, which means S_{t+1} is greater than 1, will enhance the open sector's competitiveness and improve the firm's profitability because the unit export price in domestic currency will increase, since export sales are denominated in foreign currencies. In addition, the less the resources the closed sector consumes, and the higher the value of ϕ, the greater the effect depreciation has on investment and output.

The firm's investment level and output are negatively related to the cost of capital, i^{l}, and positively to the expected exchange rate in period t+1. A higher lending rate will depress both investment and the firm's profit. So the firm makes its investment (borrowing) decision given the lending rate, i^{l}.

The firm's ex post profit after the central bank's decision on the period t+1 exchange rate is

$$\Omega_f = \lambda \cdot AL_t^a + (1-\lambda) \cdot S_{t+1} \cdot AL_t^a - L_t \cdot (1+i^{l}) \tag{3.16}$$

The solution gives the firm's ex post profit:

$$\Omega_f = \left(\frac{X}{X^{ex}} - a\right) \cdot a^{-(\eta-1)} \cdot A^{\eta} \cdot \left(X^{ex}\right)^{\eta} \cdot (1+i^{l})^{-(\eta-1)} \tag{3.17}$$

where

$$X = \phi \cdot S_{t+1}^2 + (1 - \phi - \lambda^*) \cdot S_{t+1} + \lambda^* \tag{3.18}$$

It is easy to verify that

$$\frac{\partial \Omega_f}{\partial S_{t+1}} > 0, \quad \text{and} \quad \frac{\partial \Omega_f}{\partial i^l} < 0 \tag{3.19}$$

The firm's realized profit is positively related to the future exchange rate and negatively to the interest rate. How the realized profit relates to the expected future exchange rate is ambiguous. Expectations of a larger devaluation in the future will raise output in the current phase, however, as we will see later, and can also result in a rise in the bank's lending rate, which will dampen the firm's profit.

3.3.3 Bank

In the model the banking sector is assumed to channel the consumer's savings into investment funds for the firm. The (monopoly) bank has two sources of funds: domestic saving and the international capital market. It is able to borrow an unlimited amount of capital at interest rate i* from the international market. From the bank's view point, as long as the cost of funds is the same, the bank is indifferent about borrowing from the domestic or international market, except that domestic savings are limited, whereas the international capital is unlimited. However, the bank cannot refuse domestic savings. So the bank will adjust its foreign borrowing to balance domestic savings and investment demand. This is a normal assumption made in other studies, as eg in Tarkka (1995).

The bank is a Stackelberg leader in the model, and it makes its own decision while taking into consideration the firm's reaction function and household's decision. The bank's ex ante profit function is

$$\Omega_b^e = L_t \cdot (1 + i^l) - d_t \cdot (1 + i^d) - B_t^* \cdot E_t(S_{t+1}) \cdot (1 + i^*) \tag{3.20}$$

where B* is the foreign borrowing which is denominated in foreign currency.

Balance in the capital market in period t requires that[46]

$$B_t^* = L_t - d_t \tag{3.21}$$

Before the bank decides its optimal level of lending rate,[47] the household has already made its decision on deposits. So d_t is exogenous to the bank.

Inserting (3.12) and (3.21) into (3.20), we get

$$\begin{aligned}\Omega_b^e = & (aA \cdot X^{ex})^{\eta} \cdot (1+i^l)^{-\eta} \cdot \left[(1+i^l) - E_t(S_{t+1}) \cdot (1+i^*)\right] \\ & + d_t \cdot \left[E_t(S_{t+1}) \cdot (1+i^*) - (1+i^d)\right]\end{aligned} \tag{3.22}$$

The bank solves its maximization problem:

$$\frac{\partial \Omega_b^e}{\partial i^l} = 0 \Leftrightarrow 1+i^l = \left(\frac{\eta}{\eta-1}\right) \cdot (1+i^*) \cdot E_t(S_{t+1})^{48} \tag{3.23}$$

The lending interest rate is positively related to the world interest rate and the expected exchange rate. The bank intermediates foreign borrowing to the domestic firm, and one of the main cost factors for the bank is the foreign debt cost. The bank has monopoly power, and it bears exchange rate risks; thus it charges a markup to its actual cost.

The lending rate here is related to the expected exchange rate, instead of the realized exchange rate. This result has important implications. The private sector's expectations of future exchange rates will determine the risk premium a bank perceives and thus the lending rate it charges the firm.

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[46] Remember that in period t the exchange rate is assumed to be 1, and thus we have (3.21).

[47] The bank will increase the lending level, L_t, until the lending yield i^l is equal to the expected cost of foreign borrowing, $E_t(S_{t+1})*(1+i*)$. The bank doesn't receive any profit by borrowing from the international market. The only profit is from the differential between the domestic deposit rate and the interest rate abroad. This is the case of complete competition in the domestic banking sector. In our case, the bank enjoys a monopoly position, so it can decide the lending rate to maximize its profit.

[48] The second derivative is negative, which ensures maximization:

$$\frac{\partial^2 \Omega_b^e}{\partial i^{l2}} = \frac{a^{\eta}}{(1-a)^2} \cdot (A \cdot X^{ex})^{\eta} \cdot (1+i^l)^{-1-\eta} \cdot \left[a - \frac{(2-a) \cdot E_t(S_{t+1}) \cdot (1+i^*)}{1+i^l}\right] < 0.$$

Inserting (3.6) into the bank's ex ante profit function to replace d_t, we get

$$\Omega_b^e = \frac{a^\eta}{\eta} \cdot (A \cdot X^{ex})^\eta \cdot (1+i^l)^{-(\eta-1)} + \left[\frac{\beta\omega}{1+\beta} - \frac{E_t(\Omega_b + \Omega_f)}{(1+\beta)(1+i^d)}\right] \cdot \left[E_t(S_{t+1}) \cdot (1+i^*) - (1+i^d)\right] \tag{3.24}$$

The bank's ex-ante profit composes two parts. The first part is due to the differential between the lending rate and the world interest rate, adjusted for the future exchange rate (foreign borrowing cost). The second part is due to the difference between the borrowing cost from abroad and domestic deposit rate. Overall, a higher world interest rate or deposit rate reduces the bank's profit. Higher domestic savings in the first period would tend to improve the bank's ex-ante profit.

At the start of period t+1, the central bank decides the exchange rate. The bank has to pay back foreign loans using the realized exchange rate in period t+1. Thus the bank's ex post profit is

$$\Omega_b = a^\eta \cdot (A \cdot X^{ex})^\eta \cdot (1+i^l)^{-\eta} \cdot \left[(1+i^l) - S_{t+1} \cdot (1+i^*)\right] + \left[\frac{\beta\omega}{1+\beta} - \frac{E_t(\Omega_b + \Omega_f)}{(1+\beta)(1+i^d)}\right] \cdot \left[S_{t+1} \cdot (1+i^*) - (1+i^d)\right] \tag{3.25}$$

Combining (3.17) and (3.25), we get the combined real ex post profit of the firm and bank:

$$\Omega_f + \Omega_b = a^{\eta-1} \cdot (A \cdot X^{ex})^\eta \cdot (1+i^l)^{-(\eta-1)} \cdot \left[\frac{X}{X^{ex}} - a^2 \cdot \frac{S_{t+1}}{E_t(S_{t+1})}\right] + \left[\frac{\beta\omega}{1+\beta} - \frac{E_t(\Omega_b + \Omega_f)}{(1+\beta)(1+i^d)}\right] \cdot \left[S_{t+1} \cdot (1+i^*) - (1+i^d)\right] \tag{3.26}$$

The expected combined profits can be obtained by summing up equations (3.15) and (3.24) and rearranging:

$$E_t(\Omega_b + \Omega_f) = \frac{(1+\beta)(1+i^d)}{(1+\beta)(1+i^d) + \left[S_{t+1}\cdot(1+i^*) - (1+i^d)\right]} \cdot \left[(1-a^2)\cdot a^{\eta-1}\cdot(A\cdot X^{ex})^{\eta}\cdot(1+i^l)^{-(\eta-1)} + \frac{\beta\omega_t\cdot\left[S_{t+1}\cdot(1+i^*) - (1+i^d)\right]}{1+\beta}\right] \tag{3.27}$$

Given the assumption of rational expectation on the part of the household, which imply $E_t(\Omega_b + \Omega_f) = \Omega_b + \Omega_f$ and replacing $E_t(\Omega_b + \Omega_f)$ in the right side of the equation (3.26) by (3.27), we get the ex post combined profits:

$$\Omega_b + \Omega_f = \Lambda\cdot B + \left[\frac{\beta\omega_t}{1+\beta} - \frac{(1-a^2)\cdot\Lambda + \frac{\beta\omega_t}{1+\beta}\cdot E_t(D)}{(1+\beta)(1+i^d) + E_t(D)}\right]\cdot D \tag{3.28}$$

where

$$\Lambda = a^{\eta-1}\cdot(A\cdot X^{ex})^{\eta}\cdot(1+i^l)^{-(\eta-1)} \tag{3.29}$$

$$B = \frac{X}{X^{ex}} - a^2\cdot\frac{S_{t+1}}{E_t(S_{t+1})} \tag{3.30}$$

and

$$D = S_{t+1}(1+i^*) - (1+i^d) \tag{3.31}$$

Now replacing $1+i^l$ with (3.23), we get

$$\Omega_b + \Omega_f = \Lambda^*\cdot B + \left[\frac{\beta\omega_t}{1+\beta} - \frac{(1-a^2)\cdot\Lambda^* + \frac{\beta\omega_t}{1+\beta}\cdot E_t(D)}{(1+\beta)(1+i^d) + E_t(D)}\right]\cdot D \tag{3.32}$$

where

$$\Lambda^* = a^{2(\eta-1)}\cdot(A\cdot X^{ex})^{\eta}\cdot(1+i^*)^{-(\eta-1)} \tag{3.33}$$

From equation (3.32), we know that the private sector profitability will respond positively to a change in A and negatively to movements in i*. The signs of the partial derivatives of Ω with respect to i^d, S_{t+1}, $E_t(S_{t+1})$ are ambiguous, because the impacts of these variables on the firm's profit and bank's profit is conflicting. Thus their impacts on combined profit are ambiguous.

It is easy to verify that an unexpected devaluation will raise the firm's profit in this model, as higher export prices stimulate production and markup. ($\partial\Omega_f/\partial S_{t+1} > 0$). But an unexpected devaluation will unambiguously hurt the bank, because it will have to pay back foreign loans at a higher cost ($\partial\Omega_b/\partial S_{t+1} < 0$). The effect of the unexpected devaluation on the combined profits of firm and bank is not certain and will depend on the parameters of the model and agents' expectations.[49] When there are equilibrium devaluation values, there can easily be more than one. Thus the multiplicity problem arises. The question can also be pursued as the divergent impacts of devaluation on the open and sheltered sectors of the economy.

Before proceeding to more complicated cases, we examine a simpler case with no uncertainty about the period t+1 exchange rate.

3.4 When the central bank is able to commit to the pegged exchange rate system

The previous sections have detailed the optimization behavior of private agents. In the following sections we will look at the central bank's optimization decision on the exchange rate.

We will start by looking at the simplest case: the sole objective of the central bank is to maintain the fixed exchange rate system, and the central bank is able to commit to it. Then the expectation of the future exchange rate is stable, and the fixed exchange rate regime will hold. Both S_{t+1} and $E_t(S_{t+1})$ are equal to 1. Hence X is also equal to 1. We thus get the following equations for the equilibrium state:

[49] It is assumed that hedging is not possible. Burnside-Eichenbaum-Rebelo (1999) point out that one of the basic elements of currency and banking crises is the lack of hedging of exchange rate risks by banks.

$$\Omega = \Omega_b + \Omega_f = (1-a^2)\cdot\Lambda' + \left[\frac{\beta\omega_t}{1+\beta} - \frac{(1-a^2)\cdot\Lambda' + \frac{\beta\omega_t}{1+\beta}\cdot(i^*-i^d)}{(1+\beta)(1+i^d)+(i^*-i^d)}\right]\cdot(i^*-i^d) \quad (3.34)$$

$$d_t = \frac{\beta\omega_t}{1+\beta} - \frac{(1-a^2)\cdot\Lambda' + \frac{\beta\omega_t}{1+\beta}\cdot(i^*-i^d)}{(1+\beta)(1+i^d)+(i^*-i^d)} \quad (3.35)$$

$$C_t = \frac{\omega_t}{1+\beta} + \frac{(1-a^2)\cdot\Lambda' + \frac{\beta\omega_t}{1+\beta}\cdot(i^*-i^d)}{(1+\beta)(1+i^d)+(i^*-i^d)} \quad (3.36)$$

$$C_{t+1} = (1-a^2)\cdot\Lambda' + (1+i^*)\cdot\left[\frac{\beta\omega_t}{1+\beta} - \frac{(1-a^2)\cdot\Lambda' + \frac{\beta\omega_t}{1+\beta}\cdot(i^*-i^d)}{(1+\beta)(1+i^d)+(i^*-i^d)}\right] \quad (3.37)$$

$$L_t = a^{2\eta}\cdot A^{\eta}\cdot(1+i^*)^{-\eta} \quad (3.38)$$

$$Y_{t+1} = a^{2(\eta-1)}\cdot A^{\eta}\cdot(1+i^*)^{-(\eta-1)} \quad (3.39)$$

where

$$\Lambda' = a^{2(\eta-1)}\cdot A^{\eta}\cdot(1+i^*)^{-(\eta-1)} \quad (3.40)$$

Initial wealth is positively related to consumption in both periods. The level of foreign borrowing is negatively related to initial wealth. These results imply that a shock to the wealth of the household sector, such as a drop in asset prices, will increase the need for foreign borrowing and for exports.

The differential between domestic and international interest rates, $(i^* - i^d)$, is an important variable in the model. It influences consumption, savings, and the overall profitability of the private sector, as well as foreign borrowing and net exports of the economy.

Once the central bank pegs its currency, it can no longer influence investment or output, as shown by equations (3.38) and (3.39).

Movements in the international interest rate determine the values of these two variables. The agent optimization decisions are also centered on the international interest rate. The only instrument of the central bank is the short-term interest rate, ie i^d. The level of i^d will influence the distribution of consumption over the two periods and also the interest rate differential.

The central bank cannot insulate the domestic economy from a world interest rate shock in a pegged exchange rate regime, as the investment level is determined by the international interest rate. A rise in the world interest rate will result in a rise in the lending rate and a reduction in domestic output. Under these circumstances, the central bank has to adjust the interest rate, which is the deposit rate in our case, in order to narrow the gaps between lending and deposit rates as well as between deposit and world interest rates.

The lending vs deposit rate spread is normally regarded as an important indicator of financial market efficiency. An increase in the spread will worsen the balance sheet of the private sector and thus have an adverse impact on the economy. This issue was discussed in more detail in section 2.4.4.

3.5 Monetary policy under speculative pressures

3.5.1 Monetary policy rule and the central bank optimization decision

In this model we have a central bank that decides its optimal exchange rate. For simplicity, we assume the central bank can control the exchange rate. Theoretically, the central bank can control exchange rate movements mainly through direct intervention in the foreign exchange market and the setting of short-term interest rates. As Obstfeld et al (1995) describes it, ‘By reducing its monetary base sufficiently, the central bank can raise interest rates to a level so high that speculators will find it prohibitively expensive to go short in the domestic currency.’ But generally no central bank is willing to risk destroying the economy by raising interest rates to a prohibitive level for a prolonged period. Moreover, the maneuverability of the central bank is often constrained by domestic economic fundamentals and market expectations. Hence we can regard exchange rate policy as a tradeoff between currency stability and other macroeconomic goals.

The central bank has its objectives, which are characterized by a loss function. The loss function is usually related to output and inflation.[50] In this model, the central bank is assumed to minimize exchange rate movements and to keep the profit of the private sector close to a target level.

Under a pegged exchange rate system, the central bank cares about exchange rate movements. When the central bank claims to peg the exchange rate, any deviation from the period t exchange rate (which is 1) is regarded as undesirable. $S_{t+1}-1$ is exactly the devaluation rate.[51] A sudden devaluation will also cost the central bank credibility and produce shocks among domestic agents as well as international investors.

In this model, the central bank also tries to keep the profit of the private sector as close as possible to the target value but still compatible with the fixed exchange rate regime. This profit target value should be attainable. More importantly, it should be equal to the value that the private sector can achieve under the fixed exchange rate regime with no expectations of devaluation.

The reasons for choosing profit as a key variable in the central bank's loss function in this model are manifold. First of all, the profitability of the private sector will have impacts on new

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[50] To analyze monetary policy, a central bank utility function, often in the form of a loss function, is now widely used. The most popular form is

$$L_{CB} = \frac{\theta}{2}(Y - Y^*)^2 + \frac{1}{2}(\pi - \pi^*)^2$$

where Y is the actual output level, Y* is the desired output level, π is the actual inflation rate and π^* is the desired inflation rate. This means that the central bank cares about both inflation and output. The central bank uses its instruments to move output and inflation as close as possible to their respective desired levels. θ represents the central bank's relative weighting of output and inflation.

The use of the loss function is based on the assumption that the central bank has instruments for influencing both output level and inflation rate. Often there is a tradeoff between output and inflation, so that the central bank can only achieve a compromise between desired output and inflation.

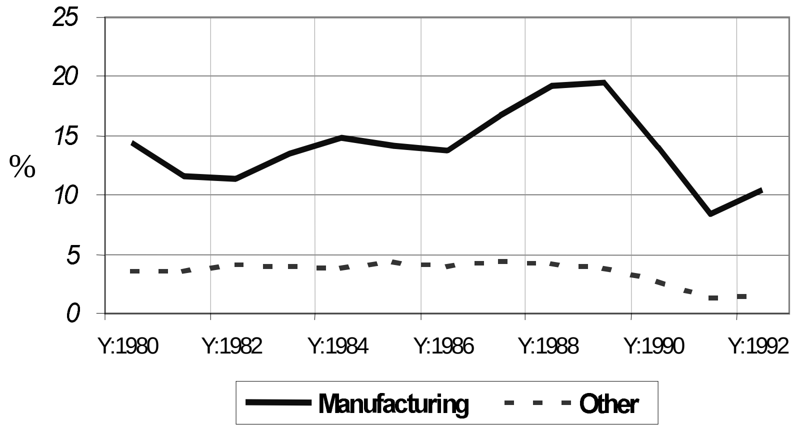
The central bank's objective function in this model is fundamentally similar to the above one. However, due to the model setups, we focus on the ex post profitability of the bank and firm and the stability of the currency as the main objectives of the central bank. The profitability of the private sector will have large impacts on new investment and firms' desire to hire more employees. Thus national output and unemployment are closely related to the profitability of the private sector, especially the industrial and financial sectors.

[51] Here it is assumed that the central bank has only devaluation pressure.

investment. Thus national output is also closely related to the private sector profitability.

In addition, the Bank of Finland has a tradition of targeting the competitiveness of the Finnish economy as an important objective. Exchange rate policy was often used to enhance the competitiveness of Finnish industry. This is one of the reasons that Finland had devalued rather frequently after the Second World War. Thus the profitability of industry was traditionally an important factor in determining exchange rate policy. Actually the deterioration of corporate profitability threatened massive bankruptcy in the early 1990s in Finland, which is one of the main reasons that the Bank of Finland abandoned the fixed exchange rate regime. This stylized fact was discussed in detail in section 2.4.2.

Figure 3.2 **Profitability of the private sector**
Gross cashflow, % of net capital stock (current prices)



Source: OECD.

Finally, the business community usually exerts considerable influence on government policymaking. Central banks are seldom free from political pressures. This is well documented in the political economy literature. As Bruno (1989) argues:

> 'Policy is modelled at least as much by a specific institutional setup, political pressures, public acceptability of a policy as well as the personality and ambitions of the politician or the policymaker himself.
>
> An independent central banker usually owes his allegiance to the general public rather than any one political group and is in

general more likely to steer closer to his academic roots than an academic appointed by the minister of finance, say. But this is not always the case. The advantage of being in the position to “Call the shots” is clear. The equally obvious cost, however, is the greater susceptibility to political pressures’

Thus the loss function in this model consists of two components: exchange rate movements and profits of the private sector. The central bank chooses an exchange rate in period t+1 to minimize its loss function:

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{1}{2}(\Omega - \Omega^*)^2 \tag{3.41}$$

where θ indicates the degree of commitment the central bank attaches to the pegged exchange rate policy relative to the other goal – profit maximization.

The central bank faces conflicting interests in deciding the exchange rate, which will have different impacts on the open and sheltered sectors. It is this conflict of interest that results in the inconsistency problem of the policymaker and thus the multiple equilibria in exchange rates.

3.5.2 Self-fulfilling currency crisis

Once there are uncertainties in the domestic economy, such as trade shocks or banking crisis, speculation on the pegged exchange rate will emerge. Then the expectation of the period t+1 exchange rate is not necessarily equal to 1. Speculation is sometimes self-fulfilling and central banks often have conflicting interests, especially during times of crisis. On the other hand, the exchange rate decision can be sometimes viewed as an optimizing decision by the central bank. The central bank faces conflicting interests, and it chooses a level of exchange rate to minimize the loss function.[52]

The central bank can use exchange rate policy to conduct monetary policy. In this case, neither the period t+1 expectation of the

[52] As Drazen (1999) points out; ‘Political nature of the decision to devalue, combined with incomplete information about government objectives in making this decision, is often crucial to the appearance of speculative pressures.’

exchange rate nor the exchange rate itself will necessarily be 1. Since the central bank understands the private sector's optimization problem, we can plug equation (3.32) into (3.41) to get

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{1}{2}\left[a^{2(\eta-1)} \cdot (A \cdot X^{ex})^{\eta} \cdot (1+i^*)^{-(\eta-1)} \cdot \left(\frac{X}{X^{ex}} - a^2 \cdot \frac{S_{t+1}}{E_t(S_{t+1})} \right) + \left[\frac{\beta\omega_t}{1+\beta} - \frac{(1-a^2) \cdot a^{2(\eta-1)} \cdot (A \cdot X^{ex})^{\eta} \cdot (1+i^*)^{-(\eta-1)} + \frac{\beta\omega_t}{1+\beta} \cdot E_t(D)}{(1+\beta)(1+i^d) + E_t(D)} \right] \cdot D - \Omega^* \right]^2 \quad (3.42)$$

where

$$D = S_{t+1}(1+i^*) - (1+i^d) \quad (3.43)$$

We denote the factor in the main brackets on right-hand side of the equation as Z.

