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On the Credibility of Currency Boards

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Abstract

The paper compares the credibility of currency boards and (standard) pegs. Abandoning a currency board requires a time-consuming legislative process and an abolition will thus be previously expected. Therefore, a currency board solves the time inconsistency problem of monetary policy. However, policy can react to unexpected shocks only with a time lag, thus the threat of large shocks makes the abolition more likely. Currency boards are more credible than standard pegs if the time inconsistency problem dominates. In contrast, standard pegs, that can be left at short notice, are more credible if exogenous shocks are highly volatile and constitute the dominant problem.

JEL-classification: E42, E52, F33

Keywords: monetary policy, currency board, standard peg, credibility,
time inconsistency problem, stochastic purchasing power parity

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1 Introduction

During the crisis-prone decade of the nineties, currency boards proved to be remarkably robust. Even in Argentina, where the currency board collapsed in 2002, not only the breakdown itself, but also the fact that the currency board could survive such a long time in spite of large strains requires an explanation. In this context, the question arises as to what constitutes the difference between a currency board and a standard peg system and under what circumstances a currency board has a credibility advantage.

A currency board is characterised by a fixed exchange rate to a stable anchor currency and full coverage of the monetary base by foreign reserves[1]. It requires a long-term commitment by policy makers and is usually introduced by law (which also specifies the fixed exchange rate). The main advantage of a currency board is the gain in credibility. The monetary base is changed only through buying and selling the anchor currency at the fixed rate. Thus, the trilemma that it is not possible to maintain a fixed exchange rate, free movement of capital and an independent monetary policy at the same time is solved by clearly abstaining from monetary independence. Moreover, the time inconsistency problem of monetary policy is solved, as it is not possible for the monetary authorities to create surprise inflation.

However, the gain in credibility of monetary policy relies on the credibility of the currency board itself, which is, of course, not complete. A currency board does not break down because it runs out of reserves necessary to intervene on the exchange rate market, as may be the case in a standard peg system. But it can be abolished if the costs of maintaining it – for example in case of a recession, a debt crisis or problems within the banking sector – exceed its advantages.

Although currency boards have been discussed thoroughly, there is not much literature that theoretically analyses the difference between a currency board and a standard fixed exchange rate regime. One of the few papers that try to model this difference is Chang and Velasco (2000). They characterise a currency board by the full coverage of the monetary base, which excludes a run on the central bank's reserves that is possible with a standard peg. As Chang and Velasco consider opportunity costs of holding reserves, but do not model any possible disadvantages of flexible exchange rates, their conclusion that a flexible exchange rate is the optimal regime is no surprise. A different approach to capture the difference between a currency board and a standard peg is used by Oliva

[1] A thorough discussion of currency boards can be found in Williamson (1995) and Ho (2002).

et al. (2001) who analyse whether monetary authorities can signal their preferences on price stability by choosing between these two exchange rate systems. They emphasise that a currency board constitutes a long term commitment and assume that it can only be abolished in the second period of their two period model, whereas with a standard peg a realignment in response to a supply shock is possible in either period. In contrast, Irwin (2004) assumes that the policy maker can abolish a currency board without any time lag, but that the costs of doing so are particularly high. The central result is that "the combination of incomplete information and persistence of unemployment can lead to a build up of pressure on a currency board system to the extent that it does collapse, even where the true devaluation cost is very high".

In this paper, we take up the idea of Oliva et al. (2001) that a currency board cannot be abolished overnight, but we do so more consistently. A currency board is established by law, and leaving it requires a political process including preceding public discussion. However, this feature is not captured adequately in Oliva et al. (2001) as they allow for a sudden exit out of the system in the second period[2]. Repealing a currency board takes time, implying that it is hardly possible to generate a surprise. When Argentina finally left its currency board, this had been largely expected.

In our model, the currency board is characterised by the assumption that – in contrast to the case of a standard peg – its abolition will be known in advance. The currency board can only be left if this was announced earlier[3]. Thus, when expectations on inflation are formed, it is known whether the currency board will still be in place in the next period. Therefore, the currency board completely solves the time inconsistency problem of monetary policy. Nevertheless, announcing the abolition of the currency board may make sense in case of a lasting misalignment.

Pressure to change the exchange rate emerges from asymmetric shocks that require an adjustment of the real exchange rate, i.e. from stochastic shocks on the purchasing power parity (PPP) (Berger et al. 2001). These shocks may for example arise from differing business cycles. They may also reflect exchange rate movements between the anchor currency and third countries. Although the Argentinean currency board ultimately collapsed because of unresolved budget problems, the sharp devaluation of the Brazilian

[2]Another unsatisfactory assumption of their model is that in case of giving up the fixed exchange rate, the currency will devalue by an exogenously given amount.

[3]Of course, this is not to be understood literally in the sense that in the real world the exact date of the abolition will be announced. The point is, that the breakdown of the currency board will be expected and no surprise inflation can be created.

