What are The Costs and Benefits of Currency Boards?

Master Thesis

To gain the degree of a holder of Master of Arts
at the School of Economics and Business Administration at
Humboldt-University at Berlin

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Examiner: Prof. Dr. Harald Uhlig

Berlin, Oktober 16th 2003

Abstract

The question of fixed or flexible, when it comes to exchange rate policy, has been an open one for all of the modern economic thought history. State of the art literature findings have been applied in practice, with more or less of success. In this paper I am giving a review of what the answers to this famous question might be, in a particular case of exchange rate policy, the monetary board. The model is presented, which provides proof that a one sided peg, hence a monetary board, contrary to common belief, is an optimal policy since it actually increases the nominal prices flexibility, this being the ultimate goal of the exchange rate policy in the first place. Solving this dilemma, the paper then turns to deal with the problems a monetary board might face in practice, mainly self-fulfilling crisis or the speculative attack risk. Again a model is provided proving that, currency crisis are showing a self-fulfilling character. Finally some conclusions, in the form of warnings and advices, are presented for countries pursuing monetary boards as their exchange rate policies.

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1. Introduction

The exchange rate policy is a part of monetary policy, which has proven to be one, that neither literature nor practice can draw a final conclusion on. After the Bretton Woods system collapse, the countries have implemented a range of exchange rate policies from fully flexible, crawling pegs, soft pegs, to hard pegs and monetary boards. None of these systems has proven to be the optimal one so that the search for optimality goes on. It is not only that the literature and practice can not agree on what the optimal exchange rate policy should be, but the practice itself often witnesses the cases where countries are choosing one policy, for example hard peg, but are actually practising its opposite, that is flexible exchange rate policy, and vice versa[1].

The argument for flexible exchange rate policy is usually one about its ability to compensate for the nominal prices rigidity and in that way alleviate external shocks to the economy. The fixed exchange rate policy defenders contradict these arguments by asking weather and to what extent there is a pass through from exchange rates to final consumers prices. They also argue that even if the effect of foreign shock alleviation does exist, it is to small and compensated by the benefits that the fixed exchange rate brings about, such as increased foreign trade and capital flows, due to increased predictability, and increased credibility in case of the emerging markets. All these aspects will be commented on in the section of the literature on exchange rate policy review.

The problem of the exchange rate policy is especially important for the countries opting for the fixed exchange rate regime, in form of a currency peg or a monetary board, because for them the exchange rate policy effectively means giving up on discretionary monetary policy, hence turning it into the ultimate monetary policy the country is perusing. In these circumstances I find the question of optimality of a monetary board as the form of monetary policy, of ultimate importance for the countries perusing it

[1] See papers by Reinhart and Rogoff (2002), Calvo and Reinhart (2002), and Alesina and Wagner (2003).

or taking steps in that direction. Currency boards have been, with more or less success and in different modifications, introduced in several countries in the world. Argentina has adopted it in 1991, Estonia in 1992, Lithuania in 1994, Bosnia and Herzegovina in 1997 and Bulgaria in 1997. Hong Kong is pursuing this policy with recurrent modifications for much of its recent 50 years history. Other countries, such as Indonesia, are taking steps or considering an introduction of a currency board.

Given the interest to pursue the question of costs and benefits of a currency board, two further questions arise. The first one is weather and why a monetary board, as a form of fixed exchange rate policy, should be perused at all. The second one is, whether, if optimal, this policy is feasible in practice. This paper answers the first question with a yes, the reason being that the fixed exchange rate, when fixed only on one side, increases nominal price flexibility, and therefore 'beats' flexible exchange rate with its own tools. This point is supported by using the model, developed by Michael Devereux in his recent paper, see Devereux (2003). To the second question a more complex answer is offered. The problem of a self-fulfilling currency crisis is recognized, and also various macroeconomic issues that render a monetary board infeasible in the long term. The self-fulfilling character of a currency crisis is proven using two models by Maurice Obstfeld (see Obstfeld 1994, and 1995). The first model is a simple version of the limited foreign currency reserves model, and the second one is fully articulated, government and agents optimizing model, both proving the point of the self-fulfillingness problem of the currency crisis. Other macroeconomic issues, that lead to the inevitable monetary board collapse, are discussed, lack of foreign currency reserves, inconsistent fiscal policy, inconsistent capital controls, inconsistent interest rates policy, high and / or growing unemployment. It also concluded that if certain criteria are met, monetary boards can be, and are an optimal policy for specific countries.

The paper is organized as follows: section two gives a brief overview of what modern economic literature has to say about the matter of optimal exchange rate policy. Section three presents some facts about monetary

boards implementation in the practice. Section four outlines a mathematical model, designed by Michael B. Devereux, which provides proof that under certain circumstances, fixed exchange rate actually increases nominal price flexibility, hence achieving the ultimate goal of the flexible exchange rate, and thus proving its superiority over it. Section five builds further on the conclusion about fixed exchange rate policy optimality, by providing a discussion on, what problems implementation of the currency board, or fixed exchange rate policy or that matter, might arise in practice. Section six outlines two models, both by Maurice Obstfeld, proving that the currency crisis, recognized by this paper to be one of the main problem currency board implementation is dealing with in practice, have self-fulfilling character. Finally section seven provides some conclusions on what conditions should be met to make currency board an optimal exchange rate or monetary policy.

2. Exchange rate policy in the literature

The debate on the question of fixed or flexible, when it comes to optimal exchange rate policy, has been present in the literature since the very beginnings of the modern economic thought. With the collapse of the Bretton Woods agreement, support for flexible exchange rates started building up. One can find one of the first arguments in favour of flexible exchange rates in the work of Friedman (1953). The grounds of his argument were, that flexible exchange rates allow for foreign monetary shocks insulation, while fixing the exchange rate would force the monetary authority to accommodate the shock. Two assumptions underlie these conclusions, first one is that the nominal prices are fixed in the producer's currency, and the second one is that there is a substantial pass-through from exchange rates to consumer prices. Both assumptions have later been challenged in the literature. See for example Obstfeld and Rogoff (2000a), McCallum and Nelson (1999), Bergin (2001) and Corsetti and Dedola (2001), for some ideas on why exchange rate pass-through to consumer prices is low, as has been found in the data. For some evidence on local currency pricing predominance over producer's currency pricing, see Engel (1998) and Devereux and Engel (2001). Empirical studies on how pass-through is low, even when producer's currency pricing is predominant, is presented in a paper by Campa and Goldberg (2002). Further papers discuss how conclusions about optimal exchange rate policy dramatically change, when assumptions about currency of pricing is changed, see Devereux and Engel (1998), (1999) and (2000).

The question of fixed or flexible got more complicated with the inclusion of capital mobility and the taking into account of the fact that apart from monetary shocks, real shocks were also present in the economy. Taking this into account, Mundell (1960, 1961a, 1961b, 1963) showed that the answer is not straight forward, and that it depends on the extent capital and other factors mobility, weather the shocks are monetary or real and on the relative country size.

Both Friedman and Mundell were assuming that the nominal prices are sticky in the short run. This assumption validates the argument of shock insulation or accommodation. Many authors have later also tackled the question of exchange rate regime optimality, assuming nominal price or wage stickiness, with some of the starting ideas belonging to Fisher (1977), Weber (1981), Aizenman and Frenkel (1985), to name a few.

Approaches to answering the question have also been different. Some authors have chosen ad hoc criteria, a rule, such as output variance minimization or quadratic loss function that captures the inflation unemployment trade-off. Those include papers like ones mentioned above by Fisher, Weber, Aizenman and Frenkel and also papers by Kimbrough (1983), Glick and Wihlborg (1990), Edwards (1996). Others have taken the welfare maximization approach. Some works in this direction include ones by Lapan and Anders (1980), Helpman (1981), Aizenman (1994), Chinn and Miller (1998).

What the literature does agree on is the reason allowing for any importance of the flexible exchange rates is stickiness of nominal prices. By being sticky, nominal prices cannot adjust to the external real shocks, but if flexible exchange rates are introduced, they will allow for the flexibility lacking in nominal prices thus solving the problem of shocks alleviation. However, the debate in recent literature on the topic has been on weather the price stickiness appears in producers or in consumer's prices. Some recent evidence speaks for the case of consumers prices stickiness, finding that the consumer prices are not much affected by the nominal exchange rate changes, see papers by Engel (1993, 1999, 2000), Engel and Rogers (1996, 2001), Rogers and Jenkins (1995), Obstfeld and Taylor (1997) and Pasley and Way (2001a, 2001b). Hence in models assuming consumer prices stickiness or so called local currency pricing, flexible exchange rates bring no welfare benefits and fixed exchange rate regime is actually the optimal one. These type of models were developed in papers by Betts and Devereux (1996, 2000), Chari, Kehoe and McGrattan (2000), and others. However some recent papers proposed alternative explanations for the observed

relationship between nominal exchange rates and consumer prices, which leave room for efficiency of flexible exchange rates. One of these is a paper by Obstfeld and Rogoff (2000), explaining the small reaction of consumer prices to nominal exchange rate change by assuming high participation of transportation and distribution costs in final cost of imported goods. Another explanation is provided in the already mentioned paper by McCallum and Nelson (1999), that being similar to the previous one, and stating that the non-traded marketing, distribution and retailing costs might be the ones with highest participation in the final imported goods cost. Another possible explanation of low exchange rate pass-through, comes from Bergin (2001) and Corsetti and Dedola (2001), proposing that the low pass-through is not the consequence of price stickiness but optimal price discrimination.
Worth mentioning is also a paper by Corsetti and Peseneti (2001), proposing that the flexible exchange rate regime, even when efficient in substituting for the prices flexibility, might not be optimal. This comes from the assumption that deterrence from the law of one price is more costly for the society than the output gap that comes through deviation from the flexible prices optimum.

Another standpoint, from which the fixed exchange rate regime is defended, is the benefit of the exchange rate stability for the emerging markets. Here it is assumed that the monetary and financial stability would bring about credibility, much needed in the developing economies, having in mind their dependence on international trade and especially international capital markets (sudden stop problem). These aspects of fixed exchange rate regimes are analysed in a paper by Calvo and Reinhart (2000).

However, a fixed exchange rate regime has been warned against, at least in cases when it is not accompanied by a sound fiscal policy. Mckinnon and Pill (1998) warn against the fact, that the fixed exchange rate encourages external borrowing to the point of causing an ‘over-borrowing’ problem, because it diminishes the perceived risk of it. Burnside, Eichenbaum and Rebello (2001), develop a model in which government guarantees against investment losses eliminate the incentive to hedge against the exchange rate

risk. Cook and Devereux (2003) also warn that, unless combined with sound fiscal policy, fixed exchange rate regimes should be avoided, as they lead to over-borrowing and a subsequent exchange rate crisis.

Obstfeld (2002) provides a survey of new open economy papers, including most of the above mentioned, pointing out that the fact that low exchange rate pass-through to consumer prices does not allow one to disregard any role for the flexible exchange rates. In the paper he points out that the transaction chain from the import to final consumption and the globalized production economic decisions are some of the factors, that can seriously influence conclusions coming from the basic local currency pricing model.

Theory has also presented a wide range of empirical studies, providing a review of de facto (or actual) and de jure (or announced) exchange rate regime, countries are adopting. Some reviews have found that it is common for countries to announce one exchange rate regime, but actually practice another. The IMF publishes the officially announced regime classification, and one can find empirical reviews on what countries are actually practising, in papers by Reinhart and Rogoff (2002), Calvo and Reinhart (2002), and Alesina and Wagner (2003). What these three papers are mainly agreeing on, is that, first there is quite a discrepancy between what countries are doing de jure and de facto, when it comes to exchange rate policy, and second that in their deviations from the de jure regime, they often seem to be getting on the 'middle way' between the strictly floating and strictly fixed exchange rate regime. Although recent literature is proposing the two extremes, hard peg or free float, as the optimal ways, see Summers (2002) and Frankel, Schmukler and Serven (2002) for example, practice is offering evidence that most countries are actually somewhere in the middle between the two extreme solutions[2].

Hence the question of fixed or flexible remains open. One can however say that the answer is not, and for the foreseeable future will not be, uniform. One will have to recognize country specific conditions, and inter-country

[2] This choice is also defended as the optimal one in the literature, see for example Reinhart and Reinhart 2003.

relations, to be able to say more about what the optimal exchange rate policy, for the country in question, could be.

Having this in mind one can say that the currency board is, by all means, not the solution suitable for every country. I will say more about this in the following chapter.