To minimize the loss function, the central bank chooses the optimal exchange rate in period t+1 by the condition

$$\frac{\partial L_{CB}}{\partial S_{t+1}} = 0 \quad (3.44)$$

We then get the following result:

$$\theta S_{t+1} - \theta + Z \cdot \frac{\partial Z}{\partial S_{t+1}} = 0 \quad (3.45)$$

From the above equation we can solve for an equilibrium value S* for the central bank. Thus given the second-order condition, ie the central bank's reaction function derived from the above optimization process is

$$S_{t+1} = f(E_t(S_{t+1}), i^*) \quad (3.46)$$

which will be highly nonlinear and often intractable. However, multiple solutions for the equilibrium exchange rate S_{t+1} are very likely.

Under a fixed exchange rate system, the dynamic-inconsistency problems faced by the central bank result in multiple solutions. The nonlinearity of central bank's reaction function could lead to more than one equilibrium. The benchmark one features no deviation of the private sector's expectations from the fixed exchange rate system. In the model, when $E_t(S_{t+1})$ is equal to 1, it is always in the central bank's interest to maintain the fixed exchange rate, ie to keep the next period exchange rate at 1. At this stage, the central bank's loss function reaches its minimum value, zero. Thus there will be no currency speculation or attack, and the fixed exchange rate system can be sustained. This is the 'heaven' state, as coined by Jeanne (1999). The solution for the economy can be found in the previous section, in which the central bank is able to commit to a fixed exchange rate regime.

When devaluation expectations arise, the situation can change very dramatically. The reasons for the sudden change of expectations may be attributed to world interest rate shocks or to other shocks such as technological or trade shocks. Then other equilibria could also emerge. These feature currency crises as changes in expectations validate changes in economic fundamentals, which makes changes in the exchange-rate inevitable, given the central bank's policy preferences. Thus the currency crisis is really self-fulfilling, and the situation resembles what Eichengreen et al (1997) describe: 'two equilibria thus exist: the first one features no attack, no change in fundamentals, and indefinite maintenance of the peg; the second one features a speculative attack followed by a change in fundamentals, which validates the exchange-rate change that speculators expected to take place.'[53]

Equation (3.32) actually reflects the conflicting interests of the central bank. For the open sector, devaluation is beneficial, but for the domestic sheltered sector, devaluation results in an increase in foreign debt and thus a reduction in profitability. For the whole economy, a decision to devalue is often based on a balancing of these two forces, if the central bank is able to control the exchange rate.

It is not possible to express S* explicitly, as the equation is highly nonlinear. We now try to simplify the matter by considering a special case. Here, let us consider the case in which the central bank cares only about the firm's profits. Then (3.32) reduces to

$$\Omega_f = (\frac{X}{X^{ex}} - a) \cdot a^{2(\eta-1)} \cdot (A \cdot X^{ex})^{\eta} \cdot (1+i^*)^{-(\eta-1)} \cdot E_t(S_{t+1})^{-(\eta-1)} \quad (3.47)$$

[53] See Eichengreen et al (1997, p. 10).

In this case, the central bank's target for the profit is

$$\Omega^* = \Omega_f^* + L_t \cdot (1+i^1) \cdot (E(S)-1) \tag{3.48}$$

where Ω_f^* is the profit under the regime in which there are no private sector expectations of devaluation and the central bank can commit to its exchange rate policy. The second item on the right-hand side of (3.48) captures the fact that the central bank's profit target grows with devaluation expectations weighted by total outstanding loans. This item is also the expected loss from bank lending due to the devaluation, when all lending is denominated in foreign currency.

When there are no devaluation expectations, (3.48) reduces to

$$\Omega^* = \frac{1}{\eta} \cdot a^{2(\eta-1)} \cdot A^{\eta} \cdot (1+i^*)^{-(\eta-1)} \tag{3.49}$$

which is the same as the firm's profit under the committed fixed exchange rate regime.

Let's simplify the matter further by considering an extreme case in which λ is fixed and close to zero. This is an approximation, since λ can never actually be zero. Empirically, this means that the economy is extremely open, and domestic consumption accounts for a very small share of domestic output. Then X simplifies[54] to

$$X = S_{t+1} \tag{3.50}$$

Now we have the following loss function of the central bank:

$$\begin{aligned} L_{CB} &= \frac{\theta}{2}(S_{t+1}-1)^2 \\ &+ \frac{1}{2}\left[\begin{aligned}&\left(\frac{S_{t+1}}{E_t(S_{t+1})} - a \cdot E_t(S_{t+1})\right) \cdot a^{2(\eta-1)} \cdot A^{\eta} \cdot (1+i^*)^{-(\eta-1)} \cdot E_t(S_{t+1}) \\ &-(1-a) \cdot a^{2(\eta-1)} \cdot A^{\eta} \cdot (1+i^*)^{-(\eta-1)}\end{aligned}\right]^2 \end{aligned} \tag{3.51}$$

or

[54] When $\phi = 0$, $\lambda^* = 0$.

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{\psi^2}{2}\left[(S_{t+1} - a \cdot E_t(S_{t+1})^2) - (1-a)\right]^2 \quad (3.52)$$

where

$$\psi = a^{2(\eta-1)} \cdot A^{\eta} \cdot (1+i^*)^{-(\eta-1)} \quad (3.53)$$

Taking the derivative of L_{CB} with respect to S_{t+1}, we get

$$\frac{\partial L_{CB}}{\partial S_{t+1}} = 0 \Leftrightarrow \theta \cdot S_{t+1} - \theta + \psi^2 \cdot \left[S_{t+1} - a \cdot E_t(S_{t+1})^2 - (1-a)\right] = 0 \quad (3.54)$$

Rearranging (3.54) and expressing S_{t+1} in terms of $E_t(S_{t+1})$, we get

$$S^* = \frac{\psi^2 \cdot a}{\theta + \psi^2} \cdot E_t(S_{t+1})^2 + \frac{\psi^2 \cdot (1-a) + \theta}{\theta + \psi^2} \quad (3.55)$$

This is the equilibrium value of the exchange rate for the central bank in reaction to the expected exchange rate.

To have rational expectations in respect of the central bank's decision on the future exchange rate, that is, using S^* to replace $E_t(S_{t+1})$ in (3.55), we have the equation

$$\frac{\psi^2 \cdot a}{\theta + \psi^2} \cdot S^{*2} - S^* + 1 - \frac{\psi^2 \cdot a}{\theta + \psi^2} = 0 \quad (3.56)$$

Because

$$\begin{aligned} b^2 - 4 \cdot a \cdot c &= 1 - 4 \cdot \left(\frac{\psi^2 \cdot a}{\theta + \psi^2}\right) \cdot \left(1 - \frac{\psi^2 \cdot a}{\theta + \psi^2}\right) \\ &= \left(1 - 2 \cdot \frac{\psi^2 \cdot a}{\theta + \psi^2}\right)^2 \geq 0 \end{aligned} \quad (3.57)$$

equation (3.56) always has one or two real roots. When

$$1 - 4 \cdot \left(\frac{\psi^2 \cdot a}{\theta + \psi^2}\right) \cdot \left(1 - \frac{\psi^2 \cdot a}{\theta + \psi^2}\right) = 0 \quad (3.58)$$

there is only one unique root, which is 1. The fixed exchange rate is always the equilibrium one. In addition, under this case, the central bank's loss is zero, the minimum of all possibilities. This is the dominant outcome of all equilibrium exchange rates. However, when (3.58) is not fulfilled, equation (3.56) will have two roots.

From (3.58), we deduce

$$\psi^2 = \frac{\theta}{2 \cdot a - 1} \tag{3.59}$$

which can be further expressed as

$$1 + i^* = A^{\frac{1}{a}} \cdot a^2 \cdot \left(\frac{2a - 1}{\theta} \right)^{\frac{1-a}{2a}} \tag{3.60}$$

Note that $a > \frac{1}{2}$ is a precondition for (3.58), which means that the elasticity of output with respect to capital has to be bigger than one-half, in order to enable a unique outcome for an equilibrium at which the pegged exchange rate system can be maintained.

(3.60) is the ultimate condition for unique solution of the exchange rate. Under this condition, the world interest rate is compatible with the pegged exchange rate in the economy. And only with this interest rate is the pegged exchange rate system the desirable and stable outcome of the economy, as fundamentals and external environment match perfectly.

When equation (3.60) does not hold, equation (3.56) has two roots, one of which is 1 and the other[55] larger than one:[56]

$$S_1^* = 1, \quad S_2^* = \frac{\theta}{\psi^2 \cdot a} + \frac{1}{a} - 1 \tag{3.61}$$

The following chart demonstrates two solutions for the central bank's reaction function. Under the condition of (3.60), the economy has only

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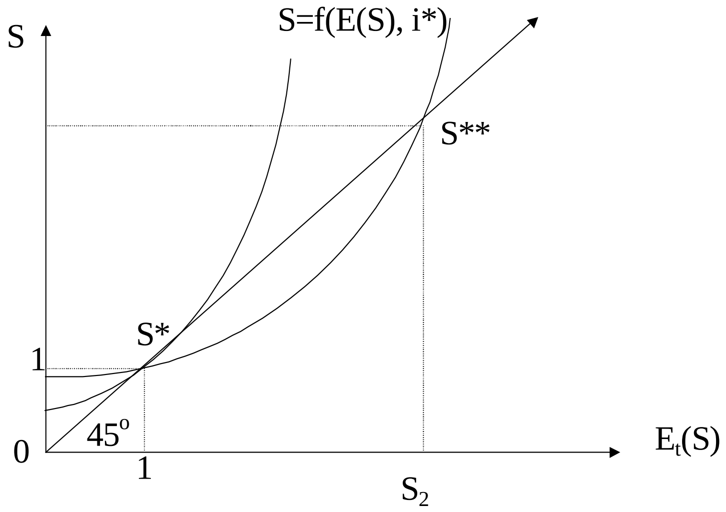
[55] See appendix 4.1 for details.

[56] Since $1/a > 1$ and ψ, θ, $a > 0$, S_2^* is always greater than 1. As for the issue of multiplicity of equilibria, we follow Obstfeld (1994, 1997), Ozkan and Sutherland (1998) and Aghion-Bacchetta-Banerjee (2000) to give examples of two equilibria to show the possibility of multiplicity.

one equilibrium exchange rate, which is always fixed at 1. This resembles the case where the international interest rate is on the level that is compatible with domestic economic fundamentals. As a result, the fixed exchange rate can always be maintained. This situation is represented by the first curve of equilibrium exchange rates that is tangent to the 45' line at 1. Otherwise the equilibrium exchange rate curve intersects with the 45' line and there are two equilibrium exchange rates.

Figure 3.3 **Equilibrium exchange rates**



Source: OECD.

The multiple equilibria of exchange rates in the economy occur when the world interest rate is not compatible with economic fundamentals. Under this circumstance, the private sector's expectations of exchange rates will play a significant role in determining whether the pegged exchange rate system can be maintained, as well as the final outcome of the equilibrium exchange rate. When the private sector's expected exchange rate is smaller than S_2^* in (3.61), the pegged exchange rate can still hold, but when it is equal to or greater than S_2^* devaluation becomes the only equilibrium outcome for the central bank, and the new exchange rate is

$$S_2^* = \frac{\theta}{\psi^2 \cdot a} + \frac{1}{a} - 1 = \frac{\theta \cdot (1+i^*)^{\frac{2a}{1-a}}}{A^{\frac{2}{1-a}} \cdot a^{\frac{1+3a}{1-a}}} + \frac{1}{a} - 1 \qquad (3.62)$$

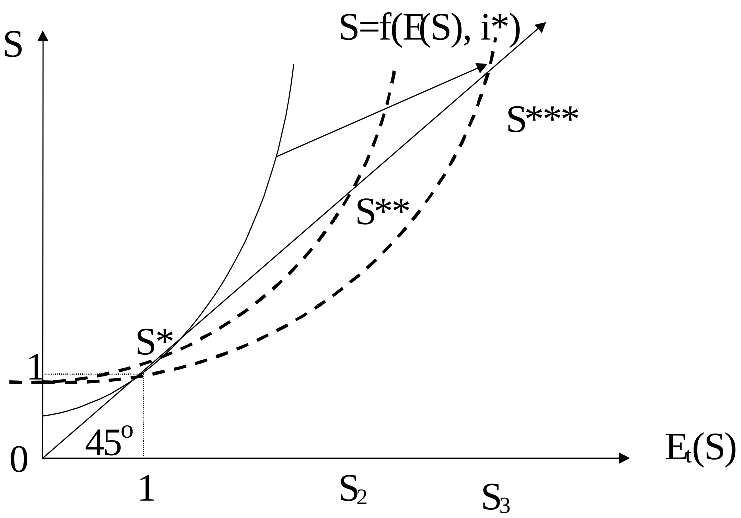
A rise in the world interest rate will not only reduce domestic investment and output but will also raise the cost of foreign borrowing and thus the cost faced by the domestic banking sector.

It is obvious from (3.62) that

$$\frac{\partial S^*}{\partial i^*} > 0 \qquad (3.63)$$

It is clear that a rise in the world interest rate, i*, exerts upward pressure on the equilibrium exchange rate, S*. This result indicates that the central bank faces pressure toward a bigger devaluation when the world interest rate rises.

Figure 3.4 **Impact of a rise in interest rate i* on equilibrium exchange rate S***



Source: OECD.

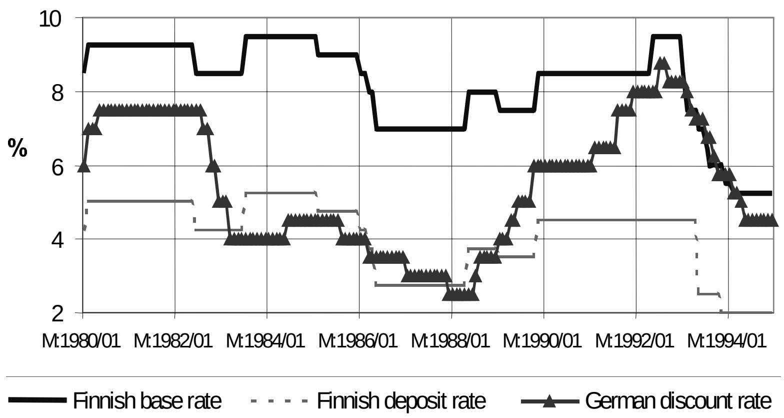
Under a pegged exchange rate regime, exchange rate policy is sensitive to world interest rates. In a certain range of world interest rates, the pegged exchange rate is compatible with domestic fundamentals and can thus be maintained. An increase in the world interest rates will however result in an increase in domestic interest rates and will subsequently affect domestic economic activity. As a result, the central bank has an incentive to adjust the exchange rate. Private sector agents build their expectations on a possible devaluation. These expectations in turn affect economic activity, which provides more incentive for the central bank to devalue. The higher the world interest rate, the larger the equilibrium devaluation.

A larger devaluation can boost the profitability of exporters. As equations (3.14) and (3.17) indicate, devaluation will have a boosting effect on overall investment and output. In addition, devaluation will increase the share of the open sector and transfer resources to the open sector.

However, devaluation will meet opposition from the sheltered sector of the economy (in this model, the banking sector), as devaluation will increase foreign debt and thus increase domestic banking sector costs. In other words, devaluation will increase the debt burden of the banking sector and reinforce the pressure to raise the lending rate, which is a critical determinant of domestic investment and output.

Another choice open to the central bank is to raise the deposit rate when there is a rise in the world interest rate. Actually the deposit rate is an alternative instrument, in addition to exchange rate adjustment, that the central bank can rely on to offset the impact of a rise in the world interest rate. In this model, a rise in the deposit rate does not have any effect on investment or output. However, a rise in the deposit rate will induce the household to reduce consumption and save more in the first period. The effect is just like a tightening of monetary policy. Savings increase and foreign borrowing decreases; hence the ability to withstand an adverse shock to the currency is strengthened.

Figure 3.5 **Official interest rates**



Source: OECD.

But on the other hand, a rise in the deposit rate will increase the cost of the banking sector and reduce the overall profitability of the private sector. A rise in interest rates is extremely harmful to the economy in reality. In a more complex case, where the lending rate is determined also by the deposit rate, a rise in the deposit rate will lead to a rise in the lending rate, which will dampen investment and output. Central banks are also reluctant to raise the deposit rate in the face of a world interest rate shock.

Thus the choice between abandoning the pegged exchange rate system or raising the interest rate in an earlier stage is often difficult to make. In the case of Finland at the end of the 1980s, the central bank did not raise the base rate early enough and high enough in the midst of the rapid rise in the German official discount rate. Thus, eventually the central bank was forced to abandon the pegged exchange rate system in a later stage.[57]

In light of the logic of currency crises as brought out by the model, we discuss the Finnish currency crisis in the following paragraphs.

Toward the end of the 1980s, a pegged exchange rate policy became a cornerstone of Finnish monetary policy. As the Finnish economy was increasingly integrated with the rest of Europe, the purpose of this policy was to reduce the volatility of the exchange rate and contain inflation at the later stage of a business cycle. But the attempt to use the exchange rate as a nominal anchor for monetary policy could be risky, for the pegged exchange rate system needs not only ample foreign reserves and good economic fundamentals, but also the time consistency of the monetary policy. Furthermore, the fixed exchange rate regime may give a false sense of stability in the value of the currency and encourage capital inflow. One of the consequences is the increased amount of foreign debts.[58]

Thus the causes of the currency crisis may lie in the new challenge facing monetary policymakers amid growing capital mobility across national boundaries. Unlike in the period of tight capital account regulation, large and sudden international capital movements make

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[57] The other instrument that the central bank can use is the cash reserve requirement ratio. A reduction in it will also stimulate domestic lending and increase the need to borrow from abroad. In the first period, the central bank could raise the cash reserve requirement to restrict total lending. Then in a later period, especially in the midst of a recession, the central bank could lower it to stimulate lending. Edwards and Vegh (1997) also discuss the role of the cash reserve requirement ratio in the Latin American crisis. The conclusion is that the central bank has to raise it high enough in the booming period. However, the high capital mobility across national boundaries makes this policy instrument increasingly less effective.

[58] See Frankel (1999) and Stockman (1999) on the complexity of keeping the pegged exchange rate system as well as comparisons of merits and shortcoming of various exchange rate systems and McCallum (1997) on design of monetary policy rules.

monetary policy in a small open economy increasingly difficult to control. The monetary authority often faces a dilemma in conducting monetary policy under the fixed exchange rate regime, namely, the need to accommodate both domestic orientation and international capital mobility.[59] When there are negative shocks to the economy, (such as the interest rate shock in Europe and the Soviet trade shock in the Finnish case), the exchange rate may require an adjustment to reflect the underlying change in economic fundamentals. Under this circumstance, even if the central bank wants to defend the pegged exchange rate system, the self-fulfilling nature of private expectations could make the defense unbearable.

An unexpected movement in the exchange rate will change the debt burden of domestic households, especially when they are significant borrowers of foreign capital. After the financial liberalisation in Finland, the domestic sector was heavily indebted. Under these circumstances, unexpected drastic movements in the exchange rate immediately cause significant changes in the net wealth of the economy and thus have big and immediate impacts on the economy. All these issues make the fixed exchange rate regime difficult to maintain for a small open economy facing severe shocks. Actually, the domestic sheltered sector demanded a stable currency and the central bank had paid much attention to the tolerance of the sheltered sector.

However, the deterioration in economic activity and employment in Finland in 1992 were so severe that some prominent Finnish economists openly advocated devaluation. Haaparanta et al (1992) emphasized the importance of open sector competitiveness in economic revival and suggested a 20% devaluation of the markka. The grave reality of economic developments at the time made many think the 'unthinkable' – floating the exchange rate of the markka. Once the expectations of the future currency policy changed and the monetary authority had lost enough credibility, speculative attacks brought on self-fulfilling consequences in 1991–1992. Markka devaluation became inevitable.

[59] See Obstfeld (1998) on impacts of a globally integrated capital market and its policy implications, especially on the pegged exchange rate system.

3.6 Overoptimistic expectations

In this section we examine how overoptimistic expectations affect the central bank's decision on exchange rates. It often happens that the household's expectations of future incomes are not correct. Particularly, there is a tendency for human beings to have optimistic expectations. Manove and Padilla (1999) point out, 'De Bondt and Thaler (1995, p. 389) in their summary of recent studies made by behavioral economists and by psychologists and sociologists, report that "perhaps the most robust finding in the psychology of judgement is that people are overconfident", that is, people are unrealistically optimistic about their ability, power and outcome of their own actions.' Taylor (1989) also provided evidence to support the argument that unrealistic optimism is one of the indispensable traits of the healthy mind.

The difficulties involved in forecasting future incomes by households can be demonstrated by the difficulty of forecasting general economic growth.[60] For example, in Finland, during the economic boom, forecasts of GDP growth in 1989 by four leading forecast institutes, made in the previous year, varied from 1.5% to 3%, whereas the realized rate was 5.7%. During the recession, forecasts of GDP growth in 1991 by the same four forecast institutes, made in autumn 1990, varied from 0% to 2%, whereas the realized rate was –7.1%. Also in 1992 and 1993, forecast institutes made consistently positive growth forecasts on average in the previous year, whereas the realized rates were quite negative, –3.6% and –1.2%.[61]

Incorrect forecasts and expectations have pronounced effects on consumption and saving behavior. How to evaluate the effects of erroneous expectations on the recession is an interesting question. In this section we discuss what happens in the model when the household is overoptimistic and expects a higher income in period t+1 than the true value, ie

$$E_t(\Omega_b + \Omega_f) = \Omega_b + \Omega_f + \sigma \tag{3.64}$$

[60] Macroeconomic forecasts play an important role in the policymaking process. Many key policies are made on the basis of forecasts of future economic activities. In most countries monetary policy, specifically interest rate decisions, are based on forecasts of future growth and inflation. Government budgets are also planned on the basis of GDP and inflation forecasts. In addition, wage negotiations, enterprise investment plans, and consumer sentiment are often influenced by economic forecasts.
[61] See Vartia (1994, p. 22) for details.

where $\sigma > 0$, measures the degree of overoptimism. We can plug equation (3.64) into equation (3.32) and get

$$\Lambda = (\Omega_b + \Omega_f)' - (\Omega_b + \Omega_f) = -\frac{\left[S_{t+1}(1+i^*) - (1+i^d)\right]}{(1+i^d)(1+\beta)}\sigma \qquad (3.65)$$

where $(\Omega_b + \Omega_f)'$ is the realized profit under overoptimistic expectations of future incomes. Λ can be positive, zero or negative depending on the sign of $S_{t+1}(1+i^*)-(1+i^d)$. Thus an overestimation of future incomes can be self-fulfilling as long as S_{t+1} is low, ie there is no currency devaluation. If the currency depreciates in the second period, the realized profit will be less than that under rational expectations.