3. Currency boards in practice

The currency board has been, with more or less success and in different modifications, introduced in several countries in the world. Argentina has adopted it in 1991, Estonia in 1992, Lithuania in 1994, Bosnia and Herzegovina in 1997 and Bulgaria in 1997. Hong Kong is also often regarded as following the currency board model of monetary policy, although under the strict definition of a currency board it has not really been doing so, but has instead followed a policy of the peg to US dollar with occasional devaluations and limited floats. However Hong Kong has preserved a fairly constant exchange rate to US dollar over a period of almost 50 years[3], and is therefore also considered an example of currency board in practice. Other countries, like Indonesia, have taken steps towards introducing a currency board.

By definition, a currency board is an arrangement under which the monetary authority has to preserve at least a 100% backing of its domestic liabilities with foreign reserves, to fix the exchange rate of domestic currency to a chosen foreign currency and to guarantee its full convertibility into the foreign currency it has chosen. As for the domestic liabilities, some countries limit the coverage only to domestic currency in circulation (Bulgarian Central Bank is obliged only to covering 100% of the monetary base with foreign reserves[4]) while some extend it also for the domestic deposits, to cover all the monetary liabilities (like Bosnia and Herzegovina)[5]. Foreign reserves are typically held as a foreign currency in a very small share and the rest is typically invested as the short-term deposit in a bank.

To be able to define the currency board as an economic term, one can draw a parallel to the exchange rate regimes. On these terms currency board can be seen as a one sided peg. Once it is observed this way, it is not difficult to

[3] Source of information, IMF-IFS.
[4] Source of information, World Bank, Sofia Office.
[5] Source of information, The Annual Report of the Central Bank of Bosnia and Herzegovina for the year 2002.

draw conclusions about the effects a currency board introduction could and should have on an economy.

If one could prove that it is to the country's benefit to fix the exchange rate against another country's currency, one would gain an answer to the question, what the benefits of a currency board are. We should ask ourselves why is it that this may not be true, i.e. why is a flexible exchange rate policy an optimal one. As we have seen in the introducing review of the literature, it is believed that the flexible exchange rate regime alleviates foreign monetary shocks, because prices are sticky and cannot adjust, so that the exchange rate flexibility provides for the flexibility lacking in prices. However if one could prove that the opposite is true, that the fixed exchange rates are actually enhancing the nominal prices flexibility, then even if the already mentioned discussions on weather prices are sticky in producer's or local currency, were speaking in favour of flexible exchange rates, all the arguments would be irrelevant and fixed exchange rate regime would be the optimal one. The model presented in this paper is showing that this is actually partially true, fixed exchange rates do enhance nominal prices flexibility but only under certain circumstances, and those being that the exchange rate is fixed only on one side, i.e. in the case of one sided peg or currency board. So I turn to the presentation of the model, which will prove the ultimate point of a currency board being a good choice.

4. The Model: Exchange rate policy and endogenous price flexibility

In order to make case for the currency board, I will here present the model from the paper written by Devereux (2003), in which he proves that fixed exchange rates can increasing the nominal prices flexibility.

The model includes two countries, both consisting of unit measure of households, which are acting as yeoman farmers. Farmers or producers are producing a differentiating goods and hence have some monopolistic power to price their goods individually. In deciding on the optimal price, they can choose weather to set their prices now and keep them fixed or to undertake a certain cost ('menu cost') and adjust the price after 'the state of the world' is known, thus making their prices flexible. If they choose the second option, producers have an option to adjust their prices after the state of the world has been realised so that they gain value by being able to adjust themselves for the shocks, that is for the realised state of nature. In other words it is strictly more valuable for producers to have the option of adjusting their prices ex post, if the menu costs were equal 0.

Household i in the home country is maximizing its utility function given by:

$$E\{U\} = E\left\{\ln(C(i)) + \chi \ln(\frac{M(i)}{P}) - \eta \frac{H(i)^{1+\psi}}{1+\psi} - I(i)\right\}$$

C(i) is aggregate consumption given by $C(i) = \left(\frac{C_h(i)}{\gamma}\right)^{\gamma}\left(\frac{C_f(i)}{1-\gamma}\right)^{1-\gamma}$, where $C_j(i)$ is consumption of the j'th countries good, j=h,f.

P is the price index given by $P = P_h^{\gamma}(SP_f^*)^{1-\gamma}$, where S is the exchange rate and P_h (P_f*) is home (foreign) currency price of the home (foreign) good. The 'law of one price' holds for every good. M(i) is the quantity of domestic money held by the household i. H(i) is the output produced by the household (farmer) i. I(i) is the indicator function representing the 'menu cost' of changing the price. It is equal 0 if the household sets the price in advance and keeps it fixed. If the household chooses to change the price after the

state of world has been realised I(i)=Ψ(i), where menu costs function Ψ(i) is such that: Ψ(0)=0, Ψ(1)>1 and Ψ'(i)>0.

Two variables are random, money velocity shock χ and relative preference for the home good γ. χ is i.i.d across countries with a mean unity. γ is symmetrically distributed between 0 and 1 and has a mean 0.5.

Consumption of each countries goods is distributed across a continuum of goods with elasticity of substitution equal to λ.

$$C_j(i) = \left(\int_0^1 C_j(i,\nu)^{1-\frac{1}{\lambda}} d\nu \right)^{\frac{1}{\left(1-\frac{1}{\lambda}\right)}}, j = h, f.$$

The price index for each countries goods are defined as:

$$P_h = \left(\int_0^1 P_h(\nu)^{1-\lambda} d\nu \right)^{\frac{1}{1-\lambda}}, \; P_f^* = \left(\int_0^1 P_f^*(\nu)^{1-\lambda} d\nu \right)^{\frac{1}{1-\lambda}}$$

The budget constraint of the household i is the following:

$$PC(i) + M(i) = P_h(i)H(i) + M_0 + T$$

where M_0+T represents initial money holding and tax or transfer from the monetary (or fiscal) authority. These are common across households.

Taking the first order conditions of the agent's optimisation problem one would get the following:

$$\frac{M(i)}{P} = \chi C(i)$$

describing the optimal income division between consumption and real money holdings, and

$$C_h(i,\upsilon) = \gamma \left(\frac{P_h(\upsilon)}{P_h} \right)^{-\lambda} \frac{PC(i)}{P_h}, \; C_f(i,\upsilon) = (1-\gamma) \left(\frac{P_f^*(\upsilon)}{P_f^*} \right)^{-\lambda} \frac{PC(i)}{SP_f^*}$$

defining demand for each of the two goods.

One can now eliminate the consumption and output terms from the utility function of the agent in order to gain the expression that would implicitly relate the utility to the prices set by the agents. For the agents setting their prices ex ante, utility function would state the following:

$$\hat{U}\left(\hat{P}_h(i), P_h, P, X \right) =$$

$$\ln\left(\hat{P}_h(i)\left(\frac{\hat{P}_h(i)}{P_h}\right)^{-\lambda}\frac{X}{P}+\frac{M_0+T-M}{P}\right)+\chi\ln\left(\frac{M}{P}\right)-\frac{\eta}{1+\psi}\left(\left(\frac{\hat{P}_h(i)}{P_h}\right)^{-\lambda}X\right)^{(1+\psi)}$$

where $\hat{P}_h(i)$ stands for the ex-ante set price (or fixed price).

For the agents that are setting their prices ex-post or after the state of the world is known, utility function would have the following form:

$$\tilde{U}\left(P_h,P,X\right)=$$

$$\ln\left(\tilde{P}_h(i)\left(\frac{\tilde{P}_h(i)}{P_h}\right)^{-\lambda}\frac{X}{P}+\frac{M_0+T-M}{P}\right)+\chi\ln\left(\frac{M}{P}\right)-\frac{\eta}{1+\psi}\left(\left(\frac{\tilde{P}_h(i)}{P_h}\right)^{-\lambda}X\right)^{(1+\psi)}$$

where $\tilde{P}_h(i)$ stands for the ex-post set price (or flexible price).

Maximizing these expressions with respect to ex-ante (ex-post) defined price, $\hat{P}_h(i)$ ($\tilde{P}_h(i)$), gives us the following optimal prices:

$$\hat{P}_h(i)=\left(\eta\frac{\lambda}{1-\lambda}\right)^{\frac{1}{\lambda(1+\psi)}}\left(E\left(P_h^{\lambda}X\right)^{1+\psi}\right)^{\frac{1}{\lambda(1+\psi)}}$$

and

$$\tilde{P}_h(i)=\left(\eta\frac{\lambda}{1-\lambda}\right)^{\frac{1}{\lambda(1+\psi)}}P_hX^{\frac{1}{\lambda}}$$

In the unity measure of agents, total measure of agents setting their prices ex-ante is z, leaving the total measure of agents setting their prices ex-post to be (1-z). The z is then determined by the condition 0<z<1, where the z'th agent is indifferent between setting his prices ex-ante or ex-post.

When we analyse the condition determining z, we can see that

$\tilde{U}\left(P_h,P,X\right)-\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)=\Psi(z)$, where 0<z<1.

It is also true that $\tilde{U}\left(P_h,P,X\right)-\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)>\Psi(1)$, or defined in words that all the agents ordered in the (1-z) unit of measure have strictly higher gain from the option to set their prices ex-post then the menu costs they incur to gain this possibility.

On other hand it is not true that $\tilde{U}\left(P_h, P, X\right) - \hat{U}\left(\hat{P}_h(i), P_h, P, X\right) < \Psi(0)$, because the menu costs can take only zero or positive value and the value of option to set prices ex-post is by its nature strictly positive.

Therefore we can conclude that it is either true that 0<z<1 or z=1.

To prove the point of how exchange rate policy affects prices flexibility, we have to examine how z changes in different policy frameworks. In order to do this we have to solve the model for its equilibrium and then analyse determination of z in various policy frameworks.

The equilibrium of the model is defined by the following equations:

$$\frac{\hat{M}(i)}{P} = \chi \hat{C}(i), \qquad \frac{\hat{M}^*(i)}{P^*} = \chi \hat{C}^*(i) \tag{1), (2)}$$

$$\frac{\tilde{M}(i)}{P} = \chi \tilde{C}(i), \qquad \frac{\hat{M}^*(i)}{P^*} = \chi \tilde{C}^*(i) \tag{3), (4)}$$

$$M_0 + z\hat{T} + (1-z)\tilde{T} = (1-z)\hat{M}(i) + z\tilde{M}(i), \tag{5}$$

$$M_0^* + z\hat{T}^* + (1-z)\tilde{T}^* = (1-z)\hat{M}^*(i) + z\tilde{M}^*(i) \tag{6}$$

$$\hat{P}_h(i) = \left(\eta \frac{\lambda}{1-\lambda}\right)^{\frac{1}{\lambda(1+\psi)}} \left(E\left(P_h^{\lambda} X\right)^{1+\psi}\right)^{\frac{1}{\lambda(1+\psi)}} \tag{7}$$

$$\hat{P}_f^*(i) = \left(\eta \frac{\lambda}{1-\lambda}\right)^{\frac{1}{\lambda(1+\psi)}} \left(E\left(P_f^{*\lambda} X^*\right)^{1+\psi}\right)^{\frac{1}{\lambda(1+\psi)}} \tag{8}$$

$$\tilde{P}_h(i) = \left(\eta \frac{\lambda}{1-\lambda}\right)^{\frac{1}{\lambda(1+\psi)}} P_h X^{\frac{1}{\lambda}} \tag{9}$$

$$\tilde{P}_f^*(i) = \left(\eta \frac{\lambda}{1-\lambda}\right)^{\frac{1}{\lambda(1+\psi)}} P_f^* X^{*\frac{1}{\lambda}} \tag{10}$$

$$P_h = \left((1-z)\hat{P}_h^{1-\lambda} + z\tilde{P}_h^{1-\lambda}\right)^{\frac{1}{1-\lambda}} \tag{11}$$

$$P_f^* = \left((1-z^*)\hat{P}_f^{*(1-\lambda)} + z^*\tilde{P}_f^{*(1-\lambda)}\right)^{\frac{1}{1-\lambda}} \tag{12}$$

$$P\hat{C} + \hat{M} = \hat{P}_h \hat{H} + M_0 + T \tag{13}$$

$$P^{*}\hat{C}^{*}+\hat{M}^{*}=\hat{P}^{*}_{f}\hat{H}^{*}+M^{*}_{0}+T^{*} \tag{14}$$

$$P\tilde{C}+\tilde{M}=\tilde{P}_{h}\tilde{H}+M_{0}+T \tag{15}$$

$$P^{*}\tilde{C}^{*}+\tilde{M}^{*}=\tilde{P}^{*}_{f}\tilde{H}^{*}+M^{*}_{0}+T^{*} \tag{16}$$

$$\hat{H}=\left(\frac{\hat{P}_{h}}{P_{h}}\right)^{-\lambda}X \tag{17}$$

$$\hat{H}^{*}=\left(\frac{\hat{P}^{*}_{f}}{P^{*}_{f}}\right)^{-\lambda}X^{*} \tag{18}$$

$$\tilde{H}=\left(\frac{\tilde{P}_{h}}{P_{h}}\right)^{-\lambda}X \tag{19}$$

$$\tilde{H}^{*}=\left(\frac{\tilde{P}^{*}_{f}}{P^{*}_{f}}\right)^{-\lambda}X^{*} \tag{20}$$

$$H=\left((1-z)\hat{H}^{1-\frac{1}{\lambda}}+z\tilde{H}^{1-\frac{1}{\lambda}}\right)^{\frac{1}{1-\frac{1}{\lambda}}} \tag{21}$$

$$H^{*}=\left((1-z)\hat{H}^{*\left(1-\frac{1}{\lambda}\right)}+z\tilde{H}^{*\left(1-\frac{1}{\lambda}\right)}\right)^{\frac{1}{1-\frac{1}{\lambda}}} \tag{22}$$

$$X=\gamma\left(\frac{P\left((1-z)\hat{C}+z\hat{C}\right)}{P_{h}}\right)+\gamma\left(\frac{SP^{*}\left((1-z^{*})\hat{C}^{*}+z^{*}\hat{C}^{*}\right)}{P_{h}}\right) \tag{23}$$

$$X^{*}=(1-\gamma)\left(\frac{P\left((1-z)\hat{C}+z\hat{C}\right)}{SP^{*}_{f}}\right)+(1-\gamma)\left(\frac{SP^{*}\left((1-z^{*})\hat{C}^{*}+z^{*}\hat{C}^{*}\right)}{SP^{*}_{f}}\right) \tag{24}$$

$$M=M_{0}+T \tag{25}$$

$$M^{*}=M^{*}_{0}+T^{*} \tag{26}$$

$$H=X \tag{27}$$

$$H^* = X^* \tag{28}$$

$$\hat{P}_h(i) = S\hat{P}_f^*(i) \tag{29}$$

$$\tilde{P}_h(i) = S\tilde{P}_f^*(i) \tag{30}$$

Equations 1 through 4 define the optimal division of income between consumption and money holdings, for home and foreign country and for flexible and fixed price setters. Equation number 5 and 6 define the equilibrium in the money market. Equations 7 through 10 define the optimal fixed (flexible) price for the home (foreign) country price setter, respectively. Equations 11 and 12 define the home (foreign) country price indices. Equations 13 through 16 are budget constraints for the fixed (flexible) price setters in home (foreign) country respectively. Equations 17 through 20 define optimal output for the fixed (flexible) price setters in home (foreign) country respectively. Equations 21 and 22 define total output (as a mix of fixed and flexible price setters output) for the home and foreign country, respectively. Equation 23 and 24 define total demand in home and foreign country, respectively. Equations number 25 and 26 define an equilibrium in monetary (fiscal) authority's budget, for the home and foreign country. Equations number 27 and 28 define an equilibrium in the goods market, for the home and foreign country. Equations 29 and 30 are defining the 'law on one price', valid for each good.

Model is completed by two random processes, one representing the money velocity shock χ, and the other one representing the home country goods preference shock γ. Distributions of χ and γ were already described in the text.

4.1. Solving the model

The model is constructed in a way that, although producers (consumers) are divided into two categories, one setting their prices as fixed and the other one keeping them flexible, we can analyse the behaviour of the equilibrium price flexibility under different circumstances by observing the aggregate variables only. This comes from the fact that by combining equations 17

through 22, and equations 27 and 28, one can get the following relation between fixed and flexible prices and outputs on one side and price index and demand on the other side:

$$\hat{P}_h(1-z)\hat{H}+\tilde{P}_h z\tilde{H}=P_h X \tag{31}$$

Then we can combine equations 1 through 6, 13 through 16 and 25 and 26 with the previous relation to get the following relation:

$$\hat{P}\hat{C}+\tilde{P}\tilde{C}=\hat{P}_h(1-z)\hat{H}+\tilde{P}_h z\tilde{H}=P_h X=\frac{M}{\chi} \tag{32}$$

Now we have an equation relating aggregate demand for the home and foreign goods to nominal money holdings in the home (foreign) country, money velocity and price indices in home (foreign) country:

$$X=\frac{M}{\chi P_h} \tag{33}$$

$$X^*=\frac{M^*}{\chi^* P_f^*} \tag{34}$$

Using these results and equations number 23 and 24, we can get the following partial solution for exchange rate:

$$S=\frac{1-\gamma}{\gamma}\frac{X}{X^*}\frac{P_h}{P_f^*}=\frac{1-\gamma}{\gamma}\frac{X}{X^*}\frac{M}{\chi H}\frac{\chi^* H^*}{M^*}=\frac{1-\gamma}{\gamma}\frac{M}{\chi}\frac{\chi^*}{M^*} \tag{35}$$

We turn now to analysing the price flexibility measure (z). The z is defined by the following conditions:

$$\tilde{U}\left(P_h,P,X\right)-\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)=\Psi(z)\text{, where } 0<z<1.$$

$$\tilde{U}\left(P_h,P,X\right)-\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)>\Psi(1)$$

where

$$\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)=$$

$$\ln\left(\hat{P}_h(i)\left(\frac{\hat{P}_h(i)}{P_h}\right)^{-\lambda}\frac{X}{P}+\frac{M_0+T-M}{P}\right)+\chi\ln\left(\frac{M}{P}\right)-\frac{\eta}{1+\psi}\left(\left(\frac{\hat{P}_h(i)}{P_h}\right)^{-\lambda}X\right)^{(1+\psi)}$$

and

$$\tilde{U}\left(P_h,P,X\right)=$$

$$\ln\left(\tilde{P}_h(i)\left(\frac{\tilde{P}_h(i)}{P_h}\right)^{-\lambda}\frac{X}{P}+\frac{M_0+T-M}{P}\right)+\chi\ln\left(\frac{M}{P}\right)-\frac{\eta}{1+\psi}\left(\left(\frac{\tilde{P}_h(i)}{P_h}\right)^{-\lambda}X\right)^{(1+\psi)}$$

We can use equations 25 and 33 to simplify the expression for the utility function of the fixed price setters into the following expression:

$$\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)=$$

$$\ln\left(\hat{P}_h(i)^{1-\lambda}P_h(i)^{\lambda-1}\frac{M}{\chi P}\right)-\frac{\eta}{1+\psi}\left(\hat{P}_h(i)^{-\lambda}P_h(i)^{\lambda-1}\frac{M}{\chi P}\right)^{(1+\psi)} \qquad (36)$$

By using equations 9, 26 and 34, we can simplify the expression for the utility function of the flexible price setters into the following expression:

$$\tilde{U}\left(P_h,P,X\right)=$$

$$\ln\left(\left(\eta\frac{\lambda}{\lambda-1}\right)^{\frac{1-\lambda}{\lambda(1+\psi)}}\left(\frac{P}{P_h}\right)^{\frac{1-\lambda}{\lambda}}\left(\frac{M}{\chi P}\right)^{\frac{1}{\lambda}}\right)-\frac{\eta}{1+\psi}\left(\hat{P}_h(i)^{-\lambda}P_h(i)^{\lambda-1}\frac{M}{\chi P}\right)^{(1+\psi)} \qquad (37)$$

The z is then defined at the crossing of the curve representing the 'menu cost' Ψ and the 'gain form flexibility' curve, that is the curve representing the difference between the utility function of the price setter who is setting his price as fixed and the one who is setting it as flexible[6]. It is defined as an assumption that the z'th price setter would be indifferent between setting his price fixed or flexible, i.e. that his 'menu cost' would be equal to his 'gain form flexibility'.

In order to determine z, we can now approximate the expression defining the difference between the equation 36 and 37, as follows[7]:

$$\Delta U=\hat{U}\left(\hat{P}_h(i),P_h,P,X\right)-\tilde{U}\left(P_h,P,X\right)\approx\frac{(\lambda-1)}{\lambda}\frac{(1+\psi)}{2}\mathrm{var}\left((\lambda-1)p_h+m-\hat{\chi}\right)$$

where p_h, m and $\hat{\chi}$ represent the log deviations of the variables P_h, M and χ.

We can also simplify the expression above by using the equation number 11 and the above given condition, to define the home price index log deviation as follows:

[6] See graphs 1 to 5.

[7] The full derivation of the second order approximation is given in the appendix.

$$p_h = \frac{\frac{z}{\lambda}\left(m - \hat{\chi}\right)}{\left(1 - z\frac{(\lambda-1)}{\lambda}\right)}$$

Now we can write 'gain from flexibility' as ΔU:

$$\Delta U = \frac{(\lambda-1)(1+\psi)}{2\lambda}\frac{1}{\left(1 - z\frac{(\lambda-1)}{\lambda}\right)^2}\text{var}\left(m - \hat{\chi}\right) = \Psi(z), \qquad 0<z<1, \qquad (38)$$

and

$$\Delta U = \frac{\lambda(\lambda-1)(1+\psi)}{2}\text{var}\left(m - \hat{\chi}\right) \geq \Psi(z), \qquad z=1. \qquad (39)$$

The graphs representing these relations will be analysed in the following section.

4.2. Model Analysis

We can represent the relations between the menu cost and the utility gain with flexibility of prices, given by equation number 38, on a graph, which is what is done on the graphs 1 through 4.

On all graphs the diagonal line starting at 0 and ending at 1 represents the 'menu costs', as these are assumed to be distributed on the interval between 0 and 1 in growing order. The curve represents the 'utility gain' or the difference between the utility producers would have in case they set their prices as flexible, in contrast to setting their prices as fixed.

First two graphs show an equilibrium flexibility of prices when the elasticity of substitution across goods, λ, is relatively low (2.0) while the second two graphs show the case of a relatively high λ, (4.0). The first and the third graph show cases of a relatively low ψ, (0.6), while the second and the fourth graph show the cases with a relatively high ψ, (0.9). Variance of (m-χ) is assumed to be 0.36, which is an arbitrary number but it only changes the scale and not the structure of the solution so that it is not of vital importance.

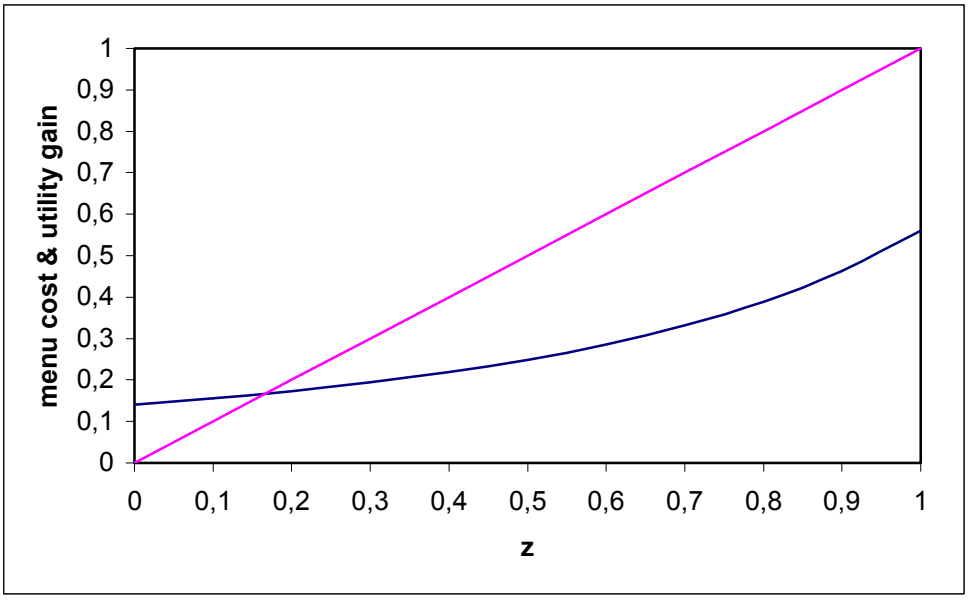
As the elasticity λ is increased, the curvature of the 'utility gain' curve increases, and as the utility coefficient ψ is increased, the scale of the 'utility gain' increases.