Consumers try to maximize utility by adjusting their consumption, which depends on future income. Consumers smooth their consumption and therefore the influence of future income change is already taken account of in the current period. In the model, in the first period, when future income is expected to be higher than actual income, consumers are overoptimistic and consume more, and consequently reduce savings, already in the first period. This smoothing of consumption over time is a standard result of consumer theory. See The Journal of Economic Perspectives (1995) for a comprehensive discussion.

The consumer boom is likely to boost production and investment. Thus foreign borrowing must rise, given the relatively limited domestic savings.[62] The accumulation of foreign debt seriously constrains monetary policy.

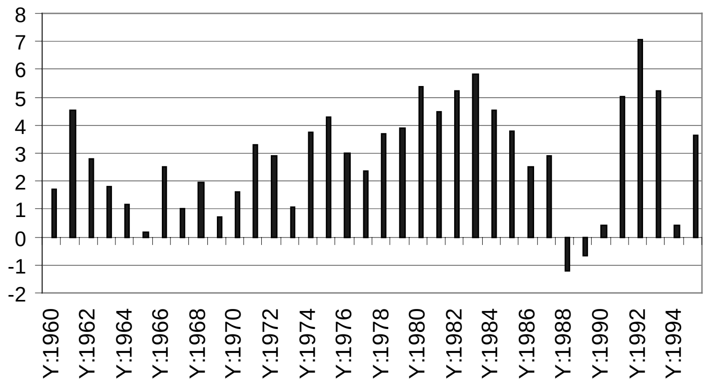
An overestimation of period t+1 profit decreases deposits and increases first period consumption. This in turn leads to high foreign borrowing and thus higher exchange rate risk for the sheltered sector. As a result, the central bank is more reluctant to devalue the currency

[62] As Kiander and Vartia (1996) wrote about the Finnish experience:

> 'Rapid economic growth and an increase in wealth gave a general feeling of optimism and prosperity which encouraged households and firms to further increase their debts. The good prospects and relatively low interest rates made it rational to do so ex ante (in fact, rising asset prices helped borrowers to borrow more and still to keep their debt/wealth ratio constant). This led to a reduction of saving as measured in the national accounts.
>
> Authority assured publicly many times that no devaluation would occur, and many borrowers of foreign currencies believed that.' (Page 80)

and has a stronger commitment to the pegged exchange rate system. The stronger the central bank's commitment, the more foreign capital the private sector will want to borrow in period t to satisfy consumption demand. But overconsumption in the first period will eventually lead to less consumption in the second period, when the realized income is less than expected. As the firm produces the same amount of goods (since investment is not influenced by the overestimation of profits), the firm sells less to the domestic sector and must export more in the last period. Devaluation can help the firms realize greater profits by exporting. Thus the conflicting interest between the open and sheltered sectors intensifies and the central bank's decision on the exchange rate has a higher stake.

Figure 3.6 **Net household saving ratio, %**



Source: OECD.

In the above chart one remarkable feature is that the household saving ratio was negative in 1988 and 1989. It is argued that Finnish households overestimated their future income, and consumption expanded rapidly.[63] It was rather clear that soaring asset prices, especially housing prices after 1985, contributed to a decline in the household saving ratio. The drop in domestic savings was accompanied by massive foreign borrowing, which became a severe burden for the economy after the devaluation in 1992.

[63] A consumer confidence index was compiled only from the end of 1987, on a biannual basis, and from 1991 on a quarterly basis. Thus we cannot use it to indicate the situation during 1985–1989.

Appendix 3.1

We have the same equation as in (3.56), ie

$$\Theta S^{*2} - S^* + 1 - \Theta = 0 \qquad \text{(A3.1)}$$

where

$$\Theta = \frac{\psi^2 \cdot a}{\theta + \psi^2} \qquad \text{(A3.2)}$$

By manipulating (A3.1), we get

$$\left(\sqrt{\Theta} S^* - \frac{1}{2\sqrt{\Theta}}\right)^2 - \frac{1}{4 \cdot \Theta} + 1 - \Theta = 0 \qquad \text{(A3.3)}$$

which implies

$$\left(\sqrt{\Theta} S^* - \frac{1}{2\sqrt{\Theta}}\right)^2 = \left(\frac{1}{2\sqrt{\Theta}} - \sqrt{\Theta}\right)^2 \qquad \text{(A3.4)}$$

Thus

$$\sqrt{\Theta} S^* - \frac{1}{2\sqrt{\Theta}} = \frac{1}{2\sqrt{\Theta}} - \sqrt{\Theta} \qquad \text{(A3.5)}$$

or

$$\sqrt{\Theta} S^* - \frac{1}{2\sqrt{\Theta}} = -\frac{1}{2\sqrt{\Theta}} + \sqrt{\Theta} \qquad \text{(A3.6)}$$

So S* has two roots; one is 1, the other is $\frac{1}{\Theta} - 1$, which is equal to $\frac{\theta}{\psi^2 \cdot a} + \frac{1}{a} - 1$

4 Exchange rate policy under imperfectly competitive labor markets

4.1 Introduction

The model in the previous chapter concentrates on the link between interest rates and equilibrium exchange rate settings. In order to expose the main points, labor as a production input and the wage setting are omitted. In this chapter we try to remedy this simplification. We consider the case where labor is an input to production and the wage is determined endogenously. The focus here is on the connection between wage determination and equilibrium exchange rates.

The literature on currency crises usually abstracts from the details of wage determination or trade union behavior. There are only a few formal theoretical explorations of the possible strategic interaction between labor market structure and current crises. Although second-generation currency crisis theory does emphasize the cost of unemployment as a reason for central banks to abandon the peg, explicit discussions of labor market structure or wage bargaining are rare.

The few exceptions that do consider the connection between labor market structure and exchange rates include a classical paper by Horn and Persson (1988), who analyze the strategic interaction between an exchange rate policymaker and a wage-setting trade union. Both wage formation and exchange rate policy are endogenous and are set in a repeated game. They show that due to the 'time-consistency' problem, a devaluation-wage spiral[64] may arise in a small open economy with nominal wage settlements and a high government employment target. Reputational forces could provide a way out of the devaluation-wage spiral.

In some well-developed countries, particularly in western and northern Europe, the labor market is not close to the perfectly

[64] Devaluation-wage spiral refers to the phenomenon that discretionary exchange rate policies reinforce high nominal wage increases in some European countries with centralized wage setting after the collapse of the Bretton Woods system.

competitive structure, so the introduction of wage bargaining provides meaningful, and sometimes vital insights for economic debates and policymaking.

Nowadays the economic literature increasingly recognizes wage determination as an important dimension in analyzing economic activity and policy. The assumption of flexible wages in response to labor demand and supply does not necessarily apply in many cases. As Iversen (1999, p. 22) writes:

> 'For all the theoretical elegance of assuming perfectly competitive labor markets, this is not how wages are actually formed – especially not in Western Europe and Japan. Instead, most wages are subject to collective bargaining between unions and associations of employers who exert market power within their own bargaining area and often have the capacity to influence aggregate prices. This fact changes the analysis of macroeconomic policies and their effects in fundamental ways, and it creates a wedge between rational expectations and the neutrality of monetary rules study.'

Wage determination is an important decision in the Finnish economy. The bargaining system in Finland is relatively complicated and can involve wage determination at a highly centralized level. Union membership is almost universal, and wage determination has influences far beyond the distribution of surplus between workers and employers. By exerting influence on the wage level, trade unions thus play an indirect role in economic policymaking. Generally speaking, central organizations of employers and employees and government are major players in determining current and future wage levels[65] in Finland.

A highly centralized wage bargaining institution could have important implications for the currency crisis. The bargaining power of the trade union is also a significant factor. In general, higher wage demands make the task of defending a pegged exchange rate system more difficult. In an adverse situation, an economy can improve its

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[65] In connection with the Finnish currency crisis, Kiander and Vartia (1996, p. 82) point out: 'In October 1991 the central organizations of employers and employees accepted an agreement which would have cut nominal wages by 5%. The purpose of the wage cut was to avoid devaluation. However, the trade unions of the export industries did not accept the proposal, which then collapsed. Soon after this the Bank of Finland was forced to devalue the markka. There has later been a lot of discussion about whether such a wage cut would really have helped the maintenance of a fixed exchange rate.'

competitiveness through either devaluation or a reduction in labor costs. However, if the trade union has strong bargaining power, the wage bargaining outcome will be less flexible. Thus devaluation may be the only means of improving international competitiveness.

There are three common ways to model trade union behavior. The first is the monopoly union model in which the trade union determines the wage, while the firm sets employment unilaterally. The monopoly trade union can also be interpreted as a Stackelberg leader vs the firm (see Oswald 1985 for a survey and Booth 1995 for details). The second is the 'right-to-manage' model in which the wage is determined by a bargain between trade union and firm, and the firm again subsequently decides employment unilaterally. The Nash bargaining solution is often utilized in this context. See eg Layard et al (1991) for details. This approach has been very popular and has been applied to many policy issue studies. The third is the efficient bargaining model in which both wage and employment are determined simultaneously by a bargain between the trade union and firm.

Holm-Honkapohja-Koskela (1994) study a monopoly union model of wage determination with application to the Finnish situation. They emphasize the effect of the trade union on the firm's choice of capital stock, in addition to labor demand. A monopoly trade union and a firm play a game in two stages, with the union and firm deciding wages and capital sock respectively in the first stage and the firm determining the level of employment in the second stage.

Koskela and Stenbacka (2000) study the interaction of wage with other variables by incorporating not only efficiency wage and profit sharing, but also capital structure of the firm in a generalized Nash bargaining solution. One interesting finding is that leverage depresses employment and has a strategic commitment value via a wage-moderating effect in wage negotiation.

This chapter endeavors to explore the effects of the wage bargaining process on exchange rate policy. The focus is on how the wage bargaining process and its outcomes interact with currency crises. The trade union model in this chapter has some similarities with Holm-Honkapohja-Koskela (1994) and Koskela and Stenbacka (2000) but differs in important respects, such as focus and basic setting. The 'right-to-manage' wage bargaining model is applied in this chapter, which allows us to explore the relation between bargaining power of trade unions and exchange rate policy. An increase in the bargaining power of trade unions will result in higher wages and lower profitability, which could make devaluation more desirable for the central bank. In addition, the 'right-to-manage' model is very versatile, its extreme form being the monopoly trade union model.

In comparison with normal trade union models, the game in this chapter has one more dimension, as there is an additional strategic player – the bank. A game framework is developed to study the interaction among trade union, firm and bank in deciding employment, wage, capital investment and bank lending rate.

The introduction of a trade union into the basic model in chapter 3 adds an important actor influencing economic policy-making. The wage setting process has a direct impact on production and investment activities. The wage negotiation outcome also changes the distribution of surplus between employers and employees. When the central bank decides its monetary policy, the wage rate is an important factor to consider. Generally speaking, the greater the bargaining power of the trade union, the higher the wage it will demand. This could reduce the profitability of the business sector and increase the likelihood of devaluation.

The wage bargaining structure and financial market are connected in the model. The wage contact period and duration of bank financing could have important impacts on model structures and final outcomes of many variables in the economy, particularly exchange rate policy. Thus there are two sequences for the actions of the trade union and bank in the model. When the bank provides short-term financing, the interest rate can vary frequently, and the bank cannot commit to an interest rate. Meanwhile, if the wage contract period is longer than the maturity of the bank financing, the bank can be treated as a Stackelberg follower, and the trade union as a leader in determining the interest rate and wage. On the other hand, when the bank provides relatively long-term financing, the maturity of the bank financing in respect of lending interest rates is longer than the wage contract period and the bank is a Stackelberg leader and the trade union a follower in the model. The sequences of agents' decisions have significant effects on the equilibrium values of the key variables concerned.

In the following three sections, two game frameworks with different time sequences of decisions are analyzed in turn. In the next section, we look at the situation where the wage contract period is relatively long and the maturity of the bank financing relatively short. Here, the trade union is a Stackelberg leader in the wage-interest rate determination process. The wage bargaining problem is treated as a typical 'right-to-manage' model, settled by the Nash bargaining solution. In an extreme form, namely, when the trade union has monopoly power in deciding the wage rate, the model becomes a typical monopoly trade union model. The following section deals with the case where the maturity of the bank financing is relative long and the wage contract period is shorter. The bank is then a Stackelberg leader in the interest rate-wage determination process. The trade union has monopoly power only over the firm; it is a follower vs the bank in deciding wage. The last section compares the results in the proceeding two sections and discusses the trade union's impacts on the exchange rate policy under different sequences of actions. When the trade union is a Stackelberg leader vs the bank, the trade union demands a higher wage, and the bank is forced to set a lower interest rate. The investment level, as well as foreign debt, is larger and thus the economy is more vulnerable to a shock to world interest rates. Nevertheless, capital investment and the firm's profit are higher, and the equilibrium exchange rate is lower.

4.2 Wage bargaining and exchange rate policy

4.2.1 Setup

As we now focus on the role of trade unions and wage bargaining in currency crises, we have one more player in the general equilibrium model outlined in chapter 3. In order to focus on the main subject, we simplify the model by exogenizing the household sector.[66]

The role of the household was to determine savings in the previous chapter. Now we assume the savings are exogenously fixed and that the household labor supply always exceeds labor demand and hence that labor supply will be rationed (see Kähkönen 1982). Thus by assuming a quasi-linear utility function, we can effectively exogenize the entire household sector.

Before the start of the first period, t, the central bank sets the period t exchange rate at 1, and the deposit rate i^d is exogenous. The economy is endowed with an initial saving d_t. In addition, the interest rate in the international market, i*, is observable.

In the first period, the trade union and firm decide the wage in a bargaining. The firm still decides labor demand unilaterally. Within the business sector, the firm and bank interact in a Stackelberg game framework, as in the previous chapters. The difference is that here wage enters into the firm's profit function.

There are only two periods in the model. In the second period, after all private agents have made their decisions and commitments,

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[66] The rationale behind the exogeneity of savings is as follows. Recall the discussion on the household sector in chapter 3. Now we just assume a quasi-linear utility function,

$$U = \ln C_t + \beta * C_{t+1} \tag{F4.1}$$

instead of a nonlinear function, as in (3.1).

The household is subject to the following constraints:

$$C_t = \omega_t - d_t, \tag{F4.2}$$
$$C_{t+1} = \Omega_f + \Omega_b + d_t\,(1 + i^d). \tag{F4.3}$$

To maximize (F4.1) subject to constraints (F4.2) and (F4.3), we take the derivative of U with respect to d_t:

$$\frac{\partial U}{\partial d_t} = \frac{-1}{\varpi_t - d_t} + \beta \cdot (1 + i^d) = 0 \tag{F4.4}$$

Thus

$$d_t = \omega_t - \frac{1}{\beta \cdot (1 + i^d)}. \tag{F4.5}$$

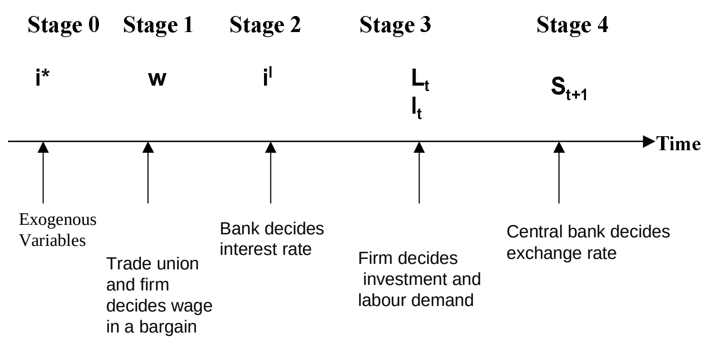
Thus as long as the deposit rate i^d and initial wealth ω_t are exogenous, saving, d_t, is also exogenous to the optimal decisions of other agents.

the central bank decides the exchange rate S_{t+1} to minimize its loss function. The central bank's decision on the exchange rate is based on the interaction of all other agents. At the end of the second period, the production process is completed and all financial assets are cleared. The firm sells its product to both the domestic and international markets. The bank uses the realized exchange rate to pay back its foreign loans. Finally the bank and firm will realize their profits.

Here the central bank is not a Stackelberg leader vs private agents. The central bank also sets the first-period exchange rate. Then the private sector – trade union, bank and firm – make their optimal decisions based on the expectations of the future exchange rate. After the private agents have made their decisions, the central bank decides exchange rates for the next period. Thus the central bank is not a Stackelberg leader, because it does not commit to its previous decision.

The following chart summarizes the time sequence of decisions in the economy:[67]

Figure 4.1 **Time sequence of decisions**



Source: OECD.

[67] Here the bank provides short-term financing and cannot commit to the interest rate during the period of the wage contract. Thus the wage contract period is longer than the bank financing maturity, and we can regard the bank as a Stackelberg follower and the trade union is a leader. The trade union determines the wage first and is able to commit to it. The bank then decides the interest rate. In next section, the order of stages 1 and 2 is reversed, and the bank is a Stackelberg leader, decides the interest rate first, and is able to commit to it.

4.2.2 Agents' optimization problems

In this section we add wage and labor to the basic model outlined in chapter 3. The structure and the variables explained in the previous chapter are still valid. I explain only the additional ones in the following sections.

4.2.2.1 Firm

The firm has a production function of the following form:

$$Y_{t+1} = A \cdot k_t^a \cdot l_t^b \tag{4.1}$$

where l_t is the labor input, $0 < a < 1$, $0 < b < 1$ and $a + b < 1$.[68]

I still assume that capital is completely depreciated in one period and the firm relies completely on the bank loan for investment, so that $K_t = L_t$.

Together with the firm's cost functions,

$$C_f = L_t \cdot (1 + i^l) + w \cdot l_t \tag{4.2}$$

where w is the wage, we obtain the firm's ex ante profit function:

$$\begin{aligned} \Omega_f^e = {} & E_t(\lambda) \cdot A \cdot L_t^a \cdot l_t^b + (1 - E_t(\lambda)) \cdot E_t(S_{t+1}) \cdot A \cdot L_t^a \cdot l_t^b \\ & - L_t \cdot (1 + i^l) - w \cdot l_t \end{aligned} \tag{4.3}$$

where $0 \le \lambda \le 1$ and λ has the same features as those discussed in chapter 3 and can be expressed as

$$\lambda = \lambda^* - \phi \cdot S_{t+1} \tag{4.4}$$

Then we can rewrite the firm's ex ante profit function as

$$\Omega_f^e = X^{ex} \cdot A \cdot L_t^a l_t^b - L_t \cdot (1 + i^l) - w \cdot l_t \tag{4.5}$$

where

[68] Thus we assume production is subject to diminishing returns to scale.

$$X^{ex} = \phi \cdot [E_t(S_{t+1})]^2 + (1-\phi-\lambda^*) \cdot E_t(S_{t+1}) + \lambda^* \quad (4.6)$$

Since the firm is the follower in a Stackelberg game, it maximizes its profits by choosing its level of investment and labor input given the lending rate and wage. Taking the derivative of Ω_f^e with respect to L_t

$$\frac{\partial \Omega_f^e}{\partial L_t} = a \cdot X^{ex} \cdot A L_t^{a-1} l_t^b - 1 - i^l = 0 \quad (4.7)$$

yields

$$L_t = \left[\frac{aA \cdot X^{ex}}{(1+i^l)}\right]^{\frac{1}{1-a}} l_t^{\frac{b}{1-a}} \quad (4.8)$$

And taking the derivative of Ω_f^e with respect to l_t,

$$\frac{\partial \Omega_f^e}{\partial l_t} = b \cdot X^{ex} A L_t^a l_t^{b-1} - w = 0 \quad (4.9)$$

yields

$$l_t = \left[\frac{bA \cdot X^{ex}}{w}\right]^{\frac{1}{1-b}} \cdot L_t^{\frac{a}{1-b}} \quad (4.10)$$

From (4.8) and (4.10), we get the firm's investment and labor demand functions, respectively:

$$L_t^* = (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-\eta_a} \cdot w^{-(\eta_b-1)} \quad (4.11)$$

$$l_t^* = (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-\eta_b} \quad (4.12)$$

where $-\eta_a = -\frac{1-b}{1-a-b}$ is the elasticity of capital investment with respect to the interest rate, and $-\eta_b = -\frac{1-a}{1-a-b}$ is the elasticity of labor demand with respect to wage.

In addition, $-(\eta_b - 1) = -\frac{b}{1-a-b}$ is the elasticity of capital investment with respect to wage and $-(\eta_a - 1) = -\frac{a}{1-a-b}$ is the elasticity of labor demand with respect to the interest rate.

Now all the absolute values of elasticity are constant and smaller than one. The absolute values of the elasticity of capital investment with respect to the interest rate, $-\eta_a$, and the elasticity of labor demand with respect to the wage, $-\eta_b$, are greater than the absolute values of both the elasticity of capital investment with respect to wage, $-(\eta_b-1)$, and the elasticity of labor demand with respect to the interest rate, $-(\eta_a-1)$. The absolute value of $-\eta_a$ is greater than that of $-\eta_b$ when a is greater than b.

These two demand functions display the well-known properties of the normal profit maximizing input demand functions. Because we have assumed earlier that the capital stock equals bank lending and that there is full depreciation in one period, the investment level equals total bank lending in the economy. The levels of investment and GDP in one country are functions of the exchange rate (in this model, the expected future exchange rate), interest rate, and wage rate. And

$$\frac{\partial I}{\partial E_t(S_{t+1})} > 0; \frac{\partial I}{\partial i^l} < 0; \frac{\partial I}{\partial w} < 0 \tag{4.13}$$

where I is investment, which is equal to bank lending in the model.