What we can see from the pictures is that, depending on the calibration, three general cases are possible, a case with unique equilibrium, a case with no equilibrium and a case with multiple equilibriums.

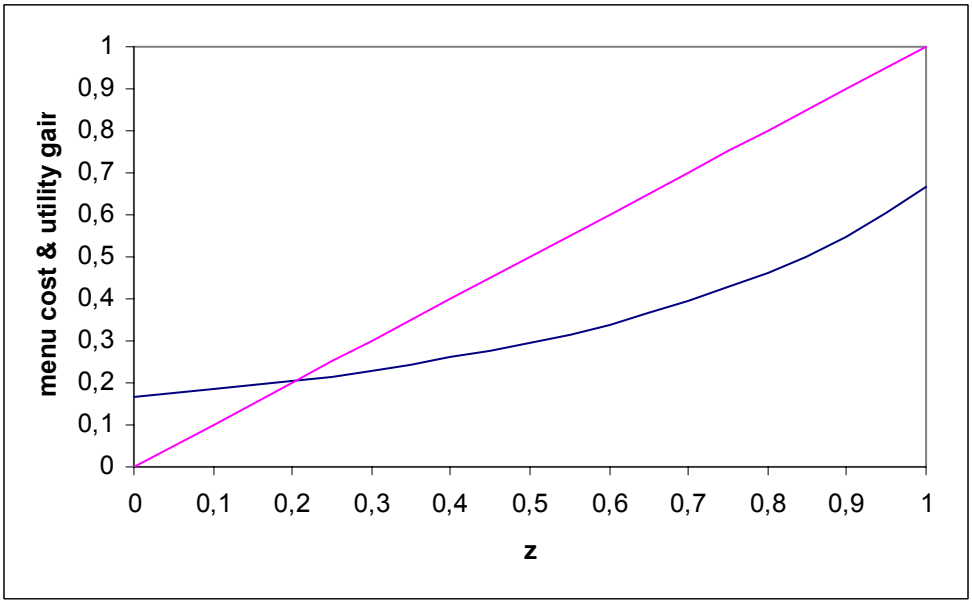
Graphs 1 and 2, show the case of a unique equilibrium, graph 3 shows the case of no equilibrium and the graph 4 shows the case of multiple equilibriums.

The main difference between the first two and the following two graphs is that the elasticity of substitution across goods is in the first two graphs lower. If the elasticity of substitution across goods is relatively low, equilibrium elasticity of prices (z) will tend to be uniquely determined. One can explain this intuitively by observing that, if the elasticity of substitution is low, producers or the price setters will have a relatively more stable demand for their goods, so that they will be prone to determine the type of prices they will be setting (as fixed or flexible) and stick to that decision no matter what other producers may decide.

We also se from the graphs 1 and 2, that the equilibrium is not much affected by the slight change in ψ (the utility coefficient attached to output - labour). This can again be explained intuitively by observing that, for the problem of determining optimal prices the key factor is demand and its stability (which in this case means coefficient of elasticity of substitution λ). If the agents know that the demend for their goods will be stable they can set the prices according to their own interests and preferences and without much reagrd for what the others are doing. This will not change much if they like to work more or less (that is if their ψ is higher or lower).



Graph 1. ‚menu costs' and ‚utility gain' depending on price flexibility z.
Calibration: λ=2.0, ψ=0.6, var(m-χ)=0.35.

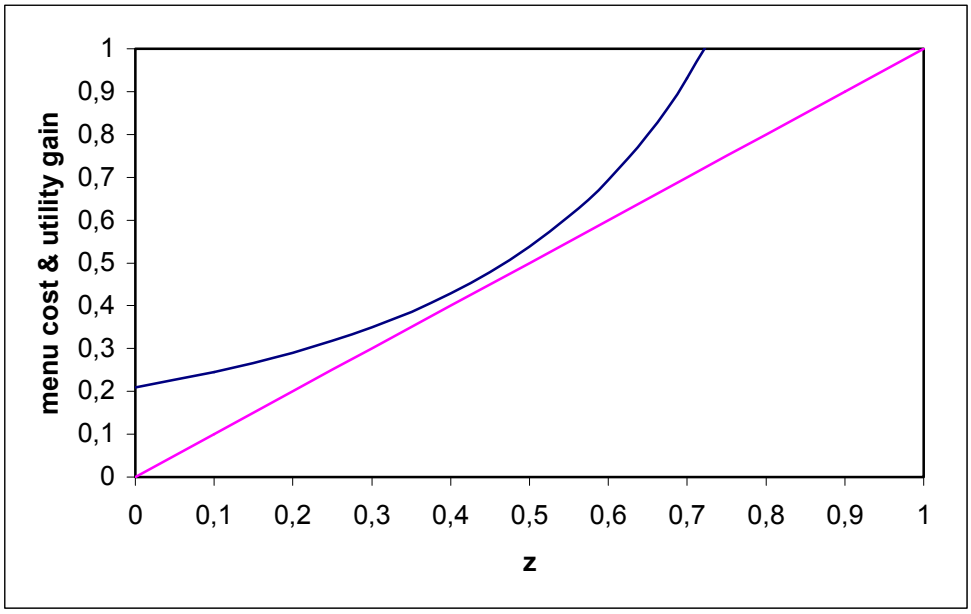


Graph 2. ‚menu costs' and ‚utility gain' depending on price flexibility z.
Calibration: λ=2.0, ψ=0.9, var(m-χ)=0.35.

If the elasticity of substitution across goods is high, while at the same time ψ, or the utility coefficient attached to output (labour investment), is also high, we get the case where there is no equilibrium. The gain from elasticity of prices is higher than 'menu cost' so that everybody will keep their prices flexible. One can see the intuition behind this kind of outcome by observing that, because of high elasticity, producers' decisions are largely dependant

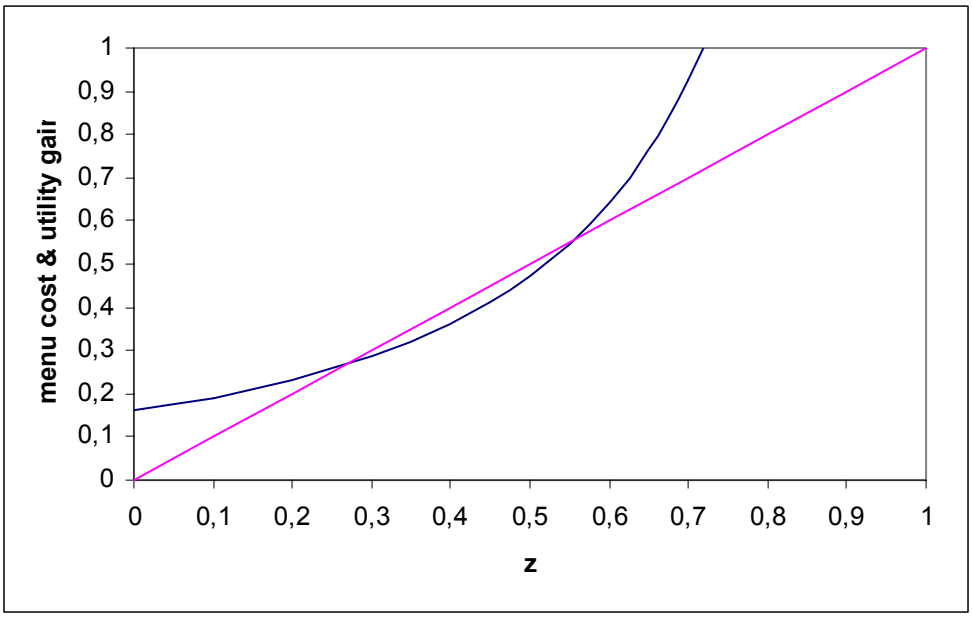
on other producers' decisions, since the demand for their goods is volatile. At the same time disutility of working (of producing output) is high, so that this creates an additional stimulant for prices to be set in such a way that the demand is met by the supply in full. As a result we get a situation in which everybody is keeping his or her prices flexible.

This case is presented on the graph 3.



Graph 3. ‚menu costs' and ‚utility gain' depending on price flexibility z;
Calibration: λ=4.0, ψ=0.6, var(m-χ)=0.36.

If the elasticity of substitution across goods is high, producers will be more prone to decide about their type of price (again fixed or flexible) based on what other producers have decided, as the demand for their goods is now more sensitive to changes in the demand for other goods. Producers will now, depending on other's decisions, be prone to either set their price fixed if others are doing so or flexible, again if others are doing so, so that we will in this case have three equilibriums, one with majority setting their prices fixed and one with majority setting their prices flexible, and the third equilibrium in which all the producers will be setting their prices flexible (z=1).



Graph 4. ‚menu costs' and ‚utility gain' depending on price flexibility z.
Calibration: λ=6.0, ψ=0.1, var(m-χ)=0.35.

What these three cases are allowing us to conclude is a very important feature proceeding from the endogeneity of the price flexibility in the model. The conclusion is that depending on the economic features, elasticity of substitution across goods and the utility coefficient attached to output (labour investment); there is a possibility of multiple equilibriums in determining price flexibility. This means that there is one desirable equilibrium (of high price flexibility) and one less desirable equilibrium (of low price flexibility). We can now analyse if and how the monetary authority can influence whether the economy will find itself in a more or less desirable equilibrium of price flexibility.

4.3. Model Results and Answers

To analyse the effects of the monetary (or the exchange rate) policy on equilibrium price elasticity, we can transform the equation number 35 into its log deviation version to obtain the following expression:

$$s = m - m^* + \left(\hat{\chi}^* - \hat{\chi} \right) - 2\hat{\gamma} \qquad (40)$$

Now if we define the monetary policy rule as a reaction to the exchange rate deviation, we can say that:

$$m = -\mu s \tag{41}$$

where μ=∞, would define a fixed exchange rate policy, while μ=0 would define a flexible exchange rate policy.

Now plugging 41 into 40, we get the following:

$$s = \frac{\left(\hat{\chi}^{*} - \hat{\chi}\right) - 2\hat{\gamma}}{1+\mu} \tag{42}$$

We can write 38 as follows:

$$\Theta(z) = \frac{(\lambda-1)(1+\psi)}{2\lambda}\,\mathrm{var}\left(m - \hat{\chi}\right) \tag{43}$$

where $\Theta(z) = \Psi(z)\left(1 - z\frac{(\lambda-1)}{\lambda}\right)^2$

Using 41 and 42, we can redefine 43 as follows:

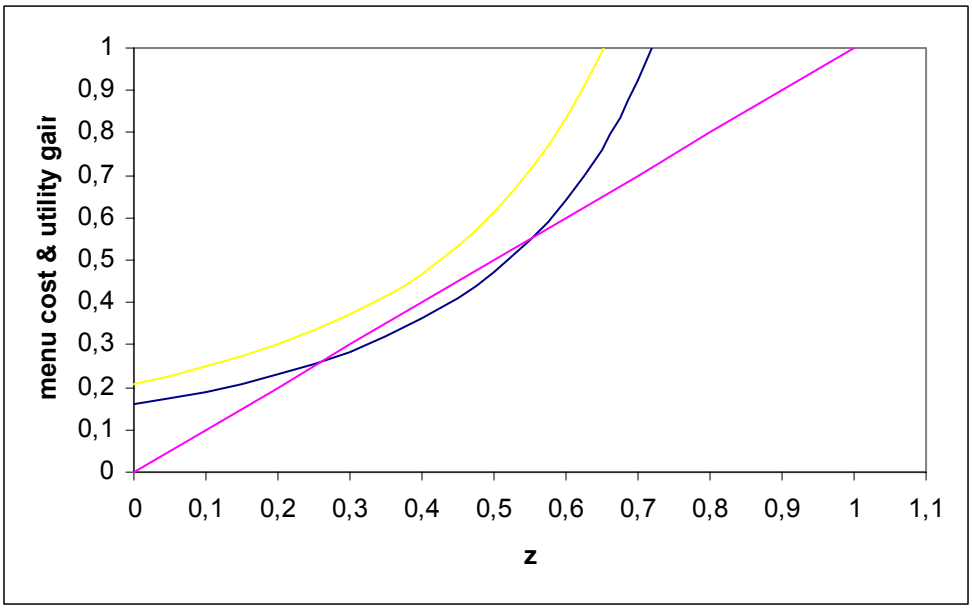
$$\Theta(z) = \frac{(\lambda-1)(1+\psi)}{2\lambda}\left\{\left(\frac{\mu}{1+\mu}\right)^2 4\sigma_{\gamma}^2 + \left(\frac{\mu-1}{1+\mu}\right)^2 \sigma_{\chi}^2\right\} \tag{44}$$

We now analyse the situation where there exists a unique equilibrium of price flexibility. One can see from the equation 44, that in this case, the price flexibility (z) is higher under fixed exchange rate then under the flexible one and in the absence of any velocity shock ($\hat{\chi}$=0), z is uniformly increasing in μ, i.e. price flexibility is higher the higher the degree of exchange rate intervention.