The firm's investment level is determined by the costs of capital and labor as well as the expected future exchange rate. The firm's investment level and output are negatively related to the cost of capital, i^l, and the wage rate, w, and positively related to the expected exchange rate in period t+1. A higher lending rate and wage will depress both investment and the firm's profit. So the firm makes its investment (borrowing) decision on the basis of the lending rate, i^l, and wage rate, w.

Like the investment level, the firm's labor demand is determined by the costs of capital and labor as well as the expected future exchange rate. The firm's labor demand is negatively related to the cost of capital, i^l and the wage rate, w, and positively related to the expected exchange rate in period t+1. Higher lending and wage rates reduce the firm's demand for labor.[69] We can summarize these results as

$$\frac{\partial l_t}{\partial E_t(S_{t+1})} > 0; \quad \frac{\partial l_t}{\partial i^l} < 0; \quad \frac{\partial l_t}{\partial w} < 0 \tag{4.14}$$

The expected exchange rate plays an important role in the firm's decision-making. The firm's investment and output are related to the expected exchange rate and the openness of the economy. The fact that the firm decides the investment level on the basis of the expected exchange rate reflects the normal time lag of production and sales. When the firm decides on a production level, it does not know how much it can sell in the market nor sometimes even the price. The firm has to rely on estimation or expectations to decide the current level of production. A larger expected devaluation will enhance the open sector's competitiveness and improve the firm's profitability because the unit price in domestic currency will increase since export sales are denominated in foreign currencies.[70] In addition, the less the sheltered sector consumes resources, or the higher the value ϕ, the greater the effect of depreciation on investment and output. All in all, the expected future exchange rate plays an important role in the firm's production and profit.

We can thus get the firm's optimal level of production and its ex ante expected profit by substituting the profit maximizing input demand functions into the production and ex-ante profit functions, respectively:

$$Y_{t+1} = A^{\eta_a+\eta_b-1} \cdot (X^{ex})^{\eta_a+\eta_b-2} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \tag{4.15}$$

$$\Omega_f^e = (1-a-b) \cdot (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \tag{4.16}$$

[69] As mentioned earlier, unemployment is not explicitly analyzed because, in the model, the labor supply is assumed to be fixed. Thus the endogenously determined labor demand alone determines unemployment. A rise in labor demand implies a decline in unemployment.

[70] See the discussion in Obstfeld and Rogoff (2000).

(4.15) also represents the firm's supply function. The firm's ex post profit after the central bank's decision on the second period exchange rate is

$$\Omega_f = \lambda \cdot AL_t^a l_t^b + (1-\lambda) \cdot S_{t+1} \cdot AL_t^a l_t^b - L_t \cdot (1+i^l) - w \cdot l_t \tag{4.17}$$

The solution gives the firm's ex post profit:

$$\begin{aligned}\Omega_f = & \left(\frac{X}{X^{ex}} - a - b \right) \cdot (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \\ & \cdot b^{\eta_b - 1} \cdot (1+i^l)^{-(\eta_a - 1)} \cdot w^{-(\eta_b - 1)}\end{aligned} \tag{4.18}$$

where

$$X = \phi \cdot [S_{t+1}]^2 + (1 - \phi - \lambda^*) \cdot S_{t+1} + \lambda^* \tag{4.19}$$

It is easy to verify that

$$\frac{\partial \Omega_f}{\partial S_{t+1}} > 0, \quad \frac{\partial \Omega_f}{\partial i^l} < 0 \quad \text{and} \quad \frac{\partial \Omega_f}{\partial w} < 0 \tag{4.20}$$

The impact the expected future exchange rate on the firm's ex-post profits is unclear, as the sign of $\frac{\partial \Omega_f}{\partial E_t(S_{t+1})}$ is ambiguous. This is because an expected devaluation raises output and (as we will see later) may also result in a rise in the bank's lending rate and in the wage, which will reduce the firm's ex-post profit. The sign of $\frac{\partial \Omega_f}{\partial E_t(S_{t+1})}$ depends on the outcome of these two offsetting effects.

4.2.2.2 Bank

As in chapter 3, the bank's ex ante profit function[71] is

$$\Omega_b^e = L_t \cdot (1+i^l) - d_t \cdot (1+i^d) - B_t^* \cdot E_t(S_{t+1}) \cdot (1+i^*) \tag{4.21}$$

or

$$\begin{aligned}\Omega_b^e = {} & (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-\eta_a} \cdot w^{-(\eta_b-1)} \\ & \cdot \left[(1+i^l) - E_t(S_{t+1}) \cdot (1+i^*)\right] \\ & + d_t \cdot \left[E_t(S_{t+1}) \cdot (1+i^*) - (1+i^d)\right]\end{aligned} \tag{4.22}$$

Solving the bank's maximization problem, we get the optimal lending rate:

$$i^l = \frac{1-b}{a} \cdot (1+i^*) \cdot E_t(S_{t+1}) - 1 \tag{4.23}$$

The bank lending rate, i^l, is positively related to the world interest rate and to the expected exchange rate. Since we have assumed before that $a + b < 1$, even under expectations of non-devaluation, the lending rate is always greater than the world interest rate, ie, $i^l > i^*$ even when $E_t(S_{t+1}) = 1$.

4.2.2.3 Wage bargaining and the trade union

In a highly unionized economy, trade unions play a vital role in deciding the wage rate. In this section we apply the Nash bargaining solution and use the 'right-to-manage' approach in analyzing wage determination. The firm unilaterally determines employment, while the trade union and firm bargain over wages.

The disagreement points or threat points are zero for both trade union and firm, ie $U^e = 0$, and $\Omega^e = 0$.[72] Under a decentralized

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[71] Here it is assumed the bank does not incur labor costs in conducting its business. Usually the labor cost in the banking is much less significant than in the production sector.

industrial bargaining, the trade union's disagreement point is usually assumed to be positive, as unemployed workers can also get unemployment benefits or other job opportunities. Since here we assume that the labor supply is rationed and the economy has a completely centralized wage bargaining system,[73] the trade union's breaking point must equal zero. So the disagreement points for the Nash bargaining solution are (0,0), which means that the household's utility is zero and the firm has zero profit should the bargain fail.

The Nash bargaining product is

$$N = (U^e)^\sigma \cdot (\Omega_f^e)^{1-\sigma} \tag{4.24}$$

where σ is the relative bargaining power of the trade union, and 1–σ is that of the firm. $1 \geq \sigma \geq 0$.

The factor U^e in the Nash bargaining product is the expected utility of the trade union. Ω_f^e is the expected profit of the firm, which is the same as in (4.16). Since the breaking points are (0,0) in this model, we have the Nash bargaining product given by (4.24).

The trade union and the firm decide on a unique value for the wage rate, w, that maximizes N subject to the labor demand function in (4.12).

In this model, we assume the trade union's utility function resembles the normal consumer utility function. Because the consumer is the representative union member, we use the consumer's utility function to analyze the trade union's optimization problem. Thus in this model, the trade union's utility function does not consider unemployment, in contrast to the conventional trade union models in the literature. As we noted earlier, due to the assumption that the labor

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[72] Usually the disagreement point for the trade union is assumed to be greater than zero, as striking workers often have other sources of support. However, the result will be the same if we assume a fixed sum for the alternative income. Thus we assume a zero disagreement point for the trade union for simplicity but without loss of generality.

[73] Normally when there is a centralized trade union, it will internalize the effect of a higher wage on price: the nominal wage demand will be transmited to the price level, which decreases the real income of workers. In this model, since prices are assumed to be fixed, we abstract from this link. In addition, a centralized trade union will recognize that its members bear the cost of reductions in the size of tax base and thus internalize the government budget constraint in choosing wage, as pointed out by Summers-Gruber-Vergara (1993). Since, in this chapter we do not discuss fiscal policy, we abstract from this aspect also.

supply is exogenous and is always larger than labor demand, ie $l^s > l^d$, unemployment is determined by labor demand. An increase in labor demand is tantamount to a decrease in unemployment. The relation between wage determination and private sector profit, as well as the central bank's exchange rate policy is the focus of this chapter. Hence we focus on labor demand and abstract from explicit discussion of unemployment.

Thus the trade union's objective is to maximize union members' utility, which consists two parts: labor income and the disutility of labor input:

$$U^e = \ln(wl_t) - \alpha l_t \tag{4.25}$$

where α is a positive parameter, measuring marginal disutility of labor. This format of consumer preference is fairly standard and is used eg by Obstfeld and Rogoff (2000).[74]

The individual worker's labor supply is rationed, as the firm's labor demand constrains the choice of individual workers. A centralized trade union rations labor supply by individual workers and thus internalizes the disutility of labor. The trade union cares about total labor income but also about disutility of labor. This is the reason that labor disutility enters the trade union's utility function.[75]

The Nash bargaining solution requires the following first-order condition to hold:

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[74] Their original format also includes money balance, which is abstracted from in this model.

[75] A simple and more commonly used trade union utility function has the following format:

$U^e = l_tU(w) + (N-l_t)B$

where N is the total labor supply and B is the unemployment benefit, which is exogenous (as in Koskela and Stenbacka 2000). By rearranging the above equation, we get

$U^e = l_tU(w) + BN - Bl_t$

Hence the utility of the unemployment benefit is equal to the marginal disutility of labor, α in (4.25). Thus, in a way, we can interpret the disutility of labor in the model as the exogenous utility of the unemployment benefit in more standard trade union models.

$$\sigma \cdot \frac{\frac{\partial U^e}{\partial w}}{U^e} = -(1-\sigma) \cdot \frac{\frac{\partial \Omega_f^e}{\partial w}}{\Omega_f^e} \qquad (4.26)$$

Substituting l_t from (4.12) into U^e, replacing Ω_f^e by the expression in (4.16), and solving for the derivatives, we get[76]

$$\lg(Q \cdot w^{-(\eta_b-1)}) = \frac{(\eta_b - 1) + \sigma}{(\eta_b - 1) \cdot (1-\sigma)} \cdot \alpha \cdot Q \cdot w^{-\eta_b} - \frac{\sigma}{1-\sigma} \qquad (4.27)$$

where

$$Q = b^{\eta_b} \cdot (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \cdot (1 + i^1)^{-(\eta_a - 1)} \qquad (4.28)$$

(4.27) gives the Nash bargaining solution for the optimal wage.

Since

$$\frac{\partial \Omega_f^e}{\partial w} \leq 0, \quad \sigma > 0, \quad 1-\sigma \geq 0, \quad U^e \geq 0 \quad \text{and} \quad \Omega_f^e \geq 0$$

it follows that $\frac{\partial U^e}{\partial w} \geq 0$.

Thus the increase in wage will unambiguously improve the expected utility of the trade union.[77] This implies that

$$Q \cdot w^{-\eta_b} > \frac{b}{\alpha \cdot (1-a)} \qquad (4.29)$$

From (4.27), we can derive unconditionally[78]

[76] See appendix 4.1 for a the detailed derivation of (4.27).

[77] Note also the left side of (4.29) is just the firm's optimal labor demand and the parameter of labor disutility, α, fulfills the following condition:

$$\alpha > \frac{b}{(1-a) \cdot l_t}$$

[78] See appendix 4.2 for the detailed calculation.

$$\frac{dw}{d\sigma} > 0 \tag{4.30}$$

Thus when the trade union has more bargaining power, it will demand higher wages.

We also have[79]

$$\frac{dw}{dQ} > 0 \tag{4.31}$$

as long as

$$\sigma \geq \frac{1}{1+\eta_b} \tag{4.32}$$

Actually condition (4.32) is rather mild, as the right-hand is smaller than one-half. Thus, as long as the trade union has at least as strong a bargaining position as the firm, (4.32) can be satisfied. (4.31) indicates that

$$\frac{dw}{dX^{ex}} > 0, \quad \frac{dw}{di^1} < 0 \tag{4.33}$$

The wage rate from the Nash bargaining outcome reacts negatively to the interest rate and positively to the expected exchange rate and the level of technology, if condition (4.32) is satisfied.

(4.33) shows that the trade union's wage demand will be the higher, the greater the expected future devaluation, because the larger the expected devaluation, the higher the production level. In addition, a larger devaluation in the later period will boost the firms' profitability, which provides the trade union with the possibility of demanding a higher wage. Thus the trade union's decision on wage is positively related to the expected exchange rate.

This relationship between the wage rate and expected future exchange rate is in line with conventional wisdom in macroeconomics. However, the mechanism is a bit different. In conventional economic literature, devaluation results in inflation,

[79] See appendix 4.3 for the calculation.

while the determination of the nominal wage rate is based on expected inflation, as shown by

$$w_t = E(S_t | I_{t-1}) \tag{4.34}$$

where w_t is current period wage rate, S_t is current period exchange rate, and I_{t-1} the previous period's information set. Nominal wage is linked positively with inflation expectations from the previous period, thus the expected devaluation results in a higher wage demand. This relationship is included in the assumptions in many influential papers (see eg Barro and Gordon 1983, Obstfeld 1997). In the model here, since the price level is assumed to be fixed, there is no inflation channel through which expected devaluation affects wages. Instead, there is a strategic element in this relation, as the expected devaluation influences the wage rate through the firm's optimization decision as well as a firm-trade union bargaining outcome.

From equation (4.33), it clearly follows that the wage rate is related also to the lending rate. Because a higher lending rate will dampen both the firm's production and profit, it will also reduce the trade union's ability to bargain for higher wages.

4.2.3 A special case: monopoly trade union model

It is impossible to express (4.27) explicitly. In order to better explain the previous game settings and obtain more explicit results, we now consider an extreme form of the general case in section 4.2.2.

When the trade union has monopoly power in determining the wage, which means σ is 1 and the 'right-to-manage' model reduces to the monopoly trade union model. The trade union takes account of the optimization behavior of other private agents in deciding on wages. The bank and firm form the business sector, which is a Stackelberg follower vs the trade union in deciding interest rates and labor demand after the wage is set. The bank is still a Stackelberg leader vs the firm. This setup is the closest to the popular monopoly trade union model.

The trade union's objective is to maximize union members' utility function, which is the same as (4.25). Solving the trade union's optimization problem, we obtain

$$w = (\alpha - a\alpha)^{\frac{1}{\mu_b}} \cdot b^{b \cdot \eta} \cdot a^{\eta - 1} \cdot (A \cdot X^{ex})^{\eta} \cdot (1 + i^l)^{-(\eta - 1)} \tag{4.35}$$

The trade union will decide a monopoly wage that is dependent of marginal labor disutility, α, technological level, A, marginal labor productivity, expected devaluation, and interest rates.

From (4.35), we can deduce

$$\frac{\partial w}{\partial A} > 0, \quad \frac{\partial w}{\partial \alpha} > 0, \quad \frac{\partial w}{\partial b} > 0, \quad \frac{\partial w}{\partial X^{ex}} > 0, \quad \text{and} \quad \frac{\partial w}{\partial i^{l}} < 0 \qquad (4.36)$$

The wage reacts positively to the labor disutility parameter, α, and to expected devaluation, and negatively to interest rates. Here the results are unconditional, whereas in the 'right-to-manage' model, the results are conditional on (4.32).

The reason the wage is related positively to marginal labor disutility is that the greater the marginal disutility, the higher the wage needed to compensate for it. The trade union internalizes this labor disutility and thus demands a higher wage rate.

(4.36) shows that the wage rate is positively related to the expected exchange rate for the next period and negatively to the lending rate.

Exchange rates have an effect not only on the firm's profitability and investment but also on the labor market, eg on employment and wages (see eg Clarida 1997 and Sheets 1996).[80] In this model, we stress the similar role played by exchange rate expectations of the private sectors.

Furthermore, the absolute value of the elasticity of wage with respect to expected devaluation, $\frac{1}{1-a}$, is greater than one and with respect to interest rates, $\frac{a}{1-a}$, is less than one.

The labor income that union members actually get is

$$w^{*} \cdot l_{t}^{*} = (\alpha - a\alpha)^{-b\eta} \cdot b^{1+b\eta} \cdot a^{\eta-1} \cdot (A \cdot X^{ex})^{\eta} \cdot (1+i^{l})^{-(\eta-1)} \qquad (4.37)$$

[80] Using US data, Revenga (1992) and Goldberg and Tracy (1999) find that exchange rates have significant effects on wages and earnings.

4.2.4 Profits of the private sector

The bank's ex ante profit is

$$\Omega_b^e = \frac{1}{\eta_a - 1} \cdot (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a} \cdot b^{\eta_b - 1} \cdot (1 + i^l)^{-\eta_a} \cdot w^{-(\eta_b - 1)} \cdot [E_t(S_{t+1}) \cdot (1 + i^*)] d_t \cdot [E_t(S_{t+1}) \cdot (1 + i^*) - (1 + i^d)] \tag{4.38}$$

At the start of period t+1, the central bank decides the exchange rate. The bank has to pay back foreign loans applying the realized exchange rate in period t+1. Thus the bank's ex post profit is

$$\Omega_b = (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a} \cdot b^{\eta_b - 1} \cdot (1 + i^l)^{-\eta_a} \cdot w^{-(\eta_b - 1)} \cdot [(1 + i^l) - S_{t+1} \cdot (1 + i^*)] + d_t \cdot [S_{t+1} \cdot (1 + i^*) - (1 + i^d)] \tag{4.39}$$

Combining (4.18) and (4.39), we get the combined real ex post profit of the firm and bank:

$$\Omega = (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \cdot b^{\eta_b - 1} \cdot (1 + i^l)^{-(\eta_a - 1)} \cdot w^{-(\eta_b - 1)} \cdot \left[\frac{X}{X^{ex}} - a \cdot \frac{S_{t+1} \cdot (1 + i^*)}{1 + i^l} - b \right] + d_t \cdot [S_{t+1} \cdot (1 + i^*) - (1 + i^d)] \tag{4.40}$$

From equation (4.40), we see that the profitability of the private sector responds positively to changes in the level of technology, A, or total domestic deposits, d_t. It responds negatively to movements in the domestic deposit rate, i^d. The sign of the partial derivative of Ω with respect to the future exchange rate, S_{t+1}, and to its expected variable, $E_t(S_{t+1})$, is ambiguous.

Since we have already known how the optimal wage and lending rate are determined, we can replace w and i^l in (4.40) to get

$$\Omega = (A \cdot X^{ex})^{\eta} \cdot \frac{a^{2(\eta - 1)}}{(1 - b)^{\eta - 1} \cdot E_t(S_{t+1})^{\eta - 1} \cdot (1 + i^*)^{\eta - 1}} \cdot \left(\frac{\alpha}{b\eta} \right)^{-b\eta} \cdot \left[\frac{X}{X^{ex}} - \frac{a^2}{1 - b} \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b \right] + d_t \cdot [S_{t+1} \cdot (1 + i^*) - (1 + i^d)] \tag{4.41}$$

4.2.5 Wage setting and exchange rate policy

The central bank's optimization problem is to minimize its loss function, as in (3.41):

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{1}{2}(\Omega - \Omega^*)^2 \tag{4.42}$$

From

$$\frac{\partial L_{CB}}{\partial S_{t+1}} = 0 \text{ we obtain } \theta S_{t+1} - \theta + (\Omega - \Omega^*) \cdot \frac{\partial \Omega}{\partial S_{t+1}} = 0 \tag{4.43}$$

Given that the second-order condition holds, the first-order condition implicitly gives a solution for the equilibrium value, S*, for the central bank. The central bank's decision on the future exchange rate can be expressed in terms of the international interest rate, wage and the expected exchange rate:

$$S_{t+1} = f(E_t(S_{t+1}), i^*, w) \tag{4.44}$$

The impact of wage on the central bank's decision on the exchange rate depends critically on the central bank's profit target. If the profit target, Ω^*, is a fixed value, or not influenced by wages, then an increase in wages, due to an increase in either the expected exchange rate or the bargaining power of the trade union,[81] will have an adverse impact on the profit of the private sector. The central bank could be pressured to devalue in order to compensate for the decline in the private sector profit. Thus the expectations of devaluation will have self-fulfilling consequences, and the wage effect plays an important role here.

When the profit target incorporates the influence of wages, (eg the profit target is wage-indexed), we use the profit of the private sector under no expectation of devaluation, plus an adjustment element, as the target for the central bank. In this case, the wage, w, is included in the central bank's loss function. By doing this, we can examine the relation between wage and exchange rate policy. However, even if we

[81] From (4.30) and (4.36), it is straightforward to show that wage relates positively to both the private sector's expectations of the exchange rate and the trade union's bargaining power.

look at the simply case in which the central bank is concerned only with the firm's profit, along the lines of the discussion in the previous chapter, the solution to (4.44) is still intractable.[82]

When wage is replaced by its optimal value, expressed in (4.35), we can obtain:[83]

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{\xi^2}{2}\left[(S_{t+1} - (a+b)\cdot E_t(S_{t+1})^2) - (1-a-b)\right]^2 \tag{4.45}$$

where

$$\xi = \frac{A^{\eta}\cdot a^{2(\eta-1)}}{(1-b)^{\eta-1}\cdot(1+i^*)^{\eta-1}}\cdot\left(\frac{\alpha}{b\eta}\right)^{-b\eta} \tag{4.46}$$

As in the previous chapter, we have

$$S^* = \frac{\xi^2\cdot(a+b)}{\theta+\xi^2}\cdot E_t(S_{t+1})^2 + \frac{\xi^2\cdot(1-a-b)+\theta}{\theta+\xi^2} \tag{4.47}$$

In order to incorporate rational expectations in the central bank's decision on the future exchange rate, we use S* in place of $E_t(S_{t+1})$ in (4.47) to obtain

$$\frac{\xi^2\cdot(a+b)}{\theta+\xi^2}\cdot S^{*2} - S^* + 1 - \frac{\xi^2\cdot(a+b)}{\theta+\xi^2} = 0 \tag{4.48}$$

Because

$$\begin{aligned} b^2 - 4\cdot a\cdot c &= 1 - 4\cdot\left(\frac{\xi^2\cdot(a+b)}{\theta+\xi^2}\right)\cdot\left(1-\frac{\xi^2\cdot(a+b)}{\theta+\xi^2}\right) \\ &= \left(1 - 2\cdot\frac{\xi^2\cdot(a+b)}{\theta+\xi^2}\right)^2 \geq 0 \end{aligned} \tag{4.49}$$

equation (4.48) has one or two real roots. When

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[82] See appendix 4.4 for details.
[83] Still we apply the same simplification, ie that X is equal to S_{t+1}.

$$\xi^2 = \frac{\theta}{2 \cdot (a+b) - 1} \tag{4.50}$$

there is only one unique root, which is one. The fixed exchange rate is always the optimal one. In addition, in this case the central bank's loss is zero, the minimum of all possibilities. This is the dominant outcome of all equilibrium exchange rates. Otherwise equation (4.48) will have two roots.

(4.50) can also be expressed as

$$1 + i^* = A^{\frac{1}{a}} \cdot a^2 \cdot \left(\frac{2(a+b)-1}{\theta} \right)^{\frac{1-a}{2a}} \cdot \left(\frac{b}{\alpha \cdot (1-a)} \right)^{\frac{b}{a}} \cdot \frac{1}{1-b} \tag{4.51}$$

Note: $a + b > \frac{1}{2}$ is a precondition for (4.51), which means that the sum of the elasticities of output with respect to capital and to labor has to be greater than one-half, in order to enable the unique outcome of equilibrium that the pegged exchange rate system can be maintained.

(4.51) is the ultimate condition for a unique solution for the exchange rate. Under this condition, the world interest rate is compatible with the pegged exchange rate in the economy. And only with this interest rate is the pegged exchange rate system the desirable and stable outcome of the economy, as economic fundamentals, wage bargaining outcome, and the external environment match perfectly.

When equation (4.51) does not hold, equation (4.48) has two roots, ie one and an other that is larger than one:

$$S_1^* = 1, \quad S_2^* = \frac{\theta}{\psi^2 \cdot (a+b)} \cdot \left(\frac{1-a}{b} \right)^{\frac{b}{1-a}} \cdot (1-b)^{\frac{a}{1-a}} \cdot \alpha^{\frac{b}{1-a}} + \frac{1}{a+b} - 1 \tag{4.52}$$

Multiple equilibria for exchange rates obtain when the world interest rate is not compatible with the economic fundamentals. Under this circumstance, private sector expectations of the exchange rate will play a significant role in determining whether the pegged exchange rate system can be maintained, as well as in the final outcome for the equilibrium exchange rate. When the private sector's expected exchange rate is equal to S_2^*, devaluation becomes the self-fulfilling outcome.

When there is a wage setting process in the economy, the international interest rate continues to be positively related to the devaluation rate. Furthermore, the bargaining over wages gives marginal labor disutility a role to play in determining the exchange rate. The bigger the marginal disutility of labor, the stronger the trade union's incentive to push for higher wages and thus the larger the equilibrium devaluation. Under wage bargaining, the equilibrium exchange rate, S_2^*, has an additional element, compared in chapter 3, ie

$$\chi = \left(\frac{1-a}{b}\right)^{\frac{b}{1-a}} \cdot (1-b)^{\frac{a}{1-a}} \cdot \alpha^{\frac{b}{1-a}} \tag{4.53}$$

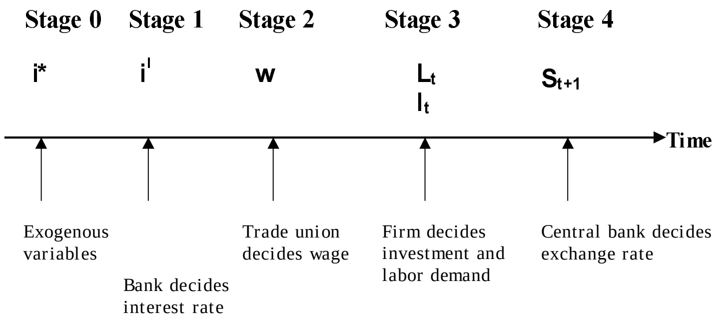
which we regard as a markup over the benchmark case in chapter 3. It is rather artificial to compare these two equilibrium exchange rates, because there is no labor factor in chapter 3. We can nevertheless state that the elasticity of output with respect to labor input and the marginal labor disutility have effects on the equilibrium exchange rate. Particularly, marginal labor disutility has a positive impact on wage demand and on equilibrium exchange rates.

4.3 The bank as Stackelberg leader

4.3.1 Setup

In the previous section, we assumed that bank financing had a relatively short maturity and that the trade union is the Stackelberg leader in the game. In this section we assume that bank financing has a relatively long maturity and thus the bank must commit to the lending interest rate for the wage contract period. Under these assumptions, the bank is a Stackelberg leader vs both the trade union and the firm. The trade union is still a Stackelberg leader vs the firm.

Figure 4.2 **Time sequence of decisions**



Source: OECD.

Bronars and Deere (1991) study the relation between trade union and corporate debt. They argue that the firm uses debt to protect shareholders wealth from the threat of unionization. The issuance of debt credibly reduces the funds that are available for sharing with the trade union, as debts must be paid in order to avoid bankruptcy.[84]

In this model, the bank increases the interest rate to counter the monopoly power of the trade union, which can determine the wage. In order to reduce wages, the bank, as a Stackelberg leader, raises the lending rate as a credible way to reduce the power of the trade union in setting the wage. In doing so, the bank curbs total lending as well as the total profit for the business sector.

The setup of the model is as follows. In the first stage, the bank and the trade union play a Stackelberg game in which the bank is the leader and the trade union the follower. The bank sets the lending rate and the trade union reacts by setting the wage rate. In the second stage, the trade union is a Stackelberg leader vs the firm in deciding the wage and labor demand. Thus the trade union has monopoly power in the wage negotiation process, for which the standard monopoly trade union model applies. The trade union sets a wage, which the firm takes as given and decides its labor demand. In addition, the bank is still a Stackelberg leader vs the firm in deciding the lending rate. Both the bank and trade union are Stackelberg leaders

[84] Likewise, Grout (1984) and Baldwin (1983) show that when a trade union can not commit to future negotiation positions, the firm has an incentive to produce inefficiently by under-investing in productive assets. The rationale behind this strategy is that a part of profits generated by production is expected to divert to the workers when there is collective bargaining, so the under-investment is a way of reducing the net revenue.

vs the firm in the process of deciding labor demand and capital investment.

4.3.2 Agents' optimization problems

4.3.2.1 Firm and trade union

The firm's optimization behavior is the same as in the previous section. The trade union is a follower vs the bank concerning interest rate determination and a Stackelberg leader vs the firm in determining the wage. So the trade union decides the wage, taking the bank's move on the lending rate as given. The wage determined by the trade union as a Stackelberg follower is the same as that under a Stackelberg leader trade union, as shown in (4.35), given the lending interest rate. However, as the bank is now the Stackelberg leader, the lending interest rate is different. Thus the final wage will also be different.

In combining the results for the optimal decisions of both firm and trade union we obtain some intermediate results, such as for the firm's investment level:

$$L_t = (A \cdot X^{ex})^{\eta} \cdot a^{\eta} \cdot (1+i^l)^{-\eta} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \tag{4.54}$$

4.3.2.2 Bank

As in the previous section, the bank's ex ante profit function is

$$\begin{aligned}\Omega_b^e = {} & (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-\eta_a} \cdot w^{-(\eta_b-1)} \\ & \cdot \left[(1+i^l) - E_t(S_{t+1}) \cdot (1+i^*)\right] \\ & + d_t \cdot \left[E_t(S_{t+1}) \cdot (1+i^*) - (1+i^d)\right]\end{aligned} \tag{4.55}$$

Replacing w in (4.55) by that in (4.35), we obtain

$$\begin{aligned}\Omega_b^e = {} & (A \cdot X^{ex})^{\eta} \cdot a^{\eta} \cdot (1+i^l)^{-\eta} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \\ & \cdot \left[(1+i^l) - E_t(S_{t+1}) \cdot (1+i^*)\right] \\ & + d_t \cdot \left[E_t(S_{t+1}) \cdot (1+i^*) - (1+i^d)\right]\end{aligned} \tag{4.56}$$

The bank solves its maximization problem using

$$\frac{\partial \Omega_b^e}{\partial i^l} = 0 \Leftrightarrow i^l = \frac{1}{a} \cdot (1+i^*) \cdot E_t(S_{t+1}) - 1 \tag{4.57}$$

Perhaps surprisingly, the result is exactly the same as in chapter 3, where there is no labor or trade union. The reason for this is that if we regard the firm and trade union as one combined sector of production, the bank's optimization problem is the same as for that without a trade union, if the bank does not have labor costs. In both cases, the bank is the ultimate Stackelberg leader, so it can utilize its market position to extract maximum profits for itself. However, though the interest rate is the same, the total investment (bank lending) and economic activity as well as the bank's and firm's profits are different. Now the labor factor enters the firm's production function, and the firm has to pay wages to labors according to a wage rate determined by a centralized trade union.

Because

$$\frac{1}{a} > \frac{1-b}{a} \tag{4.58}$$

the interest rate will be higher when the bank is the ultimate Stackelberg leader than that when the trade union is the leader. Because the bank has more power in this setup than in the monopoly trade union model, it can raise the lending rate to a higher level than otherwise. Consequently, investment and profits of the firm will be depressed, as will the wage rate. Thus the bank uses its monopoly position to raise the interest rate in advance and to depress the labor union's wage demand in the later stage.

4.3.3 Private sector profits and monetary policy

The combined real ex post profit of the firm and bank is

$$\begin{aligned}\Omega = (A \cdot X^{ex})^{\eta} \cdot a^{2(\eta-1)} \cdot (1+i^*)^{-(\eta-1)} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \cdot E_t(S_{t+1})^{-(\eta-1)} \\ \cdot \left[\frac{X}{X^{ex}} - a^2 \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b\right] + d_t \cdot \left[S_{t+1} \cdot (1+i^*) - (1+i^d)\right]\end{aligned} \tag{4.59}$$

In order to illustrate the main results explicitly, we now look at the simply case in which the central bank is concerned only with the firm's profit, as discussed in the previous section. And we apply the same simplification that X is equal to S_{t+1}. Then the central bank's loss function is

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{\xi^2}{2}\left[(S_{t+1} - (a+b)\cdot E_t(S_{t+1})^2) - (1-a-b)\right]^2 \tag{4.60}$$

where

$$\xi = \frac{A^{\eta}\cdot a^{2(\eta-1)}}{(1+i^*)^{\eta-1}}\cdot\left(\frac{\alpha}{b\eta}\right)^{-b\eta} \tag{4.61}$$

The solutions for equilibrium exchange rates are similar to those of section 4.2.5. We now directly go to the result. When condition

$$1 + i^* = A^{\frac{1}{a}}\cdot a^2\cdot\left(\frac{2(a+b)-1}{\theta}\right)^{\frac{1-a}{2a}}\cdot\left(\frac{b}{\alpha\cdot(1-a)}\right)^{\frac{b}{a}} \tag{4.62}$$

is satisfied, (4.60) has a unique solution, and the original pegged exchange rate can be maintained. Otherwise, (4.60) has two roots, ie one and an other that is larger than one

$$S_1^* = 1,\quad S_2^* = \frac{\theta}{\psi^2\cdot(a+b)}\cdot\left(\frac{1-a}{b}\right)^{\frac{b}{1-a}}\cdot\alpha^{\frac{b}{1-a}} + \frac{1}{a+b} - 1 \tag{4.63}$$

Comparing with the benchmark equilibrium exchange rate in chapter 3, the markup is

$$\chi = \left(\frac{1-a}{b}\right)^{\frac{b}{1-a}}\cdot\alpha^{\frac{b}{1-a}} \tag{4.64}$$

Thus as long as

$$\alpha > \frac{b}{1-a} \tag{4.65}$$

the marginal labor disutility α is larger than the above parameter, and the equilibrium devaluation under a Stackelberg follower trade union is larger than the benchmark case, where there is no labor or trade union.

In addition, this markup as well as devaluation rate is bigger than the case when the trade union is the Stackelberg leader.

4.4 Results and conclusions

4.4.1 Comparison of setups

Now we compare several key endogenous variables under the Stackelberg leader trade union and bank, respectively.

Trade Union as Stackelberg Leader

$$w = (\alpha - a\alpha)^{\frac{1}{\mu_b}} \cdot b^{b\cdot\eta} \cdot a^{2(\eta-1)} \cdot (A \cdot X^{ex})^{\eta}$$
$$\cdot \left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{-(\eta-1)} \cdot (1-b)^{-(\eta-1)}$$

$$i^l = \frac{1-b}{a} \cdot (1+i^*) \cdot E_t(S_{t+1}) - 1$$

$$L_t = (A \cdot X^{ex})^{\eta} \cdot a^{2\eta} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{-\eta} \cdot (1-b)^{-\eta}$$

$$\Omega = (A \cdot X^{ex})^{\eta} \cdot a^{2(\eta-1)} \cdot (1+i^*)^{-(\eta-1)} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \cdot E_t(S_{t+1})^{-(\eta-1)}$$
$$\cdot (1-b)^{-(\eta-1)}\left[\frac{X}{X^{ex}} - a^2 \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b\right] + d_t\left[S_{t+1} \cdot (1+i^*) - (1+i^d)\right]$$

$$S_1^* = 1,$$

$$S_2^* = \frac{\theta}{\psi^2 \cdot (a+b)} \cdot \left(\frac{1-a}{b}\right)^{\frac{b}{1-a}} \cdot (1-b)^{\frac{a}{1-a}} \cdot \alpha^{\frac{b}{1-a}} + \frac{1}{a+b} - 1$$

Bank as Stackelberg Leader

$$w = (\alpha - a\alpha)^{\frac{1}{\mu_b}} \cdot b^{b\cdot\eta} \cdot a^{2(\eta-1)} \cdot (A \cdot X^{ex})^{\eta} \cdot \left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{-(\eta-1)}$$

$$i^l = \frac{1}{a} \cdot (1+i^*) \cdot E_t(S_{t+1}) - 1$$

$$L_t = (A \cdot X^{ex})^{\eta} \cdot a^{2\eta} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \cdot \left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{-\eta}$$

$$\Omega = (A \cdot X^{ex})^{\eta} \cdot a^{2(\eta-1)} \cdot (1+i^*)^{-(\eta-1)} \cdot \left(\frac{\alpha}{b\eta}\right)^{-b\eta} \cdot E_t(S_{t+1})^{-(\eta-1)}$$
$$\cdot \left[\frac{X}{X^{ex}} - a^2 \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b\right] + d_t\left[S_{t+1} \cdot (1+i^*) - (1+i^d)\right]$$

$$S_1^* = 1,$$

$$S_2^* = \frac{\theta}{\psi^2 \cdot (a+b)} \cdot \left(\frac{1-a}{b}\right)^{\frac{b}{1-a}} \cdot \alpha^{\frac{b}{1-a}} + \frac{1}{a+b} - 1$$

Since the wage is a cost for the firm but not to the bank, the bank's optimization problem does not directly involve the wage. Thus wage decision is the same in the two cases if the lending rate is the same. However, the difference in time sequence of action does affect the determination of the lending rate. Thus if the lending rate is replaced by its optimal value in each case, the wage will be different in the two cases.

From the above table, it is obvious that the trade union will charge a higher wage rate if it is a Stackelberg leader than if the bank is a Stackelberg leader. When the bank is a Stackelberg leader, it is able to set a higher lending rate, which depresses investment and employment demand, and subsequently the ability of the trade union to demand a higher wage. When the trade union is a Stackelberg leader, it is able to demand a higher wage and hence reduce the bank's ability to charge a higher lending rate. Thus the ability to commit to the original decision can make the agent more powerful in the wage-interest rate setting process.

As for the lending interest rate the bank will choose a higher rate if it is the Stackelberg leader than if the trade union is the Stackelberg leader. The higher lending rate will depress the wage rate and thus maintain or increase the bank's total profit, even though investment will be adversely affected.

More interestingly, in this case, the parameter b does not enter the solution of the lending rate. As argued before, the bank regards the firm and trade union as a single group engaged in production. The outcome for the lending rate is the same as in the case where there the labor factor is excluded.

Of course when the trade union is the Stackelberg leader, it can depress the lending rate by demanding a higher wage and thus reduce the total investment.

From the table, it is obvious that the level of investment and loans will be higher if the trade union is the Stackelberg leader. Both the wage and interest rate will have a dampening impact on investment. If the wage contact lasts longer than the maturity of bank financing, the trade union is the Stackelberg leader, the wage is higher, and the lending rate is lower. In the opposite case, the wage is lower but the lending rate is higher. The effect of a higher lending rate dominates the opposing effect of a higher wage rate, so that total investment is higher under a Stackelberg leader trade union than under a Stackelberg leader banking sector.[85]

When the wage contact period is longer than the maturity of bank financing, the trade union is the Stackelberg leader vs the business sector (here the firm and the bank), and the business sector respond by increasing its debts (incl. foreign debts) and cutting interest rates. The debts are a strategic instrument for the business sector to counter the power of the trade union. This same insight is emphasized in Bronars and Deere (1991), Dasgupta and Sengupta (1993) and Koskela and Stenbacka (2000), albeit with different mechanisms.

The profit of the business community under these two scenarios is hard to compare. Under the Stackelberg leader trade union, investment is higher, but the wage is also higher. When the bank is the Stackelberg leader, the wage is lower, but the investment level is lower. A higher lending rate depresses the firm's profit but increases the bank's profit. Thus it is not straightforward to say which case results in the higher business sector profit. It turns out that if

[85] On the other hand, when we consider the combined profit of the firm and bank under the Stackelberg leader trade union, the total lending is higher, which implies that when domestic savings are fixed, the foreign borrowing or debt is higher. Thus the economy is more vulnerable to a potential devaluation by the central bank, as the domestic agents have larger foreign debts.

$$\left[\left(\frac{1}{1-b}\right)^{\eta-1}-1\right]\cdot\left(\frac{X}{X^{ex}}-b\right)>\left[\left(\frac{1}{1-b}\right)^{\eta}-1\right]\cdot\frac{a^2\cdot S_{t+1}}{E_t(S_{t+1})} \tag{4.66}$$

then the profit of the business sector is higher under the Stackelberg leader trade union and vice versa.

However, when we look only at the profit of the firm, which is

$$\Omega=\left(\frac{X}{X^{ex}}-a-b\right)\cdot(A\cdot X^{ex})^{\eta}\cdot a^{2(\eta-1)}\cdot(1+i^*)^{-(\eta-1)}\cdot\left(\frac{\alpha}{b\eta}\right)^{-b\eta} \cdot E_t(S_{t+1})^{-(\eta-1)}\cdot(1-b)^{-(\eta-1)} \tag{4.67}$$

if the trade union is the Stackelberg leader, as compared with

$$\Omega=\left(\frac{X}{X^{ex}}-a-b\right)\cdot(A\cdot X^{ex})^{\eta}\cdot a^{2(\eta-1)}\cdot(1+i^*)^{-(\eta-1)}\cdot\left(\frac{\alpha}{b\eta}\right)^{-b\eta} \cdot E_t(S_{t+1})^{-(\eta-1)} \tag{4.68}$$

if the bank is the Stackelberg leader, we obtain the unambiguous result that the firm's profit is lower if the bank is a Stackelberg leader. Thus the interest rate impact is larger than the wage impact on the firm's profit. The reason for a larger role of interest rates in this model lies mainly in the model structure in that the lending interest rate is a determinant of the wage, whereas the wage does not enter the lending rate function. Thus the interest rate has two channels for influencing the profits of the firm: the direct channel through its role in total capital investment and labor demand and the indirect channel through the wage. By contrast, the wage has only the direct channel for affecting profit, through its impact on capital investment and labor demand.

Under wage bargaining, there are still two equilibrium exchange rates possible, one featuring a stable exchange rate, with no devaluation expectation, and the other featuring devaluation. The devaluation rate is greater than in the benchmark case, where the markup element, (4.53) and (4.64), is larger than one. If the bank is a Stackelberg leader, it can ensure a lower wage demand by setting a higher interest rate. Since, as discussed in the previous paragraphs, interest rates can have both direct and indirect impacts on capital investment and labor demand, the impact of a higher interest rate will be larger than that of wage. The overall impact on firm's profit is larger if the bank is a Stackelberg leader. This is also the reason that the equilibrium devaluation rate under a Stackelberg leader bank is larger than if the trade union is a Stackelberg leader.

4.4.2 Conclusions

The impacts of devaluation on the profits of the business sector, as usual were conflicting. Devaluation benefits the export sector, via higher profits due to the wedge between domestic prices and world prices. On the other hand, devaluation is costly to domestic debtors who borrow from abroad. These two opposite forces determine the overall impact. Under a Stackelberg leader trade union, the foreign debts are larger but exports are greater than if the bank has stronger bargaining power. So it is also hard to say which case results in devaluation having a greater impact on profitability.

In conclusion, the inclusion of wage bargaining and trade union behavior does not alter the basic insight from the previous chapter, ie that it is likely that there will be multiple equilibria for the exchange rate. Furthermore, the stronger the union's bargaining power and marginal labor disutility, the higher the wage demand. In all cases, under certain conditions, a higher wage demand results in a larger devaluation, in equilibrium.

The time sequence of the actions of the trade union and bank has significant effects on the equilibrium values of the key variables. Most interestingly, compared to the case where the bank is the Stackelberg leader, if the trade union is the Stackelberg leader, it will demand a higher wage; the bank will set a lower interest rate; investment and foreign debts will be larger; provided condition (4.66) holds, the profits of the business sector may be higher; and finally one of the equilibrium devaluation rates will be lower.

Appendix 4.1

The Nash bargaining product is

$$N = (U^e)^{\sigma} \cdot (\Omega_f^e)^{1-\sigma} \tag{A4.1}$$

where σ is the relative bargaining power of the trade union and 1–σ is that of the firm. $1 \geq \sigma \geq 0$.