This results holds under unilateral fixing of the exchange rate (unilateral peg or monetary board) but not under the bilateral exchange rate fixing (monetary union). In the case of a bilateral peg the result is reversed, price flexibility is higher under a flexible exchange rate regime. However since the bilateral fixing of exchange rates is not within the scope of this work, this result will not be further elaborated upon.

In the case of multiple equilibriums of price flexibility, one gets two possible outcomes. If the economy is in the point of low price flexibility equilibrium, when the exchange rate is fixed, the price flexibility will be slightly

increased as the ‘utility gain’ or the increase in utility due to flexible price setting in comparison to fixed price setting, increases for all producers, or it will be raised all the way to z=1, as the utility change is big enough for all the producers to switch to setting their prices flexible. If the economy is in the higher flexibility equilibrium, the same will happen with the difference that here a much smaller change in ‘utility gain’ is needed for all the producers to switch to flexible prices. We can see the illustration of the case where a 10% increase in ‘utility gain’ moves the equilibrium into the case where all the producers set their prices flexible in the graph 5.



Graph 5. ‚menu costs’ and ‚utility gain’ depending on price flexibility z.
Calibration: λ=6.0, ψ=0.1, var(m-χ)=0.35.

With an exogenous shock raising demand velocity and hence the ‘utility gain’ from choosing flexible over fixed prices, by 10%, a multiple equilibriums for price flexibility turn into no equilibriums or the case where all the producers are keeping their prices flexible as the ‘utility gain’ is higher then the ‘menu cost’ for all producers. The other case, where the increase in prices flexibility would be only slight, is straightforward, as it would still be the case of multiple equilibriums with the ‘utility gain’ curve moved slightly upward.

What we can conclude is that in the case of high elasticity of substitution across goods and low utility coefficient for output (labour), fixing the exchange rate either increases prices flexibility lightly or dramatically, which means that in this case it is always beneficial for the economy.

We now have shown that, in case of unique and of multiple equilibriums, fixing the exchange rate is optimal policy. What remains an open question is if and when this optimal policy is also feasible. This question will be tackled in the next section.

5. Problems with Fixed Exchange Rate Policy Implementation in Practice

We have seen that the theory provided a rationale for a fixed exchange regime as an optimal policy. We have also seen many examples in the practice, especially in the developing countries, that the fixed exchange rate has been chosen as the optimal solution. However, history has proven that a fixed exchange rate is usually short-lived. The question arises, why and when do governments abandon the fixed exchange rate policy.

5.1. Exchange Rate Policy Instruments

The instruments that stand at the disposal of the authority (be it central bank or any other institution) for maintaining the fixed exchange rate are the following:

- borrowing foreign currency reserves at the international money and capital markets,
- increasing interest rates,
- tightening capital controls,
- tightening fiscal policy.

Each of these will be discussed briefly in the following sections.

5.1.1 Borrowing Foreign Currency Reserves

In the early seventies, international money and capital markets got bigger and so did the investors. This created a situation in which a group of private investors (or in some countries cases a private investor alone) were able to raise enough funds to buy out the entire foreign reserves of a certain country, trying to defend its currency peg. This situation created huge benefits for the them (investors), and huge losses for countries worldwide[8]. It urged the economists to start thinking about speculative attacks as a serious problem countries face in trying to maintain their currency pegs. A lack of foreign

[8] Mexico, Great Britain, Sweden, Argentina, to name a few.

currency reserves was recognized as being one of the main reasons currency pegs were collapsing.

However, the situation has changed. In the modern international money and capital markets, borrowing foreign currency reserves presents no problem for the country trying to defend its exchange rate. Central banks have an option to borrow from other central banks (from other countries foreign currency reserves), from private bank consortiums, private investors and also from international organizations such as IMF, which would typically sign a stand-by arrangement as a part of support for the exchange rate stability, in case the countries face problems with credibility when borrowing on international financial markets[9]. For this reason, lack of reserves can hardly be seen as the cause of a currency peg or monetary board collapse. The argument and the simplified model of the lack of reserves causing currency crisis will be presented further in the text, however here it is presented with the aim of showing that this concern is not the most serious one when it comes to monetary board survival, and that the trouble comes from elsewhere.

5.1.2 Interest Rates

Interest rates are the fundamental instrument of monetary policy and exchange rate policy, weather they are unique (in case of monetary board) or not. It is exactly from this fact that the problems are arising. While interest rate increase can for instance cause the capital inflow, leading to exchange rate decrease (or lowering the pressure on exchange rate appreciation in case it is fixed), it will at the same time reflect on the whole economy and will thus become an unacceptable solution if the country is facing recession. The mechanism of both processes is simple. If the interest rates rise, international investors will want to invest in the country, thus will try to change their (foreign) currency for the domestic one in order to invest it. This will create an increase in the domestic currency demand and will naturally lead to the domestic currency price increase, or, in other words, to exchange rate appreciation. On the other hand, if the interest rates increase, the

[9] IMF stand-by agreements, supporting the fixed exchange rate defence, were signed by Argentina, Estonia, Lithuania, Bulgaria and Bosnia, i.e. all of the countries establishing monetary board.

entrepreneurs will be turned away from what used to be a profitable investment under previous interest rates, and the economy will come into a slow-down, possibly a recession. This picture, however simplified, brings about a concern for the fact that the interest rate, as an instrument for controlling the exchange rate, can not be used without further consequences for the economy, or at least not without combining it with other policy instruments, raising further concerns. The next section is dealing with one of the possible instruments for exchange rate policy that might be used in combination with the interest rates.

5.1.3 Tightening Capital Controls

Capital controls can be introduced for capital inflows, capital outflows or both. Typically, if used for the exchange rate policy purposes, the capital controls would be introduced for the foreign capital inflows. The mechanism of capital controls tightening, would work so that the authorities could, by stopping the foreign capital inflow, prevent their being invested on the domestic currency markets, thus rendering the currency market interventions unnecessary and exchange rate instability impossible. This would allow for the interest rate decrease while preserving the exchange rate reaction. However, this kind of intervention would also prevent the always needed foreign investments other then those of speculative nature, so that this kind of intervention is more of a 'putting a fire out' tool than an instrument that should regularly be used for the exchange rate stabilisation.

5.1.4 Tightening Fiscal Policy

Fiscal policy, similarly to the two instruments mentioned in the previous sections, does not have a purpose of controlling the exchange rate, and should therefore be understood, not as the exchange rate policy tool, but in this context rather as the issue to be kept in mind when exchange rate policy is in question. Fiscal policy is of vital importance for any form of currency peg (and thus monetary board too) survival. It is a common knowledge that the problem of high fiscal deficit cannot be expected to be solved while

maintaining the exchange rate fixed. The obvious reason being that in case of extremely high deficits the urge for the government to put pressure on central bank to use the seigniorage as a problem fixer is just too high. In the case of a monetary board however, law eliminates this possibility, as the monetary base can only be increased if fully backed by the foreign reserves. Still the fiscal policy issues are of vital importance for the monetary board for other reasons. The problem of fiscal deficit becomes especially serious if the exchange rate is fixed, when there exists a currency misbalance in assets and liabilities, in the public sector, private sector or both. If the liabilities are in foreign currencies and assets are not the pressure in the case of devaluation becomes so high that the chances are the law itself will be changed in order to save what cannot be saved. So the fiscal policy issue should be understood as a matter of prevention rather then intervention, in a sense that when monetary board is introduced, high fiscal deficits should be avoided at all costs, and currency balance on liabilities and assets side should be kept in mind. Unfortunately, as with interest rates, fiscal deficits are not an issue affecting only the exchange rate and can therefore become a priority above the exchange rate policy, causing inconsistencies. To be specific, in the case of recession, the issue of maintaining fixed exchange rate might lose its allure if what is needed for the economy to start moving upwards is a tax cut. These problems will be discussed more in the final section of this paper.

5.2. Fundamental Threats to Monetary Boards

Some of the fundamental reasons, that cause the fixed exchange rate policy to be unattainable, are the following:

- lack of foreign currency reserves,
- lack of market confidence in the exchange rate policy, or lack of authority credibility, (related to for example fiscal policy that is inconsistent with the exchange rate policy, in a sense of running a persistent high fiscal deficit),
- high domestic nominal interest rates,
- high and / or growing unemployment,

- contagion from the other countries suffering financial and currency crisis, etc.

Each of these issues will be briefly commented on in what follows.

5.2.1 Lack of Foreign Currency Reserves

The issue of foreign currency reserves has already been mentioned in the section about foreign currency reserves borrowing. It is clearly not a problem for governments and countries to borrow foreign currencies when needing to defend their currency pegs. However currency crises do occur, so it is obvious that the problem lies elsewhere. The issue of a lack of reserves is an old one, since it used to be a problem, and for that reason some of the first models of currency crisis evolved exactly around this issue. One of these models is presented in this paper too. What is interesting today is to see that there is an issue of a lack of reserves and that it can also be overcome. It is also important to keep history in mind when it comes to a case of countries investing huge amounts of their foreign currency reserves into defending their fixed exchange rate, only to drop the issue later and incur huge losses. This can be easily avoided and therefore also should be. I will discuss this issue again in the final section of this paper.

5.2.2 Lack of Market Confidence

Lack of market confidence is perhaps the most important problem when it comes to currency crisis issues. As the next chapter of this paper will prove, currency crises have a self-fulfilling character and the matter of whether the prophecy will fulfil itself or not largely depends on the issue of market confidence. As has been largely discussed in the literature[10], credible commitment is the only thing that can solve this problem. In the case of fixing exchange rates, monetary boards do have a high degree of credibility since it by definition has a power of law, but the problem is that although a law it is still not in its own designers interest, which means that the question of credible commitment arises sooner or later and along with it a possibility

[10] Seminal paper on this issue is one by Kydland and Prescott. (1977).

of self-fulfilling crisis. What does help off course is the history of institutional stability and sound policies, but there is really no guarantee. Generally put, if a country has a record of stable institutions, including stable political institutions and stable economic (monetary and fiscal) institutions, and if a country is maintaining sound policies in a sense of respecting all the issues here mentioned that endanger the survival of fixed exchange rate (sound fiscal policy in the first place), the chances are that commitment will be perceived as credible and the economy will not end up being in the situation of a self-fulfilled crisis. This is to say that if the monetary board policy is to be pursued, the least that should be done is to maintain the credibility of commitment by respecting the main policy rules accompanying monetary board as a course of action.

5.2.3 Interest Rates

Similar to what was said about foreign currency reserves, interest rates are an instrument and a potential problem, when it comes to maintaining a fixed exchange rate or a monetary board. The logics are the same as when interest rates are observed as an exchange rate policy instrument. If the economy were in, or facing depression, a favourable step would be to lower interest rates. However if fixed exchange rate is to be maintained at the same time this may become impossible, and the higher priority must be chosen. What the problem comes down to is that by choosing the use of a monetary board as a policy option, a country gives up on its discretionary monetary policy, and along with it on the possibility to intervene by adjusting interest rates. This may become costly in times of economic slowdown but, like I said, priorities must be made. It is for this reason of utter importance that the monetary board, if chosen, is chosen so that the domestic currency is linked to one the country in question is related to in terms of business cycle coordination and high level of trade, so that the domestic monetary policy will be tracking one that is suitable for its own problems. In other words if the country to whose currency the domestic currency is pegged, has recessions at the same time when the country in question does (which will probably be true if there is high degree of trade between the two countries)

then the monetary policy of the country whose currency is the anchor will be suitable for the pegging country too. These issues will be discussed further on in the section about the monetary board anchoring currency choice.