Substituting the expression for l_t in (4.12) into the expected utility function, we obtain

$$U^c = \ln(wl_t) - \alpha l_t \tag{A4.2}$$

We now have

$$\begin{aligned} U_T = {} & \ln\left[w \cdot (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-\eta_b}\right] \\ & - \alpha \cdot (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-\eta_b} \end{aligned} \tag{A4.3}$$

The firm's expected profit is

$$\begin{aligned} \Omega_f^e = {} & (1-a-b) \cdot (A \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \\ & \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \end{aligned} \tag{A4.4}$$

The Nash bargaining solution requires the following first-order condition:

$$\sigma \cdot \frac{\frac{\partial U^e}{\partial w}}{U^e} = -(1-\sigma) \cdot \frac{\frac{\partial \Omega_f^e}{\partial w}}{\Omega_f^e} \tag{A4.5}$$

Then

$$\begin{aligned} & \frac{\sigma \cdot \left(-(\eta_b - 1)/w + \alpha \cdot \eta_b \cdot Q \cdot w^{-\eta_b}/w\right)}{\ln(Q \cdot w^{-(\eta_b-1)}) - \alpha \cdot Q \cdot w^{-\eta_b}} \\ & -(1-\sigma) \cdot (\eta_b - 1)/w = 0 \end{aligned} \tag{A4.6}$$

which reduces to

$$\ln(Q \cdot w^{-(\eta_b - 1)}) - \alpha \cdot Q \cdot w^{-\eta_b} + \frac{\sigma}{1-\sigma} - \frac{\sigma}{1-\sigma} \cdot Q \cdot w^{-\eta_b} \cdot \frac{\alpha(1-a)}{b} = 0 \tag{A4.7}$$

where

$$Q = b^{\eta_b} \cdot (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \cdot (1 + i^l)^{-(\eta_a - 1)} \tag{A4.8}$$

Rearranging (A4.7), we get (4.27).

Appendix 4.2

From (4.27), we can derive

$$-\frac{b/w}{1-a-b}dw = \left(-\frac{1}{(1-\sigma)^2} + \frac{1-a}{b\cdot(1-\sigma)^2}\cdot\alpha\cdot Q\cdot w^{-\eta_b}\right)d\sigma$$
$$-\frac{(1-a)/w}{1-a-b}\cdot\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)}\cdot\alpha\cdot Q\cdot w^{-\eta_b}dw \tag{A4.9}$$

Rearranging (A4.9), we get

$$\frac{dw}{d\sigma} = \frac{(1-a-b)\cdot w\cdot\left(1-\frac{1-a}{b}\cdot\alpha\cdot Q\cdot w^{-\eta_b}\right)}{b\cdot(1-\sigma)^2\cdot\left(1-\frac{1-a}{b}\cdot\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)}\cdot\alpha\cdot Q\cdot w^{-\eta_b}\right)} \tag{A4.10}$$

Since from (4.29), we have

$$\frac{1-a}{b}\cdot\alpha\cdot Q\cdot w^{-\eta_b} > 1 \tag{A4.11}$$

and it is obvious that

$$\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)} = 1+\frac{\sigma}{1-\sigma}\cdot\frac{1-a}{b} > 1 \tag{A4.12}$$

Thus we can deduce from (A4.10) unconditionally that

$$\frac{dw}{d\sigma} > 0 \tag{A4.13}$$

Appendix 4.3

From (4.27), we can derive

$$\frac{1}{Q}dQ - \frac{b/v}{1-a-b}dw = \frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)}\cdot\alpha\cdot w^{-\eta_b}dQ$$
$$-\frac{(1-a)/w}{1-a-b}\cdot\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)}\cdot\alpha\cdot Q\cdot w^{-\eta_b}dw \qquad \text{(A4.14)}$$

Rearranging (A4.14), we get

$$\frac{dw}{dQ} = \frac{(1-a-b)\cdot w\cdot\left(1-\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)}\cdot\alpha\cdot Q\cdot w^{-\eta_b}\right)}{b\cdot Q\cdot\left(1-\frac{1-a}{b}\cdot\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)}\cdot\alpha\cdot Q\cdot w^{-\eta_b}\right)} \qquad \text{(A4.15)}$$

By assumption, we have

$$\frac{1-a}{b}\cdot\alpha\cdot Q\cdot w^{-\eta_b} > 1 \qquad \text{(A4.16)}$$

Thus, as long as

$$\frac{b+\sigma\cdot(1-a-b)}{b\cdot(1-\sigma)} = 1+\frac{\sigma}{1-\sigma}\cdot\frac{1-a}{b} > \frac{1-a}{b} \qquad \text{(A4.17)}$$

we have

$$\frac{dw}{dQ} > 0 \qquad \text{(A4.18)}$$

Solving (A4.17), we get the condition for (A4.18), which is

$$\sigma \geq \frac{1-a-b}{1-a-b+(1-a)} \qquad \text{(A4.19)}$$

Appendix 4.4

In order to illustrate the main results explicitly, we now look at a simply case: The central bank is concerned only with the profit of the firm, as discussed in the previous chapter. Again we apply the same simplification that X is equal to S_{t+1}, so that the private sector's profit is

$$\Omega_f = \left(\frac{X}{X^{ex}} - a - b\right) \cdot (A \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \cdot b^{\eta_b - 1} \cdot (1 + i^l)^{-(\eta_a - 1)} \cdot w^{-(\eta_b - 1)} \tag{A4.20}$$

The central bank's target for the profit rate is

$$\Omega^* = \Omega_f^* + \frac{a+b}{a} \cdot L_t \cdot (1 + i^l) \cdot (E_t(S_{t+1}) - 1) \tag{A4.21}$$

where

$$\Omega_f^* = (1 - a - b) \cdot A^{\eta_a + \eta_b - 1} \cdot a^{2(\eta_a - 1)} \cdot b^{\eta_b - 1} \cdot (1 - b)^{-(\eta_a - 1)} \cdot (1 + i^*)^{-(\eta_a - 1)} \cdot w^{-(\eta_b - 1)} \tag{A4.22}$$

Then the central bank's loss function is

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{\xi^2}{2}\left[(S_{t+1} - (a+b) \cdot E_t(S_{t+1})^2) \cdot E_t(S_{t+1})^{\frac{b}{1-a-b}} - (1 - a - b)\right]^2 \tag{A4.23}$$

where

$$\xi = \frac{A^{\eta_a + \eta_b - 1} \cdot a^{2(\eta_a - 1)} \cdot b^{\eta_b - 1}}{[(1 - b) \cdot (1 + i^*)]^{\eta_a - 1} \cdot w^{\eta_b - 1}} \tag{A4.24}$$

We obtain the equilibrium exchange rate for the central bank[86] as

[86] From (A4.25), we can verify that when $E_{t+1}(S_{t+1}) = 1$, $S^* = 1$.

$$S^* = \frac{\theta + (a+b)\cdot\xi^2\cdot E_t(S)^{2+\frac{2b}{1-a-b}} + (1-a-b)\cdot\xi^2\cdot E_t(S)^{\frac{b}{1-a-b}}}{\theta + \xi^2\cdot E_t(S)^{\frac{2b}{1-a-b}}} \qquad \text{(A4.25)}$$

We have

$$\frac{\partial S^*}{\partial(\xi^2)} < 0 \qquad \text{(A4.26)}$$

when

$$(a+b)\cdot E_t(S_{t+1})^2 + (1-a-b)\cdot E_t(S_{t+1})^{\eta_b - 1} < 1 \qquad \text{(A4.27)}$$

This is also the condition for

$$\frac{\partial S^*}{\partial w} > 0 \qquad \text{(A4.28)}$$

Thus the central bank's policy on the exchange rate depends also on the wage rate prevailing in the economy. The equilibrium exchange rate will be positively linked to the wage demand as long as condition (A4.27) holds. A higher wage rate will, under some circumstances, prompt the central bank to devalue by a larger amount. In this sense, concerted efforts to reduce the wage rate may in effect reduce the possibility of devaluation in the future.

5 Fiscal policy, wage setting and exchange rate policy

5.1 Introduction

This chapter focuses on the role of the fiscal authority in affecting the central bank's decision on exchange rates via its impact on wages. We use the framework developed in chapters 3 and 4, and add a fiscal authority to the model. Thus, the game discussed in the previous chapters will now have one more strategic player: the fiscal authority. In addition to the trade union, the fiscal authority will affect not only investment and output but also wage setting and exchange rate policy. The strategic interaction between fiscal policy and other aspects of economic decision-making by private agents and the central bank is the focal point of this chapter.

Adding a fiscal authority to the model is not only theoretically interesting in that it allows us to explore, given the strategic elements already existed in the models in chapter 4, the effects of the fiscal authority, as an additional strategic player, on the optimal behavior of all other strategic players. It is also empirically relevant, as fiscal policy is an inseparable part of the wage determination process in the Finnish context.

In Finland the government plays an active role in the wage bargaining process. As the wage bargaining system is highly centralised, the fiscal authority and trade union are important institutions in influencing economic policy. The fiscal authority uses mainly tax policy and government expenditure to achieve its objectives, such as maximization of output and employment in the economy. Under some circumstances, the fiscal authority is able to moderate the trade union's wage demands by agreeing to cut income taxes or increase transfer payments, so as to increase real after-tax income, even if the wage increase is modest. This strategic interaction between the fiscal authority and trade union may have important implications for the conduct of monetary policy.[87] This institutional element of the Finnish economy is incorporated into the theoretical model framework.

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[87] Of course, the ability of the government to offer such deals depends on the overall economic situation, particularly the government's fiscal situation.

The role of government in wage bargaining is observed and discussed, for example, in Iverson (1999, p. 31):

> '…Class cooperation in highly centralised bargaining system has always been premised on the capacity of the government's commitment to full employment. By socialising the risks of employment, the government facilitates "responsible" union behaviour.'

The interaction among the fiscal authority, central bank and trade union provides a richer and more complete picture of many factors related to currency crises.

The early literature on currency crises, especially the first-generation models, focuses on the conflicting stance of the central bank and fiscal authority. Krugman (1979) is actually the first, and one of the most significant, papers on this topic. If the fiscal authority issues money to finance its expenditure and a monetary authority is committed to the pegged exchange rate system, then, sooner or later, foreign exchange reserves will decline to a critical level that induces speculative attacks. It is the unsustainable expansionary fiscal policy that results in speculative attacks and currency crises.

De Kock and Grilli (1993) study the relation between fiscal policy and the optimal choice of exchange rates. Faced with unusually large government spending (or deficits), the government may find it optimal to devalue the formally pegged exchange rate in order to generate unexpected inflation and thus impose a lump-sum tax on its nominal liabilities.

Recently more sophisticated approaches to the relation between fiscal policy and currency crises focus on the moral hazard problem resulting from the government's implicit guarantee of foreign debts. Corsetti et al (1999) develop this along the lines of Krugman (1979), and the logic of speculative attacks is the same as in Krugman (1979). But Corsetti et al (1999) endogenize the rate of money growth by the policymaker, whereas in Krugman (1979), the money growth is exogenously fixed. In addition, Corsetti et al (1999) focus on so-called 'debt socialization', which means that the implicit guarantee of foreign debt results in over-indebtedness and subsequent currency crises when there is shock. Thus the government's commitment to bail out bad loans in the future tends to encourage foreign borrowing to finance unprofitable projects. When the foreign creditors refuse to refinance the country's cumulative losses, the government is forced to use seigniorage to obtain extra resources to deal with the debt issue. In anticipation of such a possibility of inflationary financing, a currency crisis – or sometimes even a financial crisis – can occur.

Another paper on the similar topic by Burnside-Eichenbaum-Rebelo (1999) focuses on the effects of the prospects of higher future public debts on the exchange rate policy. They show that government guarantees to domestic and foreign lenders tend to lower interest rates and generate an economic boom, which may eventually lead to fragility of the banking sector. Foreign debts could thus drive the banking sector into difficulty if the fixed exchange rate is abandoned.

The second-generation currency crisis models also consider the role of fiscal policy in currency crises. Obstfeld (1994) provides a self-fulfilling currency crisis model in which high nominal interest rates have an effect on the government fiscal position. The government is modeled to care only about the distorting effects of ex post inflation and the tax rate. The maturity structure of the government's domestic debt and the currency composition of overall public debts are two important factors for the likelihood of a currency crisis. Under certain conditions, devaluation expectations will push up interest rates and make the fiscal burden unbearable for the government. The government is forced to abandon the currency peg, which would have been viable under an other set of private sector expectations.

In this chapter we use the monopoly trade union model developed in the previous chapter as a basis for exploring the implications of this strategic interaction between fiscal authority and trade union. As in that model, the trade union is still a Stackelberg leader vs the bank and the firm. Now the fiscal authority plays a Nash non-cooperative game with the trade union in deciding the wage, government expenditure, or income tax level. The government can reduce government expenditure to induce the trade union to moderate its wage demand. However, the government also has a tendency to increase expenditure in order to achieve the goal of output maximization. In addition, an increase in government expenditure will induce higher taxation in a later period, via the intertemporary budget constraint. The increase in government expenditure will boost production, but it will also result in an increase in the wage and taxation. The government's decision is based on the outcome of these competing effects.

The setting of a non-cooperative Nash game between the trade union and fiscal authority is partly based on the institutional facts of the Finnish economy. In Finland, critical fiscal decisions are often made in connection with the wage determination process. The fiscal authority and trade union must make decisions almost simultaneously. A full cooperative game may be more efficient, but pre-commitment to the optimal policy is often not possible, as Kydland and Prescott (1977), Barro and Gordon (1983) and Lucas and Stokey (1985) demonstrate. Thus, under this centralized bargaining system, the setting of the Nash game can be reasonable.

There may exist a certain difference in the goals of the fiscal authority and central bank. Under the fixed exchange rate system, the central bank usually cares about currency stability, while the fiscal authority, representing the government, tends to value the maximization of output and employment. The central bank uses the exchange rate as the key policy instrument whereas the fiscal authority uses the income tax and public expenditure. While both of these policymaking bodies care about the overall welfare of the economy, sometimes the emphasis on different goals can make the economy vulnerable to currency crises.

The results of the model have the following features. Under the strategic game framework, if the fiscal authority decides to lower government expenditure, it can directly moderate wage demand, but also lower output. However, the moderation of wage demand will boost production. Thus a reduction in government expenditure will have two offsetting effects on production: It lowers production directly, but boosts production indirectly via a reduction in the wage. These impacts will affect the central bank's policy on the exchange rate. Normally when the fiscal authority increases debt-financed public expenditure, it has to pay back the borrowings by raising taxes in the future. Thus the overall impact of a combination of higher interest rates, higher wages and higher output can result in an eventual deterioration of business sector profits. The central bank may be willing or forced to devalue in order to maintain a satisfactory level of profits in the business sector. On the other hand, under some conditions and amid devaluation expectations, an increase in public investment will increase the firm's productivity and can thus compensate for the impacts of a wage increase on the firm's profit. In this circumstance, an increase in public investment can prevent the profit from deteriorating and make devaluation unnecessary. Therefore, an expansionary fiscal stance may break the 'devaluation expectations-wage-devaluation' spiral.

5.2 Setup

As we are now focusing on the role of fiscal policy in currency crises, the model in this chapter has one more strategic player than that in chapter 4: a fiscal authority.

Before the start of the first period, t, the central bank sets the period t exchange rate, S_t, at one and the deposit rate at i^d. The economy is endowed with initial wealth of ωt. In addition, the interest rate in the international market, i*, is observable.

In the first period, the trade union decides the wage and the fiscal authority decides government expenditure in a Nash noncooperative game. They both act as Stackelberg leaders vs the firm and bank, which react to the determined levels of the wage and government expenditure by setting their optimal interest rate and private investment. Within the business sector, the firm and bank interact in a Stackelberg game framework, as in the previous chapters.

There are only two periods in the model. In the second period, after all private agents have made decisions and commitments, the central bank decides the exchange rate, S_{t+1}, to minimize its loss function. The central bank's decision on the exchange rate is based on the interaction of the other agents. In the end, the production process is completed and all financial assets are cleared.

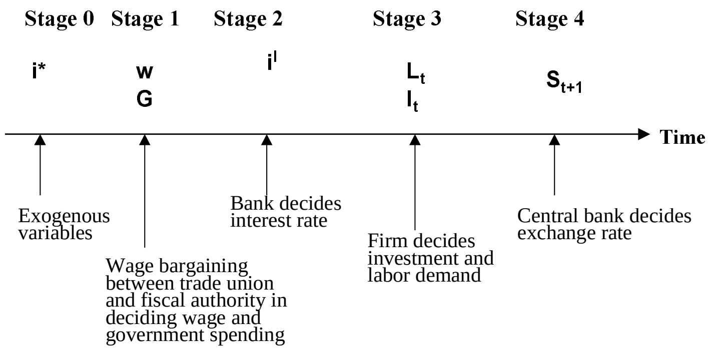
The fiscal authority issues government bonds in the first period to finance public investment and repays its debt by levying an income tax in the next period. Government bonds are purchased by international investors at the world interest rate, which is equal to that charged to the domestic bank.[88] In the next period, the government uses the labor income tax to redeem the government bonds. The government is assumed to balance the budget at the end, not period by period.

The following chart summarizes the time sequence of decisions in the economy:[89]

[88] In reality, government bonds usually bear lower interest rates than the loan rates. However, this assumption simplifies the matter without loss of generality, as long as the difference between the world interest rate and the domestic lending rate is exogenous.

[89] Here we assume that bank lending is of shorter maturity than the wage contract and fiscal policy periods.

Figure 5.1 **Time sequence of decisions**



Source: OECD.

5.3 Agents' optimization problems

5.3.1 Firm

In the model, government expenditure is modeled as public infrastructure investment.[90] The government invests in infrastructure and education, which will have an effect on labor productivity. This is an important channel through which the government can affect wage bargaining. This is based on growth theory, where public investment is regarded as instrumental in improving total factor productivity.[91]

Aschauer (1989a) finds empirical evidence to support the view that public sector capital accumulation, especially infrastructure capital investment such as streets, highways, airports, mass transit, and water system, can have significant explanatory power for overall productivity in the economy. Aschauer (1989b) also finds empirical evidence in cross-national (G7) studies. In addition to Aschauer (1989a), Holtz-Eakin (1989) and Munnell (1990) find that the

[90] There are other ways to model government expenditure, eg as government transfer payments or taxes. However, since the household sector in this chapter is exogenized, transfer payments cannot be modeled. Though taxes are a viable choice, the exposition would be more complicated. Thus the choice of modeling public investment is mainly for simplicity.

[91] For more details on the spillover effects of infrastructure investment and knowledge accumulations, see eg Lucas (1988), Romer (1986, 1990), Grossman and Helpman (1989). The eighth volume of the Journal of Economic Perspectives (1994) focuses on this topic.

slowdown in productivity growth in the United States in the 1970s was due to a slowdown in public sector capital accumulation.[92]

The firm has a production function of the following form:

$$Y_{t+1} = A \cdot G_t^{\mu} \cdot k_t^{a} \cdot l_t^{b} \tag{5.1}$$

where A represents the level of technology level, G_t is public infrastructure investment by the government, k_t is capital in period t, l_t is the labor input. $0 < \mu < 1$, $0 < a < 1$, $0 < b < 1$, and $a + b + \mu < 1$. Thus, as in the previous chapters, we continue to assume that the production technology features decreasing returns to scale, even with the government investment.

By assuming that capital is completely depreciated in one period and that the firm relies totally on the bank loan for investment, we can replace K_t in the above equation with L_t, which is the bank lending to the firm in period t.

Taking into account the firm's cost,

$$C_f = L_t \cdot (1 + i^l) + w \cdot l_t \tag{5.2}$$

we get the firm's ex ante profit:

$$\begin{aligned} \Omega_f^e = {} & E_t(\lambda) \cdot A \cdot G_t^{\mu} \cdot L_t^{a} \cdot l_t^{b} + (1 - E_t(\lambda)) \cdot E_t(S_{t+1}) \cdot A \cdot G_t^{\mu} \cdot L_t^{a} \cdot l_t^{b} \\ & - L_t \cdot (1 + i^l) - w \cdot l_t \end{aligned} \tag{5.3}$$

where $0 \le \lambda \le 1$. λ represents the percentage share of output sold in the domestic market in period t+1, and it has the same features as in the previous chapter.

Since the firm is the follower in a Stackelberg game, it maximizes its profit by choosing its level of investment and labor input given the lending rate, wage, government investment, and expectations of the future exchange rate. Taking the derivative of Ω_f^e with respect to L_t yields

[92] Holtz-Eakin (1994) disputes the viability of the empirical evidence provided by these papers. Instead, Holtz-Eakin (1994) shows that the use of aggregate data does not reveal sufficiently strong linkages between public sector capital stock and private productivity.

$$L_t = \left[\frac{aA \cdot G_t^{\mu} \cdot X^{ex}}{(1+i^l)} \right]^{\frac{1}{1-a}} l_t^{\frac{b}{1-a}} \tag{5.4}$$

where

$$X^{ex} = \phi \cdot E_t(S_{t+1})^2 + (1-\phi-\lambda^*) \cdot E_t(S_{t+1}) + \lambda^* \tag{5.5}$$

And taking the derivative of Ω_f^e with respect to l_t yields

$$l_t = \left[\frac{bA \cdot G_t^{\mu} \cdot X^{ex}}{w} \right]^{\frac{1}{1-b}} \cdot L_t^{\frac{a}{1-b}} \tag{5.6}$$

From (5.4) and (5.6), we get the firm's input demand functions:

$$L_t^* = (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-\eta_a} \cdot w^{-(\eta_b-1)} \tag{5.7}$$

$$l_t^* = (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-\eta_b} \tag{5.8}$$

(5.7) is the firm's capital investment function and (5.8) the labor demand function, with the lending rate determined by the bank, the wage determined by the trade union, and government investment as the determinant.

We thus get the firm's optimal level of production and its ex ante expected profit:

$$\begin{aligned} Y_{t+1} = {} & (A \cdot G_t^{\mu})^{\eta_a+\eta_b-1} \cdot (X^{ex})^{\eta_a+\eta_b-2} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \\ & \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \end{aligned} \tag{5.9}$$

$$\begin{aligned} \Omega_f^e = {} & (1-a-b) \cdot (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \\ & \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \end{aligned} \tag{5.10}$$

The firm's investment level and output are negatively related to the cost of capital, i^l, and the wage rate, w, and positively to public investment and the expected exchange rate in period t+1. A higher lending rate or wage will depress both investment and labor demand, which can be summarized as

$$\frac{\partial L_t}{\partial w} < 0, \frac{\partial L_t}{\partial i^l} < 0, \frac{\partial l_t}{\partial w} < 0, \frac{\partial l_t}{\partial i^l} < 0 \tag{5.11}$$

On the other hand, the increased devaluation expectations and higher government investment will boost both investment and labor demand:

$$\frac{\partial L_t}{\partial G_t} > 0, \frac{\partial L_t}{\partial E_t(S_{t+1})} > 0, \frac{\partial l_t}{\partial G} > 0, \frac{\partial l_t}{\partial E_t(S_{t+1})} > 0 \tag{5.12}$$

The firm's ex post profit after the central bank's decision on the second period exchange rate is

$$\begin{aligned} \Omega_f = & \left(\frac{X}{X^{ex}} - a - b\right) \cdot (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \cdot b^{\eta_b - 1} \\ & \cdot (1 + i^l)^{-(\eta_a - 1)} \cdot w^{-(\eta_b - 1)} \end{aligned} \tag{5.13}$$

and it is clear that

$$\frac{\partial \Omega_f}{\partial S_{t+1}} > 0, \frac{\partial \Omega_f}{\partial G_t} > 0, \frac{\partial \Omega_f}{\partial i^l} < 0, \quad \text{and} \quad \frac{\partial \Omega_f}{\partial w} < 0 \tag{5.14}$$

5.3.2 Bank

In macroeconomic theory, the impact of fiscal policy on interest rates depends critically on whether the country is considered small or sufficiently big. The typical reasoning is as follows:[93]

> 'The interest rate impact of government borrowing is crucial to fiscal policy. If fiscal deficits raise interest rates, interest-rate-sensitive business and household purchases are discouraged or "crowed out" to support fiscal policy goals. Fiscal policy-makers in large countries thus have a crowded-out constituency to consider, whereas no such constituency exists in small countries. Symmetrically, reduced government deficits in large countries would lower interest rates and "crowd in" this same constituency, but reduced deficits in small countries would not provide any

[93] Allen (1999, p. 180).

spillover benefits to the private sector via the reduced interest rate effect.'

To simplify the model, we assume that the government can borrow unlimited amounts directly from the international capital market at a fixed world interest rate. As in a small open economy model, fiscal policy does not influence domestic interest rates in this model and thus has no 'crowd-out' effects on investment either.[94]

So the bank's optimization problem is the same as in section 4.2.2.2 of chapter 4. The result is

$$i^{l} = \frac{1-b}{a} \cdot (1+i^{*}) \cdot E_{t}(S_{t+1}) - 1 \tag{5.15}$$

Thus the bank's ex post profit is

$$\begin{aligned}\Omega_{b} &= (A \cdot G_{t}^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a} \cdot b^{\eta_b-1} \cdot (1+i^{l})^{-\eta_a} \cdot w^{-(\eta_b-1)} \\ &\quad \cdot \left[(1+i^{l}) - S_{t+1} \cdot (1+i^{*})\right] + d \cdot \left[S_{t+1} \cdot (1+i^{*}) - (1+i^{d})\right]\end{aligned} \tag{5.16}$$

Combining (5.13) and (5.16), we get the combined real ex post profit of the firm and bank:

$$\begin{aligned}\Omega &= \Omega_{f} + \Omega_{b} \\ &= (A \cdot G_{t}^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \cdot (1+i^{l})^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \\ &\quad \cdot \left[\frac{X}{X^{ex}} - \frac{a^{2}}{1-b} \cdot \frac{S_{t+1}}{E_{t}(S_{t+1})} - b\right] + d \cdot \left[S_{t+1} \cdot (1+i^{*}) - (1+i^{d})\right]\end{aligned} \tag{5.17}$$

From equation (5.17), we know that the profitability of the private sector will respond positively to a change in A and negatively to a change in i^{d}. The sign of the partial derivatives of Ω with respect to S_{t+1} and $E_t(S_{t+1})$ is ambiguous. The sign of

[94] But the foundation for the assertion, ie that in a small open country fiscal policy does not affect interest rates, is a simplification. It neither distinguishes between various interest rates in a country nor takes into account the financial structure of a country. This assumption is made because the solutions are intractable if government fiscal financing is channeled through the intermediation of the domestic banking sector. In appendix 5.1 we depart from this assumption and take into consideration the financial structures concerned. The banking sector within the country will charge domestic borrowers, including the government, a premium over the world interest rate.

$$\frac{X}{X^{ex}} - \frac{a^2}{1-b} \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b \tag{5.18}$$

is of particular interest, as it determines whether devaluation will have an overall positive or negative impact on the combined profits of the bank and firm. Actually the sign represents the diverging impacts of devaluation on the open and sheltered sectors of the economy. When

$$\frac{X}{X^{ex}} - \frac{a^2}{1-b} \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b > 0 \tag{5.19}$$

the beneficial impact of devaluation on the open sector dominates the negative impact on the banking sector due to the increased debt burden. (5.19) will not always hold. When it does not, the increased debt burden due to devaluation outweighs the benefit of the improved terms of trade of the open sector.

5.3.3 Fiscal authority

In the first period the fiscal authority issues bonds in the international capital market in order to finance public investment. The interest rate, i*, is equal to that charged to the domestic bank. In the next period, the government uses income tax revenue to redeem the bonds. Thus the government is also subject to an exchange rate risk, as the bonds must be paid in foreign currencies.

Government revenues come from bond sales in the first period and income taxes in the second period. Government expenditures go to public investment in the first period and redemption of bonds in the second period. Budget constraints mean that revenue and expenditure should balance in each period. So the government's budget constraints in the first and second periods, respectively, are

$$G_t = GB \tag{5.20}$$

$$GB \cdot S_{t+1} \cdot (1+i^*) = \tau \cdot w \cdot l_t \tag{5.21}$$

where GB is the amount of government bonds issued and τ is the income tax rate.

Consolidating these two items we get

$$G_t = \frac{\tau \cdot w \cdot l_t}{S_{t+1} \cdot (1+i^*)} \quad \text{or} \quad \tau = \frac{G_t \cdot S_{t+1} \cdot (1+i^*)}{w \cdot l_t} \tag{5.22}$$

Government investment is determined in the first period. This constitutes the fiscal deficit for the economy. In the second period, the government levies a tax on labor income to pay off the initial fiscal deficit. The tax rate is determined in such a way that government revenue and expenditure are balanced. The tax rate is determined endogenously and varies with the exchange rate in the second period.

Governments throughout the world endeavor to promote economic growth, which is normally measured by the growth rate of GDP. Higher output usually means higher employment and provides a means of improving the welfare of the society. It is common in economics literature to assume that governments favor higher output. To maximize output is often modeled as one of the goals of governments.

In addition to the preference for maximizing output, governments are assumed to dislike the distortionary effect of taxation in this model.[95] Government infrastructure investment tends to boost output, but the taxes that have to be levied to finance the investment is eventually disliked. From the economic efficiency view point, taxation entails a deadweight loss to the economy[96] and, from the political economy view point, an increase in taxation is often unpopular with ordinary voters. This insight has become conventional wisdom, and it is well documented.[97] The modeling of tax distortion as a cost to policymakers is adopted eg by de Kock and Grilli (1993), and Obstfeld (1994).

Thus the government's objective function involves a tradeoff between output and tax distortion (instead of inflation distortion). The fiscal authority's objective is to maximize output and minimize the

[95] In most models, governments are assumed to dislike inflation. There is usually a tradeoff between output and inflation. Governments can use policy instruments, such as fiscal spending or devaluation, to stimulate output. However, inflation will also increase as a consequence. So governments have to balance the benefits of higher output and costs of higher inflation. In this model, as prices are assumed to be sticky, the normal output-inflation tradeoff does not exist. Instead, the tradeoff between output and tax distortion is captured.

[96] The deadweight loss of taxation is related to the consumer's optimization decision. Whereas in this chapter the household is exogenous, we do not consider the details of the deadweight loss of taxation.

[97] For a textbook treatment, see Stiglitz (2000).

distortion effects of taxation. Here the cost of distortion due to taxation is captured in the last item, and the distortion increases with the total labor income tax.

$$F = Y_t - \delta \cdot (\tau \cdot w \cdot l_t) \tag{5.23}$$

where δ is a positive parameter that measures the distortion of government tax revenue.

As we discussed in section 5.3.1, government investment can boost output, and it will also affect the income tax rate. Thus government investment is beneficial to the firm's investment and labor income, but the subsequent income tax will depress after-tax income. The fiscal authority chooses its optimal level of investment to achieve its goal of output maximization and tax distortion minimization. As (5.22) indicates, once we solve for the level of public investment, the future income tax rate is determined endogenously.

Substituting the constraints of (5.22) and (5.9) into (5.23), we get

$$\begin{aligned} F = {} & (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot (X^{ex})^{\eta_a+\eta_b-2} \cdot a^{\eta_a-1} \cdot b^{\eta_a+\eta_b-1} \\ & \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_a+\eta_b-1)} - \delta \cdot G \cdot (1+i^*) \cdot E_t(S_{t+1}) \end{aligned} \tag{5.24}$$

Now solving (5.24), we get[98]

$$G_t^{1-\mu-a-b} = \frac{a^a \cdot b \cdot A \cdot (X^{ex})^{a+b}}{\left[\frac{\delta}{\mu} \cdot (1-a-b) \cdot E_t(S_{t+1}) \cdot (1+i^*)\right]^{1-a-b} \cdot (1+i^l)^a} \cdot \frac{1}{w} \tag{5.25}$$

(5.25) is the public investment supply function. It can also be regarded as the reaction function of the fiscal authority, which determines the optimal value of government investment given a certain wage rate decided by the trade union.

Because we have assumed that $a + b + \mu < 1$, it is clear that from (5.25) we can obtain

[98] By taking the derivative of F with respective to G_t, we get the first order condition. It is easy to verify $\frac{\partial^2 F}{\partial G_t^2} < 0$.

$$\frac{\partial G_t}{\partial w} < 0 \qquad (5.26)$$

Thus the government will respond to a wage rise by cutting government investment. The intuition of this result is as follows.

An increase in the wage will depress total output, ceteris paribus. The government should increase government investment to compensate for the shortfall in output. However, meanwhile, the wage increase will also depress overall labor income. From the previous section, we can calculate the labor income in terms of w;

$$wl_t = (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a - 1} \cdot b^{\eta_b} \cdot (1 + i^l)^{-(\eta_a - 1)} \cdot w^{-(\eta_b - 1)} \qquad (5.27)$$

and it is clear that

$$\frac{\partial (wl_t)}{\partial w} < 0 \qquad (5.28)$$

Thus to hold the same income tax ratio fixed, the government will need to cut government investment. There are two offsetting forces determining the direction of government investment. In the face of a rise in wage, condition (5.28) implies that the government needs to reduce investment more due to the tax distortion effect than it needs to increase investment due to the output effect.

The outcome demonstrates that the fiscal authority will use government expenditure as a bargaining tool against the trade union. When the trade union threatens to increase the wage, the government will respond by reducing public investment. Total output and labor income will thus decline, which erodes the initial benefit to the trade union of raising the wage.

5.3.4 Trade union

The trade union's optimization problem is the same as in the previous chapter, except that here it is the after-tax income that enters the union member's utility function. The trade union chooses the wage rate that maximizes the union members' utility function:

$$U_T = \ln[w \cdot l_t \cdot (1 - \tau)] - \alpha \cdot l_t \qquad (5.29)$$

where wl_t is the labor income and α is a positive parameter.

As the tax rate is endogenous and determined by both government investment and wage, we replace t by (5.22). Putting in the firm's optimal level of labor demand from (5.8), we get

$$\begin{aligned} U_T = \ln\Big[& w \cdot (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \\ & \cdot (1+i^1)^{-(\eta_a-1)} \cdot w^{-\eta_b} - G_t \cdot (1+i^1)\Big] \\ & - \alpha \cdot (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \\ & \cdot (1+i^1)^{-(\eta_a-1)} \cdot w^{-\eta_b} \end{aligned} \tag{5.30}$$

$$\begin{aligned} & \frac{\partial U_T}{\partial w} = 0 \quad \Rightarrow \\ & w \cdot b = (\alpha - a\alpha) \cdot w^{-(\eta_b-1)} \cdot Q - G_t \cdot (1+i^1) \cdot (\alpha - a\alpha) \end{aligned} \tag{5.31}$$

where

$$Q = (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b} \cdot (1+i^1)^{-(\eta_a-1)} \tag{5.32}$$

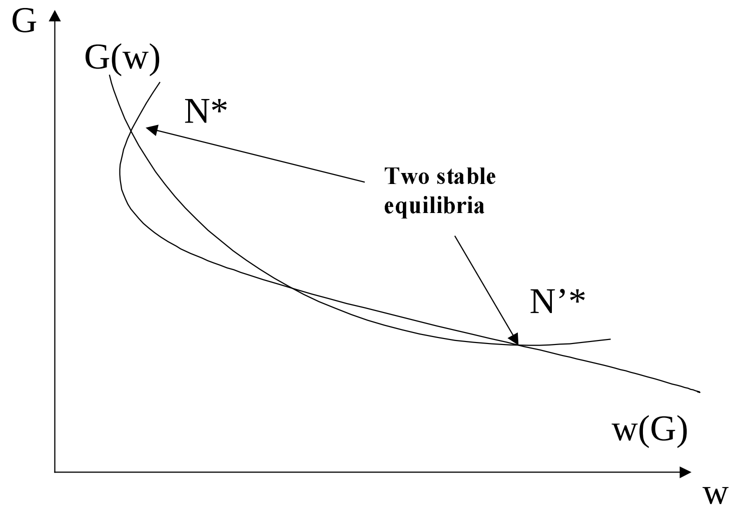
(5.31) is the trade union's reaction function to government investment, $w(G_t)$, which is also the implicit wage function. Compared with the wage function in chapter 4, government investment is an additional determinant here. It is impossible to transform (5.31) into such a format that wage w can be expressed explicitly in terms of government investment, G_t.

The expectations of the future exchange rate and international interest rate, as well as other parameters, such as α and μ, will determine the shape of the trade union's reaction function.

From (5.26), we know that the fiscal authority always reacts negatively to a wage rise, as $\frac{\partial G_t(w)}{\partial w} < 0$. Thus the fiscal authority's reaction function, $G_t(w)$, is downward-sloped and convex. The shape of the trade union's reaction function, $w(G_t)$, is unknown, as $\text{sign}\left(\frac{\partial w(G_t)}{\partial G_t}\right)$ is ambiguous. It could be positive or negative. The slope of the trade union's reaction function is an important determinant for the possibility of a single unique equilibrium, multiple equilibria, or no equilibrium at all, for the outcomes of the Nash game between fiscal authority and trade union.

The following chart shows that there could be two stable equilibria if the slope of the reaction function $w(G_t)$ changes from positive to negative. The two reaction functions intersect at three points. There are two stable equilibria and a multiplicity of equilibrium wage and government investment.

Figure 5.2 **Possibility of multiple equilibria**



Source: OECD.

The multiple equilibria already in the stage of wage and fiscal policy determination create uncertainty and extra channels for multiple equilibria in exchange rate policies. A change in the expectations of the future exchange rate could thus lead to multiple results not only for real exchange rates, as shown in the previous chapters, but also for the wage and government investment.

5.4 Wage negotiation, fiscal policy and currency crises

We now have a Nash non-cooperative game between the government and trade union in determining the equilibrium values of the wage and fiscal expenditure. The trade union decides the wage and the government decides public investment, given each other's decisions. The equilibrium values for the wage and fiscal expenditure can be found jointly.

We have already deduced the reaction functions for the two players in the proceeding sections. The government's reaction function is (5.25) and the trade union's reaction function is (5.31). We can solve these two equations jointly and obtain optimal values of government investment, G_t, and the wage rate, w, in terms of the international interest rate, i*, and expected exchange rate, $E_t(S_{t+1})$. However, the reaction functions are highly nonlinear and the solutions for equilibrium values are intractable.

In order to make the model solvable and obtain a closed form solution, we make a simplification concerning the fiscal authority's behaviour rule: we assume that the optimal income tax rate is known to both the government and trade union, and the government must commit to it. This assumption can also be supported by empirical observations, as it is difficult to change the predetermined tax rate path. Thus, in the following sections, the tax rate is assumed to be exogenous ($\tau = T$).

Thus the total tax revenue will vary solely according to the labor income, which depends partly on government expenditure. On the other hand, under the balanced budget constraint, the government expenditure must equal the total tax revenue. The assumption of an exogenous tax ratio has important implications for the outcome of the Nash game, especially concerning the behavior of the trade union, as we are able to deduce explicitly the optimal wage decision by the trade union in terms of government expenditure.

5.4.1 Fiscal authority under a predetermined tax rate

When the tax rate is predetermined and exogenous, we can replace wl_t in (5.22) by (5.27), and express G_t in terms of w directly:

$$G_t^{1-a-b-\mu} = \frac{T^{1-a-b} \cdot A \cdot \left(\frac{a^2}{1-b}\right)^a \cdot b^{1-a} \cdot X^{ex}}{\left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{1-b}} \cdot \frac{1}{w^b} \tag{5.33}$$

Comparing (5.33) with (5.25), we find that the reaction functions have similar structures and characteristics. In particular

$$\frac{\partial G_t}{\partial w} < 0, \quad \frac{\partial G_t}{\partial i^1} < 0, \quad \frac{\partial G_t}{\partial i^*} < 0 \tag{5.34}$$

The result that government expenditure is related negatively to borrowing costs is fairly conventional. And government expenditure reacts negatively to an increase in wage. However, the mechanism by which fiscal expenditure respond to an increase in the wage is different. When the government has a predetermined tax rate, it must conduct fiscal policy solely via government investment. The government's decision on government investment is tightly related to the total labor income. An increase in the wage will have an overall dampening effect on total labor income, as shown in (5.28). This is a critical condition for (5.34), as a higher wage will depress overall labor income via its effect on total labor demand. Thus the overall income tax revenue is smaller, given the tax rate. Thus the government must cut government investment in order to balance the budget. This means that the government must reduce government investment if the trade union demands a higher wage. If the tax rate is endogenous, an increase in wage will have two opposing effects: one is to increase government expenditure to boost output and the other is to decrease government expenditure to reduce tax distortion. Only because the need to reduce tax distortion dominates the need to boost output do we have the same outcome, ie that government expenditure relates negatively to an increase in wage.

5.4.2 Trade union under a predetermined tax rate

The trade union's optimization problem now is to choose a wage rate that maximizes the union members' utility function under a predetermined tax rate, T:

$$U_T = \ln\left[w \cdot l_t \cdot (1-T)\right] - \alpha \cdot l_t \qquad (5.35)$$

where T is the exogenous income tax rate.

Substituting the firm's optimal level of labor demand from (5.8) into (5.35) and solving the first-order condition, we get

$$w = \frac{b^{\frac{b}{1-a}} \cdot (\alpha - a \cdot \alpha)^{\frac{1-a-b}{1-a}} \cdot \left(\frac{a^2}{1-b}\right)^{\frac{a}{1-a}} (A \cdot X^{ex})^{\frac{1}{1-a}}}{\left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{\frac{a}{1-a}}} \cdot G_t^{\frac{\mu}{1-a}} \qquad (5.36)$$

From (5.36), we deduce

$$\frac{\partial w}{\partial G_t} > 0, \quad \frac{\partial w}{\partial E_t(S_{t+1})} > 0, \quad \frac{\partial w}{\partial i^l} < 0, \quad \frac{\partial w}{\partial i^*} < 0 \tag{5.37}$$

When the tax rate is endogenous, an increase in government investment has three separate effects on wage determination. First it stimulates total output and profit for the firm, whose enhanced profitability provides the trade union an opportunity to demand a higher wage. Second it increases taxation and, third, it increases labor demand and hence disutility. The first impact tends to increase the wage, whereas the second and third impacts dampen the wage. The overall impact is ambiguous. There are several possible outcomes of the Nash game, as discussed in the previous section.

When the tax rate is exogenous, there is no second impact from taxation, and we get the unambiguous result that the first impact dominates the third: the trade union demands a higher wage when the government increases government investment. Thus the trade union's decision on the wage rate will vary with government investment.

The trade union will demand a higher wage rate if the expected future exchange rate is higher, because the larger the expected devaluation, the higher the production level. In addition, a larger devaluation in the later period will boost the firm's profitability, which enables the trade union to demand a higher wage. Thus the trade union's decision on the wage will vary with the expected exchange rate.

It is straightforward from (5.37) to show that the wage rate is related negatively to the lending rate. As a higher lending rate dampens both the firm's production and profit, it also reduces the trade union's ability to bargain for a higher wage.

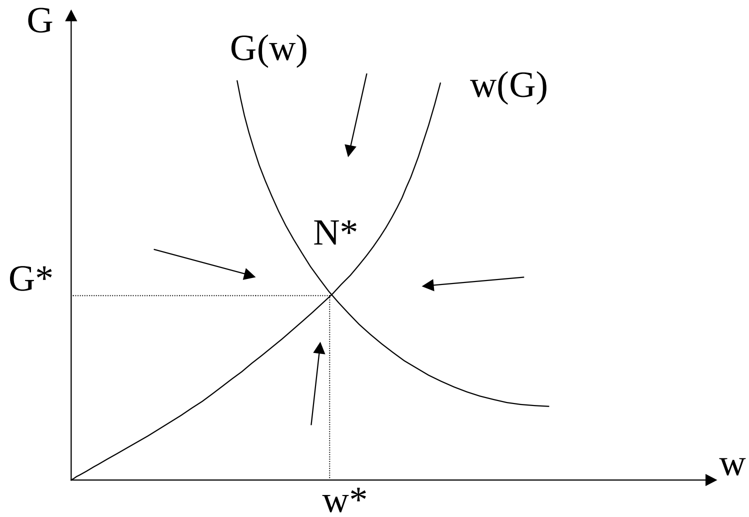
Replacing w on the right hand of (5.27) by (5.36), we get the equilibrium labor income:

$$(w \cdot l_t)^* = (\alpha - a\alpha)^{\frac{-b}{1-a}} \cdot b^{\frac{1-a+b}{1-a}} \cdot (A \cdot G_t{}^{\mu} \cdot X^{ex})^{\frac{1}{1-a}} \cdot \left(\frac{a}{1+i^l}\right)^{\frac{a}{1-a}} \tag{5.38}$$

5.4.3 Equilibria of government investment and wage

Now we have two explicit reaction functions: The government's reaction function, from (5.33), and the trade union's reaction function is from (5.36). As noted earlier, government investment is negatively related to wage increases, whereas the wage is always positively related to government investment. By the assumption that $a + \mu < 1$, we get a unique and stable equilibrium set of wage and government investment. The equilibrium is shown in the following chart.