5.2.4 Unemployment

The problem of unemployment is closely related to the issue of fixed exchange rate survival, because of the fact that fixing exchange rate in a form of adopting monetary board, means giving up on the discretionary monetary policy and along with it tying ones hands on the matters of fiscal policy too. In case there is high and/or rising unemployment, this burden might become too heavy to carry and the issue of credible commitment arises. The costs and benefits of maintaining the monetary board must be weighted and this is where the issue of choosing when and how to introduce the monetary board arises, an issue that will be discussed more in the section about the monetary board anchoring currency choice.

5.2.5 Contagion

Contagion is an issue that unfortunately can strike a country even if all the rules of 'healthy' currency pegging are respected. The cases of contagion, when it comes to currency crises, are most common in the countries of South America. Although the possibility of a crisis due to contagion can arise with no realistic cause, so having self-fulfilling character, it is also true that it generally will do so if the countries in question have a history of making similar mistakes when it comes to exchange rate policy. With that we come back to the issue of credible commitment and back to guidance that will be given in the final section of this paper.

6. The Model: Self-fulfilling Currency Crisis

6.1. The Limited Reserves Model

One of the first reasons, recognized in the literature as the reason for currency peg failures, is the pegging country's lack of foreign currency reserves. Krugman presented a model, in his 1979 paper, that shows how once the speculators become aware of the fact that the pegging country has a lack of foreign reserves, a speculative attack and hence currency peg failure, becomes inevitable. The model also allows for a precise determination of the point of time when this occurs.

In this section I will present a simplified version of this original Krugman's idea, showing how in certain macroeconomic environments, a speculative attack becomes inevitable outcome of the speculators arbitrage game.
The model is also presented in a paper by Obstfeld (1994).

The model contains three agents, a government that holds foreign currency reserves, trading them to preserve the fixed exchange rate and two private holders of domestic money, who can both trade with the government. The government commits a certain amount of reserves (R) to defending the currency peg. The amount of reserves should be understood as the lower limit of the reserves government is holding. At the same time, the higher this limit (the higher the R), the higher is the commitment of the government to defend the peg, and vice versa.

Now we can present what happens in the foreign currency market in a matrix illustrating a non-cooperative game between the two private holders and the government.

The rules of the game are the following: each private holder had domestic money resources of 6, which he can hold ('hold') or sell to the government in exchange for the foreign currency reserves ('sell'). The private holders bear some cost if they decide to sell their domestic money holding, these

being equal to 1. The following three matrices present three cases of the foreign reserves trading when government possess low (6), intermediate (10) and high level of foreign currency reserves (20).

Figure 1

Trader 1 \ Trader 2	Hold	Sell
Hold	0, 0	0, -1
Sell	-1, 0	-1, -1

(a) High reserve game (R=20)

Trader 1 \ Trader 2	Hold	Sell
Hold	0, 0	0, 2
Sell	2, 0	1/2, 1/2

(b) Low reserve game (R=6)

		Trader 2	
		Hold	Sell
Trader 1	Hold	0, 0	0, -1
	Sell	-1, 0	3/2, 3/2

(b) Intermediate reserve game (R=10)

6.1.1. Model Results and Answers

We can see from the matrix (a) that if the government commits a high level of reserves to maintaining the currency peg, speculation against the peg brings a certain loss, and will not occur. Matrix (a) shows that speculating (selling) is for both agents a strictly dominated strategy, with Nash equilibrium of the game being a northwest corner of the matrix, or holding for both agents.

Matrix (b) presents a case with government reserves so low that one private holder alone can buy out the whole amount of the reserves, making a profit of 2 (devaluation of 50% is assumed if the currency peg fails). If both private holders decide to sell their domestic money holdings, they will split the profit, earning 3/2 each. So now the strictly dominated strategy is to hold the domestic money, and the Nash equilibrium resides in the southeast corner of the matrix, and means selling for both private holders.

Matrix (c) presents the case of intermediate government reserves, when no private holder alone can buy out the whole reserves, but combined they have enough domestic money to do so. Here there is no strictly dominated strategy for the two agents, and there are therefore two Nash equilibriums,

one being for both agents to hold their domestic money and earn nothing (but lose nothing too), and the other one being for both agents to sell their domestic money holdings and earn 3/2 each (again with the 50% devaluation after the peg failure). What we see from this example is that, the question of whether speculative attack will occur or not depends not only on the macroeconomic conditions (here foreign currency reserve) but also on belief of what the other players in the market will do. So if the agent believes the other players will enter a speculative attack, he will do so himself. His beliefs however can be changed at any minor event, making a speculative attack in this case one with the self-fulfilling character. As we saw in this simplified example, speculative attacks of a self-fulfilling nature are a possibility recognized both in literature and in practice.

However the explanation given by the simplified model presented above should not be taken as fundamental, for the reason that the issue of lack of the foreign currency reserves has, since its first mention by Krugman in 1979, become less of a problem with countries gaining access to the international capital markets. Modern currency crises cannot be explained by the lack of reserves alone, but this example does provide some insight into the problem of self-fulfillingness of the currency crisis.

When it comes to fiscal deficit and high public debt, as a reason for the currency peg to fail, one should look for the mechanism in how the public perceives government policy and how it creates its expectations about it. It is straightforward to understand that, if the government is mounting ever-higher fiscal deficit, it becomes rational to expect that at least a part of this deficit will be financed through seigniorage, thus rendering the currency peg a matter of history. Most famous examples of currency peg failure, coupled with fiscal imbalance, are the crises in Russia in 1989 and Brazil 1999. The public expectations of peg failure become more inevitable if the government in question already ‘enjoys’ a reputation of non-credibility, or if the country in question undergoes a negative shock which makes other possibilities for closing the fiscal deficit (such as increased taxation) less likely to solve the

problem. A lesson for the government can then only be, to couple exchange rate with sound fiscal policy, but this issue will be discussed more later on.

When it comes to unemployment, the mechanism of how it endangers a currency peg is similar to the discussion on peg failure and fiscal policy. The higher the unemployment, the less credible is the government's dedication to the peg, which contradicts the expansionary monetary and fiscal policy needed to overcome the unemployment problems. Again the more the government has a history of low credibility and the worse the negative shock, country experiences, the higher the chances of the public to expect the peg failure, and the higher the chances of this expectations to become self-fulfilling.

What we can see, is that even if the realistic macroeconomic threats exist, the currency-peg failure is still not an unavoidable event, but also that, even if it is not necessary at all, it is highly likely it will happen if the public expectations are forming in an unfavourable way.

Practice has certainly shown that some exchange rate peg failures, or the so-called currency crisis, can't really be explained with these or any other factors alone. In many cases even though all of the above listed factors, which lead to a currency peg failure, were not an issue, crisis occurred nevertheless, so that some of the crises so can only be explained as self-fulfilling.

One of the famous examples of these 'unexplainable' currency crisis is the European Monetary System, that practically collapsed in August 1993, when member countries agreed to widen the fluctuation band from ±2.25% to around ±15%. I refer here to the EMS history in 1993, as the 'unexplainable' crisis because at the time, all of the member countries of EMS were although facing some of the macroeconomic problems such as unemployment at the level of two digits number (Italy, France, Belgium), high public debt (Belgium) and high fiscal deficit (Italy), still very able to maintain the

currency peg as it was originally devised. A question then arises of why did they abandon it.

Even the crises recurrently hitting the countries of middle and south America (although almost always tied with massive macroeconomic problems), often have features that make them hardly, if at all, explainable by understanding strictly macroeconomic problems, in a sense that although the peg might have been maintained, the government choose to abandon it.
Even when crises have fundamental macroeconomic inconsistencies in their background, there is still a speculative part to them if for nothing then for the timing of the crisis. It is easy to see this in examples of currency crisis occurring in Sweden, Mexico, Thailand and Korea.

It is therefore a question to be discussed here when, (rather than whether) self-fulfilling currency crises are possible, and how probable they are.

6.2. The Multiple Equilibriums Model

To answer this question I will here use a model constructed by Maurice Obstfeld (see Obstfeld 1994).
The output in the country is defined as:

$$y_t = \alpha(e_t - w_t) - u_t, \qquad (2.1)$$

where e_t stands for exchange rate between domestic and foreign currency in logs. PPP holds and foreign price index in logs (p^*_t) is normalized to 0, so that $e_t=p_t-p^*_t$. w_t is wage in domestic currency, and u_t is mean zero, serially independent shock, reflecting foreign interest rate and demand (government and private) changes.
Period t wages are set in advance (in period t-1), and depend on time t-1 expectations of the time t exchange rate, so that the real wage value is preserved.

$$w_t = E_{t-1}[e_t] \qquad (2.2)$$

Given 2.2, workers can't adjust the wages in accordance with the u_t outcome, but the government can make its own adjustments. The loss function that the government is minimizing, thus defining a policy rule is the following:

$$L_t = \sum_{s=t}^{\infty} \beta^{s-t} l_s = \sum_{s=t}^{\infty} \beta^{s-t} \left[\theta (e_s - e_{s-1})^2 + (y_s - y^*)^2 \right], \qquad (2.3)$$

where β, 0<β<1, stands for the government's discount factor, and θ is the coefficient that determines the degree of government's discomfort with inflation. Apart from the inflation, the government is also suffering a loss from the output deviation from its target y*.

By plugging 2.1 into 2.3, one gets the following form of governments period t loss function:

$$l_t = \frac{\theta}{2}(e_t - e_{t-1})^2 + \frac{1}{2}\left[\alpha(e_t - w_t) - u_t - y^*\right]^2 \qquad (2.4)$$

Differentiating 2.4, with respect to the policy variable e_s, gives the following optimality rule:

$$\theta(e_t - e_{t-1}) + \alpha\left[\alpha(e_t - w_t) - u_t - y^*\right] = 0 \qquad (2.5)$$

If we now define λ as $\lambda = \frac{\alpha^2}{\theta + \alpha^2}$, we can rewrite 2.5 as follows:

$$e_t - e_{t-1} = \lambda\left(\frac{u_t}{\alpha}\right) + \lambda(w_t - e_{t-1}) + \lambda\left(\frac{y^*}{\alpha}\right) \qquad (2.6)$$

From 2.6 we can see that by adjusting the exchange rate from period t-1 to period t, the government can accommodate the period t's shock u_t, but also reverse possible wage inflation and push the output over its target y*, by 'surprise' devaluation. So since the period's t wages are fixed in period t-1, government can use this wage rigidity to increase foreign competitiveness of the domestic output and thus push the output above its target level, with a simple increase in period t's exchange rate. Only if θ is infinitely large (θ→∞), hence if the government has infinitely large distaste for inflation, will the exchange rate be ex-post fixed.

As workers are rational, they understand the government strategy set out in 2.6, so that they set their wages accordingly:

$$w_t = e_{t-1} + \lambda E_{t-1}\left[\frac{u_t}{\alpha}\right] + \lambda(w_t - e_{t-1}) + \lambda\left(\frac{y^*}{\alpha}\right)$$

and, since $E_{t-1}[u_t] = 0$:

$$w_t = e_{t-1} + \frac{\lambda}{\lambda - 1}\left(\frac{y^*}{\alpha}\right) \qquad (2.7)$$

Now combining 2.6 and 2.7, one obtains the optimal exchange rate:

$$e_t - e_{t-1} = \lambda u_t + \frac{\lambda}{\lambda - 1}\left(\frac{y^*}{\alpha}\right) \qquad (2.8)$$

One can see from 2.8, that unless λ=0, government will always generate inflation, as a consequence of its attempts to use wage rigidity in pushing output above its natural level. Like already said above, unless θ is infinitely large, the exchange rate can't be credibly fixed.

To solve this anomaly in governments behaviour, one can model the fixed cost government suffers if it devalues into the government's loss function. This fixed cost can be understood as the cost of a loss in credibility for the government. Now the government's loss function will take the following form:

$$l_t = \frac{\theta}{2}(e_t - e_{t-1})^2 + \frac{1}{2}\left[\alpha(e_t - w_t) - u_t - y^*\right]^2 + cZ_t, \qquad (2.9)$$

where c is the fixed cost of exchange rate realignment and Z_t=1 if e_t-e_{t-1}≠0, and Z_t=0 otherwise.