Figure 5.3 **Reaction functions of the government and trade union**



Source: OECD.

If the government intends to raise government investment, the trade union will react by raising the wage to share the benefit of rising production and profits. However, the rise in the wage will depress private investment and labor demand as well as total labor income. Facing a fixed labor income tax, the government must reduce its investment in order to balance the government budget in the later stage. Thus there is a bargaining process between the trade union and the government. Finally an equilibrium combination of wage and government investment can be found, at N* in the chart.

Solving (5.33) and (5.36), we get the equilibrium value for government investment and wage

$$G^* = \sqrt[1-a-\mu]{\frac{T^{1-a} \cdot \left(\frac{a^2}{1-b}\right)^a \cdot b^{1-a+b} \cdot A \cdot X^{ex}}{(\alpha - a \cdot \alpha)^b \cdot E_t(S_{t+1}) \cdot (1+i^*)}} \qquad (5.39)$$

and

$$w^* = \sqrt[1-a-\mu]{\frac{T^{\mu} \cdot b^{b+\mu} \cdot (\alpha - a \cdot \alpha)^{1-a-b-\mu} \cdot \left(\frac{a^2}{1-b}\right)^{a} \cdot (A \cdot X^{ex})}{\left[E_t(S_{t+1}) \cdot (1+i^*)\right]^{a+\mu}}} \tag{5.40}$$

The equilibrium values of government investment and wage have the following characteristics.

First of all, a larger T means that when the income tax rate or revenue in the future is larger both the current government expenditure and wage demand will be higher

$$\frac{\partial G_t}{\partial T} > 0, \quad \frac{\partial w}{\partial T} > 0 \tag{5.41}$$

When the future government revenue is expected to be higher, current government investment will increase, as will the wage demand.

A higher international interest rate, i*, means that the wage demand will be lower and the government expenditure should also be lower

$$\frac{\partial w}{\partial i^*} < 0, \quad \frac{\partial G_t}{\partial i^*} < 0 \tag{5.42}$$

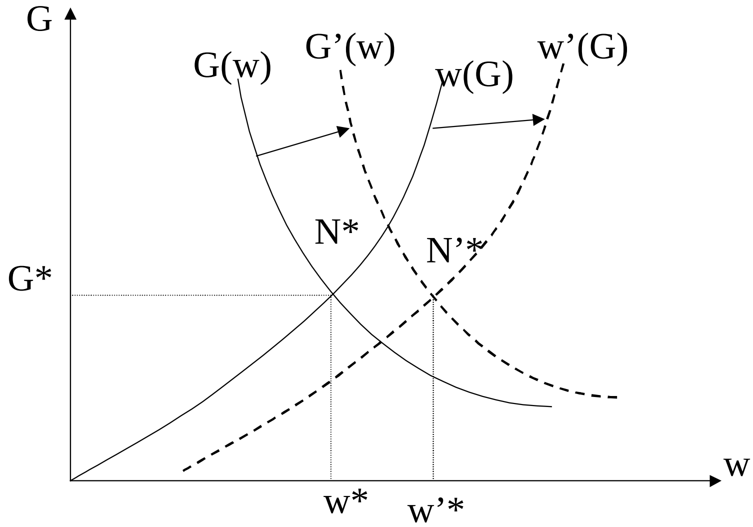
The above results demonstrate that when international interest rates rise the government should respond by cutting the fiscal expenditure simultaneously, and the wage should decline.

Finally, and most significantly, the wage is positively related to the increased devaluation expectations;

$$\frac{\partial w}{\partial E_t(S_{t+1})} > 0 \tag{5.43}$$

but the relation between government expenditure and devaluation expectations is ambiguous: It can be positive, negative or even constant, depending on the parameters Φ and λ^*.

Figure 5.4 **When devaluation expectations increase**



Source: OECD.

When

$$E_t(S_{t+1}) \geq \sqrt{\frac{\lambda^*}{\phi}} \tag{5.44}$$

$$\frac{\partial G}{\partial E_t(S_{t+1})} \geq 0. \tag{5.45}$$

The initial openness of the economy, as well as the open sector's sensitivity to devaluation, are important determinants of the relation between the expected exchange rate and fiscal expenditure. Both λ^* and Φ are exogenous parameters. When expectations of the future exchange rate exceed this threshed, fiscal expenditure will increase with the expected exchange rate.

Thus when devaluation expectations intensify, the interaction between fiscal authority and trade union will result in a higher wage and an uncertain (in direction) change in government expenditure. Thus when devaluation expectations increase, the wage will always rise but public investment will not necessarily change. If the expected devaluation does not exceed the threshold as shown in (5.44), public investment will decease or remain constant in response to a rise in devaluation expectations. Then the expectations of devaluation will result in an increase in the wage but a decrease in public investment.

Both of these two developments will result in a deterioration in business sector profits. This will pressure the central bank to devaluate the currency, which in turn will vindicate the initial expectations of devaluation. Thus there is a devaluation expectation-wage-devaluation dynamic mechanism at work in the model, in contrast to the original wage-devaluation spiral in Horn and Persson (1988). Fiscal policy is powerless in breaking this devaluation expectations-wage-devaluation spiral.

On the other hand, when the expected devaluation exceeds the threshold shown in (5.44), public investment will also increase, compensating the adverse impact of a rise in the wage on private sector profit. The overall impact of a rise in the wage and public investment on private sector profit is ambiguous. When the impact of public investment dominates that of a wage increase, the overall effect is an increase in profit, and there is no need for the central bank to devalue. In this case, public investment can break the devaluation expectations-wage-devaluation spiral.

5.4.4 Fiscal policy and exchange rate determination

The central bank's optimization problem is to minimize its loss function by choosing an optimal exchange rate:

$$L_{CB} = \frac{\theta}{2}(S_{t+1}-1)^2 + \frac{1}{2}\left\{ \begin{array}{l} (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a+\eta_b-1} \cdot a^{\eta_a-1} \cdot b^{\eta_b-1} \cdot (1+i^l)^{-(\eta_a-1)} \cdot w^{-(\eta_b-1)} \cdot \\ \left[\left[\frac{X}{X^{ex}} - \frac{a^2}{1-b} \cdot \frac{S_{t+1}}{E_t(S_{t+1})} - b\right] + d \cdot \left[S_{t+1} \cdot (1+i^*) - (1+i^d)\right] - \Omega^* \right. \end{array} \right\}^2 \quad (5.46)$$

From the above equation we can solve for an equilibrium value, S*, for the central bank. In general, given the second-order condition, we can express the central bank's decision on the future exchange rate in terms of the international interest rate, expected exchange rate, wage and public investment, that is, $S^* = f(i^*, w, G_t, E(S_{t+1}))$.

In order to illustrate the main results explicitly, we now look at the simple case in which the central bank is concerned only with the profit of the firm as discussed in the previous chapter. We apply the same simplification, ie that X is equal to S_{t+1}. Then the central bank's loss function is

$$L_{CB} = \frac{\theta}{2}(S_{t+1} - 1)^2 + \frac{\xi^2}{2}\left[(S_{t+1} - (a+b) \cdot E_t(S_{t+1})^2) \cdot E_t(S_{t+1})^{\eta_b - 1} - (1 - a - b)\right]^2 \tag{5.47}$$

where

$$\xi = \frac{(A \cdot G^{\mu})^{\eta_a + \eta_b - 1} \cdot a^{2(\eta_a - 1)} \cdot b^{\eta_b - 1}}{\left[(1-b) \cdot (1+i^*)\right]^{\eta_a - 1} \cdot w^{\eta_b - 1}} \tag{5.48}$$

We get the equilibrium exchange rate for the central bank:

$$S^* = \frac{\theta + (a+b) \cdot \xi^2 \cdot E_t(S)^{2+2(\eta_b - 1)} + (1-a-b) \cdot \xi^2 \cdot E_t(S)^{\eta_b - 1}}{\theta + \xi^2 \cdot E_t(S)^{2(\eta_b - 1)}} \tag{5.49}$$

We have

$$\frac{\partial S^*}{\partial(\xi^2)} > 0 \tag{5.50}$$

when

$$(a+b) \cdot E_t(S_{t+1})^2 + (1-a-b) \cdot E_t(S_{t+1})^{\eta_b - 1} > 1 \tag{5.51}$$

This is also the condition for

$$\frac{\partial S^*}{\partial G} > 0 \tag{5.52}$$

Thus the central bank’s policy on the exchange rate depends also on fiscal expenditure. The equilibrium exchange rate will be positively linked with fiscal expenditure as long as condition (5.51) holds. All looser fiscal stance under this condition will prompt the central bank to devalue by a larger amount.

In conclusion, the introduction of fiscal policy creates a channel for countering the effect of a wage increase. Under the strategic game framework, if the fiscal authority decides to reduce government investment, it can directly moderate wage demands, but output is also reduced as a result. On the other hand, moderation of wage demand will induce the fiscal authority to raise government investment. Thus a reduction in government investment will directly lower production but indirectly boost production via a reduction in the wage. Most importantly, both government expenditure and wage are positively related to increased devaluation expectations. When devaluation expectations intensify, the interaction between fiscal authority and trade union will result in a higher wage, but an ambiguous change in government expenditure. All these impacts will have effects on the central bank's policy on the exchange rate, as the overall impact of a combination of higher interest rates, higher wages and output can result in an eventual deterioration in profits for the business sector. The central bank may be willing or forced to devalue in order to keep a satisfactory level of profits for the business sector.[99]

[99] This discussion of the central bank's optimal policy on exchange rates resembles that of chapter 4.

Appendix 5.1

Here we depart from the above assumption and take into consideration the financial structures concerned. The banking sector in a small open country will charge domestic borrowers a premium over the world interest rate. The premium is larger than the exchange rate risk. Fiscal policy actually has an important role to play in influencing this critical premium. So fiscal policy can also influence interest rates and have 'crowd-out' effects on investment in a small open economy.

The bank's ex ante profit function is

$$\Omega_b^e = (L_t + GB) \cdot (1 + i^l) - d_t \cdot (1 + i^d) - B_t^* \cdot E_t(S_{t+1}) \cdot (1 + i^*) \tag{A5.1}$$

where GB is the government bond issue and B* the foreign borrowing, which is denominated in foreign currency. The bank is assumed to buy the government bonds as an investment.

Capital market equilibrium in period t requires

$$B_t^* = L_t + GB - d_t \tag{A5.2}$$

Inserting (5.7) and (A5.2) into (A5.1), we get

$$\begin{aligned}\Omega_b^e = &\left[(A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a} \cdot b^{\eta_b - 1} \cdot (1 + i^l)^{-\eta_a} \cdot w^{-(\eta_b - 1)} + G\right] \\ &\cdot \left[(1 + i^l) - E_t(S_{t+1}) \cdot (1 + i^*)\right] + d_t \cdot \left[E_t(S_{t+1}) \cdot (1 + i^*) - (1 + i^d)\right]\end{aligned} \tag{A5.3}$$

As GB=B in the government budget constraint in the first period, the bank solves the maximization problem, yielding

$$\begin{aligned}&\left[a + (-1 + b) \cdot \frac{E_t(S_{t+1}) \cdot (1 + i^*)}{1 + i^l}\right] \cdot (A \cdot G_t^{\mu} \cdot X^{ex})^{\eta_a + \eta_b - 1} \cdot a^{\eta_a} \\ &\cdot b^{\eta_b - 1} \cdot (1 + i^l)^{-\eta_a} \cdot w^{-(\eta_b - 1)} \\ &= G \cdot (1 - a - b)\end{aligned} \tag{A5.4}$$

It is difficult to express i^l explicitly by solving the above equation. By assuming a = b = 1/3, we can express (A5.4) as

$$\begin{aligned}&27 \cdot G \cdot w \cdot (1 + i^l)^3 - \left(A \cdot G \cdot X^{ex}\right)^3 \cdot (1 + i^l) \\ &+ (A \cdot G \cdot X^{ex})^3 \cdot \left[E_t(S_{t+1}) \cdot (1 + i^*)\right] = 0\end{aligned} \tag{A5.5}$$

We can solve this equation to get

$$1+i^{1}=\frac{\left(\frac{2}{3}\right)^{\frac{1}{3}}}{\sqrt{\frac{27\cdot G\cdot w}{(A\cdot G\cdot X^{ex})^{3}}}\cdot C}+\frac{C}{2^{\frac{1}{3}}\cdot 3^{\frac{2}{3}}\cdot\sqrt{\frac{27\cdot G\cdot w}{(A\cdot G\cdot X^{ex})^{3}}}} \quad \text{(A5.6)}$$

where

$$C=\left(-9\cdot\sqrt{\frac{27\cdot G\cdot w}{(A\cdot G\cdot X^{ex})^{3}}}\cdot E_{t}(S_{t+1})\cdot(1+i^{*}) + \sqrt{3}\cdot\sqrt{-4+27\cdot\frac{27\cdot G\cdot w}{(A\cdot G\cdot X^{ex})^{3}}E_{t}(S_{t+1})^{2}\cdot(1+i^{*})^{2}}\right)^{\frac{1}{3}} \quad \text{(A5.7)}$$

(A5.6) simply becomes intractable.

Since we know L_t from equation (5.7), we can express (A5.4) as

$$\left[a+(-1+b)\cdot\frac{E_{t}(S_{t+1})\cdot(1+i^{*})}{1+i^{1}}\right]\cdot L_{t}=G\cdot(1-a-b) \quad \text{(A5.8)}$$

Rearranging (A5.8), we get

$$1+i^{1}=\frac{L_{t}\cdot(1-b)\cdot E_{t}(S_{t+1})\cdot(1+i^{*})}{a\cdot L_{t}-G\cdot(1-a-b)} \quad \text{(A5.9)}$$

Compare this result with that without a government sector, ie with G_t equal to zero. Then (A5.9) reduces to

$$1+i^{1}=\frac{(1-b)\cdot E_{t}(S_{t+1})\cdot(1+i^{*})}{a} \quad \text{(A5.10)}$$

When G_t is greater than zero, the interest rate is higher than in the case without a fiscal authority, given the private investment. That is

$$\frac{\partial i^{1}}{\partial G}>0 \quad \text{(A5.11)}$$

(A6.9) can also be expressed as

$$1 + i^l = \frac{(1-b) \cdot E_t(S_{t+1}) \cdot (1+i^*)}{a - G/L_t \cdot (1-a-b)} \quad \text{(A5.12)}$$

Then we have

$$\frac{\partial i^l}{\partial (G/L_t)} > 0 \quad \text{(A5.13)}$$

Thus the lending rate relates positively to the ratio of government investment to private investment. When this ratio increases, the lending rate also increases. There is a ‘crowding out’ effect on fiscal expenditure.

6 Concluding remarks

Traditional currency crisis models are rather vague about micro-foundations in explaining the logic of crises. The strategic interaction of private agents, particularly an optimizing banking sector, is often abstracted from the general framework in second-generation currency crisis models, as in Obstfeld (1994). Although recent models, such as Velasco and Chang (1999), model currency crises by stressing the role of the banking sector, they explain currency crises as liquidity crises and are more like the bank-run type pioneered by Diamond and Dybvig (1983). Macroeconomic variables and the central bank's optimal decision are not considered.

This study is an attempt to fill this gap. The model in this study extends the standard currency crisis theory (especially the second-generation models) by adding and emphasizing strategic interactions of economic agents in anticipating currency crises. In particular, the model focuses on the role of an endogenous banking sector in determining interest rates, which has important implications for the central bank's decision on the exchange rate. Thus this study also attempts to combine the literature of currency crisis theory with that of the banking sector's role in macroeconomics.

In addition, this study makes an effort to incorporate imperfectly competitive labor markets and the involvement of fiscal policy in wage bargaining into currency crisis models. Trade unions' bargaining power and marginal labor disutility, as well as different time sequences of actions between trade union and business sector make a difference in the equilibrium exchange rate. The interaction between trade union and fiscal authority can produce a 'wage-devaluation' spiral under certain conditions.

The logic of currency crises is as follow. The exchange rate and private sector expectations thereof will affect private sector profitability. The overall impacts of a devaluation on private sector profits depend on a tradeoff between benefits to the open sector and costs to foreign debt holders. In addition, both the trade union's optimal decisions on wage and government's fiscal policy can influence the overall profits of the private sector. The central bank's exchange rate decision is based on this tradeoff and is ultimately a function of private sector expectations of the exchange rate and international interest rates, as well as wages and fiscal spending. The nonlinearity of the solutions results in multiple equilibria for exchange rates.

The policy implications highlighted by the theoretical model in this study are manifold.

Firstly, the banking sector plays a key role in transmitting monetary policy in the economy. Under a pegged exchange rate regime, expectations of the future exchange rate, which also measures the confidence of the private sector in the peg, will be incorporated into the banking sector's decision on interest rates. Larger devaluation expectations represent a higher risk premium for the banking sector, which will raise the interest rates on lending to firms. High interest rates in the economy dampen economic activity and private sector profitability.

Secondly, the central bank gives up defending the pegged exchange rate system but not because of depletion of foreign exchange reserves or pure desperation. Devaluation is sometimes considered a way of increasing competitiveness. To continue defending the currency peg would exaggerate the recession. Under a pegged exchange rate system, the central bank always faces a dilemma in deciding whether or not to defend the peg when there is a big shock to the economy.

Thirdly, overexpansion in bank lending, often as a result of overoptimistic expectations, could make the economy vulnerable to currency crises. If consumers overestimate their future incomes, they will consume more already in the current period due to consumption smoothing. The increase in demand will in turn prompt the firm to expand production and investment. The resultant rapid credit expansion and overindebtedness (particularly foreign debt) make the economy vulnerable to both interest rate and balance of payment shocks. The subsequent rash of bankruptcies and severe credit crunch reveal how disruptive free mobility of capital can be.

Fourthly, a highly centralized wage bargaining institution could have important implications for currency crises. The bargaining power of the trade union also has a significant impact. In an adverse situation, an economy can gain competitiveness through either devaluation or a reduction in labor costs. However, when the trade union has strong bargaining power, the wage bargaining outcome will be less flexible. Thus devaluation may be the only option for improving international competitiveness. In general, a higher wage demand will make the task of defending a pegged exchange rate system more difficult.

Finally, fiscal policy also has significant implications for the defense of a pegged exchange rate system. As discussed earlier, when the monetary policy has lost power in macroeconomic management, fiscal policy can play a useful role. In Finland, the government plays an active role in the wage bargaining process. Under some circumstances, the fiscal authority is able to moderate the trade union's demand on wages via certain fiscal measures. Thus the involvement of the government in the wage bargaining process between employee and employer organizations allows fiscal policy to play a role in wage bargaining as well.

There have been many incidences of currency crisis around the world over the past several decades. Each currency crisis has its own features and special characteristics. In addition, the economies involved have some unique institutions. Some of the assumptions made in this study are based on the Finnish situation. The main stylized facts of the Finnish crisis that are highlighted in this study include the price stickiness in the face of a huge devaluation after the crisis, the widening of the interest rate spread during the crisis, the traditional policy priority of focusing on competitiveness, as well as a centralized wage bargaining framework. These represent the assumptions made in the models, which are rather distinct from other currency crisis models in the literature.

In relation to the Finnish currency crisis, the financial deregulation that occurred during the course of the 1980s resulted in a boom in domestic bank lending. Foreign borrowing was an important means of satisfying the growing appetites of domestic borrowers. Finnish households and firms accumulated a large amount of debt including substantial debt denominated in foreign currencies in the late 1980s. The debt seemed harmless as long as the Finnish economy maintained its rapid growth momentum. Foreign debt was as manageable as domestic debt, assuming that the promise of a pegged exchange rate regime would be kept.

Then came the external shocks. The rise in interest rates at the end of the 1980s was due to both the internal factor of an overheating economy and the external shock of tight monetary policy in Germany, a core EMS country.[100] In the beginning of the 1990s, the Finnish economy was already in a recession. The pegged exchange rate system induced speculative attacks on the Finnish markka, as private sector's expectations on devaluation intensified. Domestic interest rates shot up, induced by a higher risk premium due to the heightening

[100] The collapse of the Soviet trade was an additional shock to the economy. The pure export shock may not be sufficient to explain the extent to which the economy collapsed. However, this trade shock which resulted in a widening of currency account deficits had strong psychological effects on the financial markets. The subsequent devaluation expectations might also have pushed up domestic interest rates.

of devaluation expectations. As deposit rates were rather stable, the interest rate spread widened substantially. The consequences of the credit crunch in Finland were the collapse of asset prices, the deterioration of profitability in both the financial and enterprise sectors, and the threat of massive bankruptcy.

Due to a highly unionized labor market and a centralized wage bargaining structure in Finland, the trade union's bargaining power was very strong. Negotiations over wage reductions met with difficulties. The government's fiscal policy might have provided some incentives for a more favorable wage negotiation outcome, but unfavorable developments in the economy constrained the government's choices.

Under a recession, the economic as well as political costs of defending the pegged exchange rate regime were simply regarded as too high by the policymakers. For the peg to hold, interest rates would have had to be high enough to compensate for devaluation expectations. The export sector could not gain cost competitiveness, and the profitability of the business sector would continue to deteriorate. Thus a large devaluation of the currency was regarded as a way of starting the economy on an export-led recovery.[101] Thus the Bank of Finland had to let the markka float freely in September of 1992, which validated the devaluation expectations in the first place.

The typical reason for devaluation in the literature is the need to boost economic activity and reduce unemployment or to reduce the real public debt by means of inflation. Here another explanation is provided, which may be more relevant in the context of Finland in 1992. The deterioration of business profitability brought the threat of a rash of bankruptcies, which put political pressure on Finnish policymakers. Despite the fact that the domestic sector was heavily indebted and devaluation would further increase the debt burden, the Bank of Finland had to consider the consequences of profit deterioration in the open sector. The decision on devaluation is the outcome of competing and sometimes conflicting interests between the sheltered and open sectors.

The best thing a central bank can do to maintain a pegged exchange rate system is to reduce the vulnerability of the whole economic system beforehand. Preemptive tightening of monetary policy, elaborate supervision of financial institutions, proper fiscal

[101] In retrospect, it was precisely the export-led recovery that led the Finnish economy to recovery, albeit it was a painful and slow process.

policy and flexible labor markets are important factors for maintaining a pegged exchange rate system. Of course, some of these things are not central bank responsibilities, and the coordination of these economic policies becomes pivotal.

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