From 2.2, one can derive the period t's inflation as follows:

$$\pi_t = w_t - e_{t-1} = E_{t-1}[e_t] - e_{t-1}$$

Now we see that in case the exchange rate is fixed, the government's loss function, defined under 2.9 becomes:

$$l_t^F = \frac{1}{2}\left[\alpha\pi_t + u_t + y^*\right]^2 \qquad (2.10)$$

and if the exchange rate is realigned in period t, the government faces loss defined as:

$$l_t^R = \frac{1}{2}(1-\lambda)\left[\alpha\pi_t + u_t + y^*\right]^2 + c \qquad (2.11)$$

Obviously if the difference between the loss accrued under fixed exchange rates and loss under flexible exchange rates is higher then 0.

$$l_t^F - l_t^R = \frac{1}{2}\lambda\left[\alpha\pi_t + u_t + y^*\right]^2 - c > 0$$

or if:

$$\frac{1}{2}\lambda\left[\alpha\pi_t + u_t + y^*\right]^2 > c \qquad (2.12)$$

6.2.1. Model Results and Answers

Solving 2.12 for u_t, we get two solutions, so that when u_t is lower then the lower of the two solutions $\underline{u}$, the revaluation will occur and when the u_t is higher then the higher of the two solutions $\bar{u}$, the devaluation will occur. In other words, the band is defined, within which the exchange rate stays unchanged, and outside of which, on the lower side, revaluation, and on the upper side, devaluation occurs. In case realignment of the exchange rate is optimal, according to the rule 2.12, the exchange rate will be realigned in accordance with the 2.6.

The problem with this solution is again time-inconsistency. The lower and the upper point of the band within which there occurs no exchange rate realignments, depend on the expectation of inflation and this one in turn depends on perception of the band extreme points. This circularity creates the possibility for multiple equilibriums in which, due to expectations, a minor shock can produce high movements in what used to be perceived as an easily maintainable fixed exchange rate.

To illustrate this possibility on a simplified example, one can assume that if realised u_t is higher then $\bar{u}$, devaluation will occur, while the revaluation is not possible. Further, the distribution of u_t is assumed to be uniform, over the interval [-μ,μ], and with the mean zero.

Due to the circularity that we mentioned, the procedure of finding the equilibrium exchange rate will take two steps. First the expectation of the inflation rate, given the expected threshold upper level $\bar{u}$, is determined, and then the actual threshold level, given the market's expectations of the inflation rate, is calculated.
The market form its expectation of the inflation rate as follows:

$$\pi = \Pr\left[u_t \le \bar{u}\right]0 + \Pr\left[u_t > \bar{u}\right]E\left[e_t - e_{t-1}\middle| u_t > \bar{u}\right]$$

with:

$$\Pr\left[u_t > \bar{u}\right] = \frac{\mu - \bar{u}}{2\mu} \qquad E\left[u_t \middle| u_t > \bar{u}\right] = \frac{\mu + \bar{u}}{2}$$

Now given 2.6., one can calculate the expected exchange rate devaluations as follows:

$$E\left[e_t - e_{t-1} \middle| u_t > \bar{u}\right] = \lambda\left(\frac{\mu + \bar{u}}{2\alpha}\right) + \lambda\pi + \lambda\left(\frac{y^*}{\alpha}\right)$$

and putting it together we obtain the expression for inflation which government will take as a given:

$$\pi = \left(\frac{\mu - \bar{u}}{2\mu}\right)\left[\lambda\left(\frac{\mu + \bar{u}}{2\alpha}\right) + \lambda\pi + \lambda\left(\frac{y^*}{\alpha}\right)\right]$$

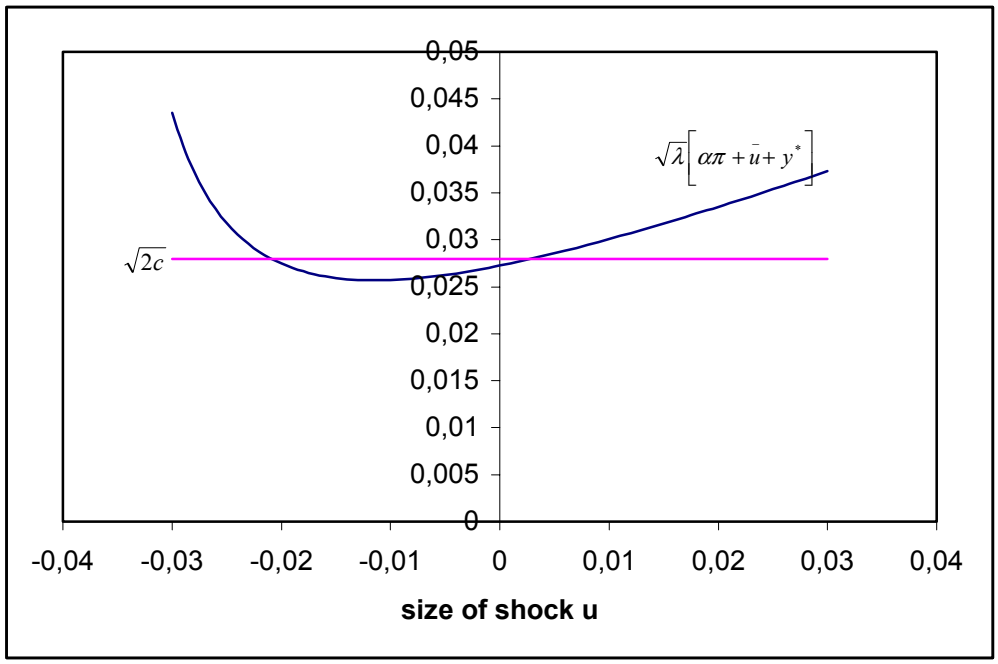
or in a reduced form:

$$\pi = \frac{\lambda\left(\frac{\mu - \bar{u}}{2\mu}\right)\left[\left(\frac{\mu + \bar{u}}{2\alpha}\right) + \left(\frac{y^*}{\alpha}\right)\right]}{\left[1 - \lambda\left(\frac{\mu - \bar{u}}{2\mu}\right)\right]} \qquad (2.13)$$

Now going back to 2.12, we can define the solution to the threshold level that, when crossed (from below), produces a devaluation, as follows:

$$\sqrt{\lambda}\left[\alpha\pi + \bar{u} + y^*\right] = \sqrt{2c} \qquad (2.14)$$

2.14 has multiple solutions, as shown on the graph 5. The graph was produces using the following calibration: α=1, and θ=0.15 (giving λ=0.87), y*=0.01, and μ=0.03.



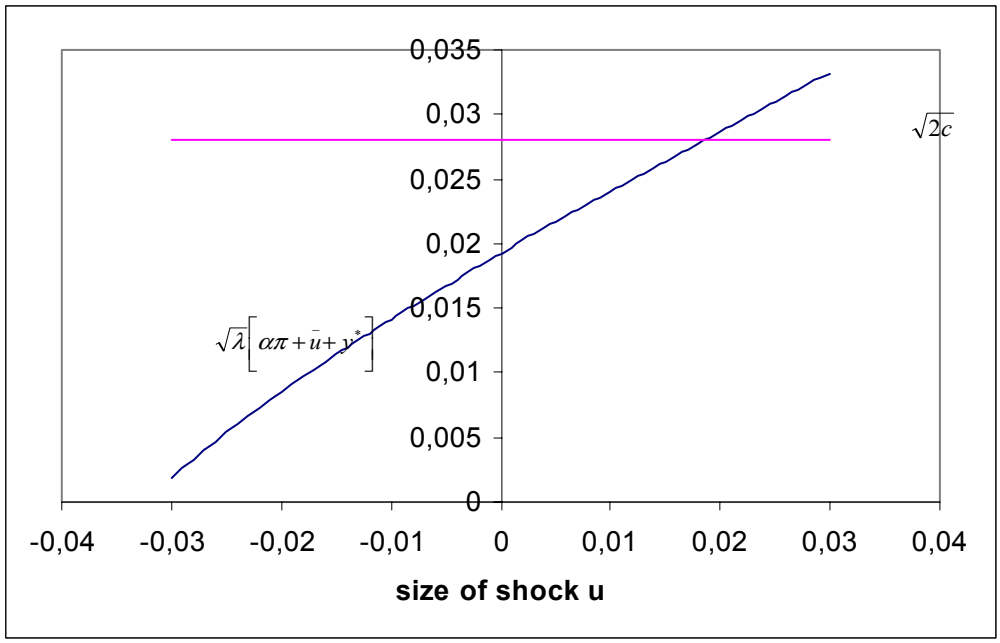
Graph 5.Equilibrium exchange rate devaluations,
depending on the size of the shock u_t, (with θ=.15).

As we can see on the graph 5., the devaluation occurs if the realised shock u_t crosses the threshold level of, in the first case $\bar{u} = -0.021$, in which case the resulting inflation rate is 4.11%, or in the second case if the realised shock u_t crosses the threshold level of $\bar{u} = 0.003$, in which case the resulting inflation rate will be 1.7%. If the expectations form the equilibrium of the first case, with extremely high inflation and thus unemployment, the devaluation will become inevitable unless a very positive shock occurs so that the expectations here become self-fulfilling.

The question of which equilibrium will be realised is an open one. It is still possible to see that any minor event can cause expectations to form in an unfavourable way, hence around the self-fulfilling devaluation point.

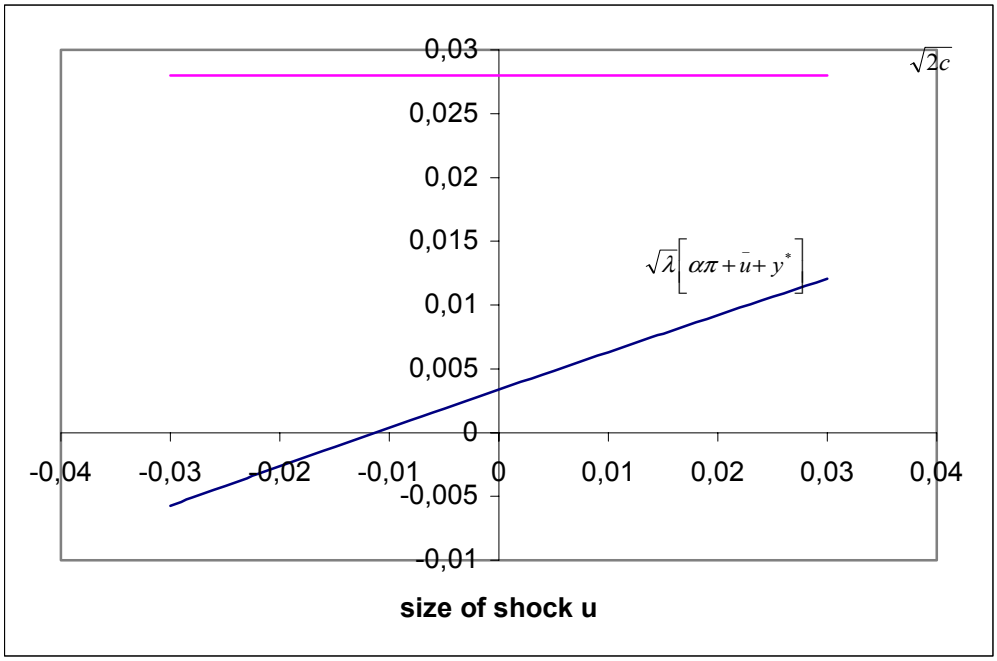
However, if the calibration is changed, so are the results. Specificly, if we allow the government's discomfort with devaluation (or revaluation) to be higher, the occurrence of multiple equilibriums will be less possible.
Graph 6 presents the case where government's discomfort with exchange rate changes is medium, i.e. θ=0.45. In this case there is a unique

equilibrium with u_t=0.019, which means in the case of a rather negative shock, which here produces an inflation rate of 0.5%.



Graph 6.Equilibrium exchange rate devaluations,
depending on the size of the shock u_t, (with θ=.45).

Graph 7 presents the case where governments discomfort with exchange rate changes is very high, i.e. θ=10. In this case there is no unique equilibrium with already assumed distribution of μ on in the interval [-0.03, 0.03], which means that in this case, a shock has to be extremely negative for the exchange rate change to occur.



Graph 7.Equilibrium exchange rate devaluations,
depending on the size of the shock u_t, (with θ=10).

What we can conclude from the results that the self-fulfilling crisis model is presenting is that although self-fulfilling character of the currency crisis is there it is not impossible to affect its occurrence. If the government manages to present its policy of fixing the exchange rate as credible, that is if its overall economic policy is consistent with exchange rate peg, then the probability of currency crisis becomes considerably smaller.

The issue of economic policy consistency will be discussed further in the following section of the paper.

7. Currency Board – How To

We have seen what the benefit of adopting a monetary board might be increased nominal prices flexibility. We have also seen what costs adopting it might bring loss of discretion in monetary and fiscal policy, high foreign reserves requirement, and a possible currency crisis bringing along with it, usually, huge foreign currency reserves losses. The question arises of how to balance these benefits and costs, or in other words what to do to make a monetary board worthwhile.

Here I will outline, what has allready been mentioned in a form of a list of problems and also some toher issues, as a list of guidelines to be followed if a monetary board is to be adopted.

7.1 Choice of monetary board anchor currency

What countries adopting a monetary board are doing is chosing one or a basket of foreign currencies to peg (fix) their exchange rate to. The currencies appearing in practice as the anchoring ones are US Dollar and Euro[11]. Argentina adopted a monetary board in 1991, linking its currency to the US Dollar, Estonia linked its currency, the Kroon, to the German Mark in 1992, Lithuania linked its currency, Litas, to the US Dollar in 1994, Bosnia and Herzegovina linked its convertible Mark to German Mark in 1997 and Bulgaria linked its Lev to a basket of currencies, consisting of 50% US dollar and 50% Euro, in 1997. Hong Kong pegged its dollar to US dollar.

The question is, how the anchoring currency should be chosen once the decision of adopting a monetary board is made. Literature has provided some answers to this question[12]. Mainly the answers come down to the following:

- the anchoring currency should be the currency of a country that has similar business cycles like the country linking its currency to it;

[11] Euro also replaced the German Mark as the anchoring currency when the Mark was redrawn from official use on 31st December 2001.

[12] There is an extensive literature dealing with the topic of currency areas optimality, see for example Frankel and Rose (1998), that can be applied for answering the question asked here, about anchoring currency optimality.

- the anchoring currency should be the currency of a country with which the country in question has important trade relations (country's main trading partner).

The logics of these two rules are rather simple. Since introducing a monetary board means that the country is giving up on its discretionary monetary policy, and effectively following the monetary policy of the country whose currency it chose as an anchor, then the monetary policy of the anchoring currency becomes its own. So what country is effectively doing when choosing an anchoring currency is choosing a monetary policy. Obviously it is in countries' best interests to choose a monetary policy, which will best suit its needs, that is, its business cycles, and this policy would be the policy of the country with the matching business cycles.

As for the importance of extensive trade relations, there is empirical work suggesting that trade benefits from exchange rate stability, see for example Glick and Rose (2002), Rose (2001) and Rose and Wincoop (2001). One can understand this by assuming the traders to be risk averse, and remembering that the exchange rate, if not fixed, brings along a certain risk. This logic does have a flaw in disregarding the possibility of exchange rate risk hedging, which is actually developed to the level where the exchange risk is nullified. Still empirical results prove that the trade does benefit from the elimination of exchange rate fluctuations (be it through a monetary board or currency union), and one can try to explain it further by the possibility that it is not the exchange rate risk elimination alone that boosts the trade but the combined effect of countries convergence, which itself starts with the exchange rate risk elimination. Choosing the currency of an important trade partner as an anchor for the monetary board benefits trade, and this in turn will benefit the two countries convergence making their business cycles more in tune with one another, thus making the monetary policy appropriate for both countries.

7.2 Fiscal policy

Fiscal policy as a problem for maintaining the fixed exchange rate has been discussed in the previous section. Here I would like to point to a few facts

that vast amounts of literature[13] point to, more as what to do and not what could be a problem when it comes to fiscal policy and monetary board.
The soundness of fiscal policy must be preserved if the monetary board is adopted. Soundness here means first of all Solvency. The fiscal deficit at high levels is to be avoided at all costs. Reasons are simple: once the fiscal deficit rises to the level where it becomes obvious that the government can not struggle out of it, without turning its back on fixed exchange rate course, the credibility is destroyed and the crisis becomes inevitable even if the fixed rate was actually maintainable.
The problem off course arises in the fact, that maintaining the monetary board might become too costly since it means giving up on discretionary fiscal policy. This problem should be dealt with by choosing an appropriate anchor currency so that 'putting the fire out' with insolvent fiscal measures will not become necessary.
One additional question arises here. One might ask him- or herself, for what reason does the fiscal policy become so unsound, insolvent that is. One can again look for answers in history, and one will find that the dangerous source of fiscal misbalance is bailing out state owned sectors (usually the banking sector[14]). What this means is that the problem should be dealt with at its origin, or that structural changes, if needed, should be made in the state owned sectors before the decision on giving up on discretionary economic policies by adopting a monetary board is made. These issues are again complex enough to be the topic of yet another paper of this scale, and so will not be further discussed here.

7.3 Foreign Currency Reserves

The issue of foreign currency reserves was also commented on in the previous sections. Here I would like to point to one more thing. The level of

[13] Here I refer mainly to the literature analysing the Argentinean monetary board collapse, which many attributed to the unsound fiscal policy, among other problems. See for example Edwards (2002) and Calvo, Izquierdo and Talvi (2003).
[14] One can find typical examples of the banking sector bail out that turned out to bare huge costs for the state budget, in recent experiences of Argentina and post transition experiences of Czech Republic.

foreign currency reserves is practically prescribed by law, when a monetary board is adopted, since full backing of monetary base is part of the monetary board agreement. It is costly for the country to hold these reserves as they are usually invested at the minimum rate of return to provide the minimal risk. This issue can become something to try to negotiate on and when it comes to negotiating it is important to remember that the costs of these funds are not to be compared to other opportunities but to the benefits coming from the minimal risk that these funds are baring, and these benefits mainly come down to the credibility, which, although it can hardly be quantified, is an issue of utter importance for the monetary board itself and economy as a whole.

8. Summary and Concluding Remarks

This paper had an aim to give answers to a question of what the costs and benefits of a currency board could be. We have seen that the main benefit of introducing a monetary board is an increase in nominal prices flexibility. This goal was what motivated the exchange rate policy in the beginning, and what gave a rationale to the flexible or floating exchange rates. Off course the model by Devereux presented here, like any other model is just a rough approximation of what might be happening in the real world, and as such suffers shortcomings of too many and too restrictive assumptions. Still, the model's explanation of reality deserves at least to be considered seriously and tested with further empirical work. The scope of this paper however, assumes that the fixed exchange rates are indeed increasing the nominal prices' flexibility, and proceeds to discuss what the costs of adopting a monetary board might be.

To analyse the costs a country might suffer by adopting the monetary board, first all the problems with implementing it are discussed. We have seen that the problems are many and that especially important one is the problem of self-fulfilling character of the currency crisis. Once this is recognized as a problem, and some quantitative results are given of what exactly the costs of these self-fulfilling crises might be, the paper proceeds with analysing the rules that should be obeyed in order for these costs to be minimised, and the possibility of self-fulfilling crises, if not ruled out, brought to minimum.

I listed the rules to be maintaining a sound fiscal policy, keeping appropriate level of foreign currency reserves and wise choice of anchor currency of the monetary board. Problems of interest rates policy was also discussed and along with it problem of unemployment, contagion and finally maybe the most serious problem of market confidence.

What is underlying to all these issues is that a monetary board is a rather radical form of exchange rate and monetary policy, and as such requests rather rigid set of accompanying policies, which can be costly. It is rather a difficult political decision not to intervene in times of high unemployment, but it is also necessary not to if the monetary board is a chosen option. The ultimate cost of abandoning the monetary board is loss of credibility, which

can render all future attempts to intervene in any way, unsuccessful. Worse still if the decision to abandon the currency peg is not made, as it is practice often not maid, early in the process of defending it, losses can be much more material since they will then measure in billions of lost foreign currency reserves. So the rule should also be don't abandon but if you abandon then do it immediately, not waiting for the speculators to make you do so.

It can finally be said that the monetary board is a good choice for a country that has a rather stable course of economic policies, meaning balanced current account and budget, stable unemployment and growth, so that no radical interventions are needed, since once the monetary board is adopted they are not likely to be taken without severe consequences. It is also a practice that he monetary boards are introduced in countries lacking history of credibility, and this indeed is the case where monetary board can be a good solution. On the other hand is the monetary board becomes a solution no longer attainable due to change in macroeconomic environment it should be abandoned before the speculative attack occurs, thus preventing the unnecessary losses.

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10. Appendix

The second order approximation of the utility difference, for the agent that does, and the agent that does not, adjust his price, can be derived as follows. The utility function for the agent that does not adjust its price is the following:

$$\hat{U}\left(\hat{P}_h(i), P_h, P, X\right) = \ln\left(\hat{P}_h(i)^{1-\lambda} P_h(i)^{\lambda-1} \frac{M}{\chi P}\right) - \frac{\eta}{1+\psi}\left(\hat{P}_h(i)^{-\lambda} P_h(i)^{\lambda-1} \frac{M}{\chi P}\right)^{(1+\psi)}$$

The utility function for the agent that does not adjust its price is the following:

$$\tilde{U}\left(P_h, P, X\right) = \ln\left(\left(\eta \frac{\lambda}{\lambda-1}\right)^{\frac{1-\lambda}{\lambda(1+\psi)}}\left(\frac{P}{P_h}\right)^{\frac{1-\lambda}{\lambda}}\left(\frac{M}{\chi P}\right)^{\frac{1}{\lambda}}\right) - \frac{(\lambda-1)}{\lambda(1+\psi)}$$

For simplicity of notation it is assumed that $Z = \frac{M}{\chi P}$ and $Q = \frac{P}{P_h}$.

Then we can approximate the difference in utility, when adjusting the price, and when not, to be the following:

$$\tilde{U} - \hat{U} =$$

$$0 + \left[\frac{1}{\lambda} - 1 + \eta \bar{H}^{1+\psi}\right]\frac{Z-\bar{Z}}{\bar{Z}} + \left[\frac{1-\lambda}{\lambda} + \eta \bar{H}^{1+\psi}\right]\frac{Q-\bar{Q}}{\bar{Q}} - \left[(\lambda-1) - \lambda\eta \bar{H}^{1+\psi}\right]\frac{P_h - \bar{P}_h}{\bar{P}_h}$$

$$-\frac{1}{2} + \left[\frac{1}{\lambda} - 1 + \eta \bar{H}^{1+\psi}\right]\frac{\left(Z-\bar{Z}\right)^2}{\bar{Z}^2} - \frac{1}{2}\left[\frac{1-\lambda}{\lambda} + \eta \bar{H}^{1+\psi}\right]\frac{\left(Q-\bar{Q}\right)^2}{\bar{Q}^2}$$

$$+\frac{1}{2}\left[(\lambda-1) - \lambda\eta \bar{H}^{1+\psi}\right]\frac{\left(P_h - \bar{P}_h\right)^2}{\bar{P}_h{}^2}$$

$$+\frac{\eta(1+\psi)\bar{H}^{1+\psi}}{2}\left(\frac{\left(Z-\bar{Z}\right)^2}{\bar{Z}^2} + \lambda\frac{Z-\bar{Z}}{\bar{Z}}\frac{P_h - \bar{P}_h}{\bar{P}_h} + \frac{P_h - \bar{P}_h}{\bar{P}_h}\frac{Q-\bar{Q}}{\bar{Q}}\right)$$

$$+\frac{\eta(1+\psi)\bar{H}^{1+\psi}}{2}\left(\frac{\left(Q-\bar{Q}\right)^2}{\bar{Q}^2}+\lambda\frac{Q-\bar{Q}}{\bar{Q}}\frac{P_h-\bar{P}_h}{\bar{P}_h}+\frac{Z-\bar{Z}}{\bar{Z}}\frac{Q-\bar{Q}}{\bar{Q}}\right)$$

$$+\frac{\eta(1+\psi)\bar{H}^{1+\psi}}{2}\left(\frac{\left(P_h-\bar{P}_h\right)^2}{\bar{P}_h{}^2}+\lambda\frac{Q-\bar{Q}}{\bar{Q}}\frac{P_h-\bar{P}_h}{\bar{P}_h}+\frac{Z-\bar{Z}}{\bar{Z}}\frac{P_h-\bar{P}_h}{\bar{P}_h}\right)$$

All the terms inside the square brackets are, at the initial non-stochastic equilibrium, equal to zero. Taking expectations and using the fact that, again in equilibrium $\eta\bar{H}^{1+\psi}=\frac{\lambda-1}{\lambda}$, we get that the sum of the last three expressions in the brackets is var(λp_h+m-χ), which leads us to the final result given in the text.

Affidavit

I hereby state that I have written this paper on my own and with full acknowledgement of the used sources.

Tamara Bašić

Berlin, 16. Oktober 2003