Real in 1999 and the strength of the US$ in the years 2000 until mid 2002 contributed to Argentina's difficulties and help to explain the time of the breakdown.

The *PPP*-shocks are assumed to be autocorrelated, meaning that a shock has lasting effects. After observing the shock of the first period, the policy maker will decide whether to initiate the process of repealing the currency board. If the shock is large, he knows that with a high probability the misalignment will continue in the following period. But if the currency board is abolished, the time inconsistency problem of monetary policy reemerges. In contrast, in a standard peg regime the policy maker can make use of an escape clause after observing the shock in each period. He can respond to a large shock, but he is also tempted to create surprise inflation. As a result, a currency board arrangement is more credible than a standard-peg regime, if the time inconsistency problem is the dominant one, whereas the peg is maintained with a higher probability, if the ability to react to future shocks is more important.

This paper is organised as follows: in the next section we develop our two-period model. In section 3 we consider the regime of a floating exchange rate, which will be in operation if the fixed exchange rate is abolished. Section 4 analyses the policy options under a currency board. We derive conditions under which the currency board will be maintained and show in which situations it will be abandoned. In section 5 the behavior of the policy maker in a standard fixed exchange rate system is considered. Section 6 compares the credibility of the two fixed exchange rate regimes considered. Section 7 concludes the paper.

2 The Model

We consider a two-period model of a small open economy that has a time inconsistency problem of monetary policy modelled as in Kydland and Prescott (1977) and in Barro and Gordon (1983). In each period t, the deviation from natural output y_t is given by a standard *Lucas supply function*

$$y_t = \gamma(\pi_t - \pi_t^e), \quad \gamma > 0. \tag{1}$$

Output depends on unanticipated inflation $(\pi_t - \pi_t^e)$, where π_t denotes inflation in period t and π_t^e is the inflation rate expected by the private sector. Expectations are formed rationally. The inflation rate and the exchange rate are linked by the *stochastic purchasing power parity (PPP)*

$$\pi_t = \pi_t^* + e_t + \phi_t \ , \tag{2}$$

where π_t^* denotes foreign inflation, e_t the percentage change of the nominal exchange rate in period t, and ϕ_t is a random shock (BERGER et al. 2001).
The shock ϕ_t is autocorrelated[4]

$$\phi_t = \eta\phi_{t-1} + u_t \ , \quad \eta \in (0,1) \ , \tag{3}$$

and it is assumed that initially there is no inherited shock, i.e. $\phi_1 = u_1$.

ϕ_t represents an asymmetric shock that changes the equilibrium real exchange rate reflecting for example differing business-cycles or exchange rate movements between the anchor currency and third countries. A positive ϕ_t corresponds to the necessity of a real appreciation, which can either be realised by an inflation rate exceeding foreign inflation or by a falling exchange rate. New shocks u_t are i.i.d. with $\mathrm{E}(u_t) = 0$ and $\mathrm{Var}(u_t) = \sigma_u^2$ for all t. In sections 5 and 6, we will assume in addition that u_t is uniformly distributed on the interval $[-A, A]$.

Normalizing the foreign inflation π^* to zero, equation (2) can be rewritten as

$$\pi_t = e_t + \phi_t \ . \tag{4}$$

The monetary authorities' loss in period t is given by the function

$$L_t = (y_t - k)^2 + \theta\pi_t^2 + \delta c \ , \tag{5}$$

where k is the target output-level of the policy maker, which is higher than the natural output level, meaning that the desired deviation from natural output is positive. The higher k is, the larger is the policy maker's incentive to create unexpected inflation i.e. the larger is the time inconsistency problem. The relative weight of inflation in the loss-function is given by θ. In addition, there are political costs c that arise when the fixed exchange rate is given up under a peg regime or when the currency board arrangement is abandoned. These political costs can either be interpreted as reputation costs or as costs caused by political institutions in society (LOHMANN 1992). δ is a dummy variable, which equals one when leaving the peg or the currency board and equals zero otherwise. Using equations (1), (4) and (5), the loss function is given by

$$\begin{aligned} L_t &= (\gamma(\pi_t - \pi_t^e) - k)^2 + \theta\pi_t^2 + \delta c \\ &= (\gamma(e_t + \phi_t - \pi_t^e) - k)^2 + \theta(e_t + \phi_t)^2 + \delta c \ . \end{aligned} \tag{6}$$

[4]Equivalently, we could assume that shocks ϕ_t are uncorrelated, but prices are sticky instead. This would mean that inflation reflects the current shock only partially, leaving some of the required adjustment for future periods. In this sense, the parameter η can be interpreted as a degree of price stickiness.

In our model, the essential difference between a currency board and a standard peg lies in the procedure of abolishing the particular system. A currency board, characterised by its establishment by law and the complete renunciation of individual monetary policy, can only be repealed, if this was announced one period in advance, i.e. before the private sector made its expectations on inflation. In contrast, monetary authorities can leave the fixed exchange rate in a far more flexible way after the shock was observed. The sequence of the model is depicted in the following figure.

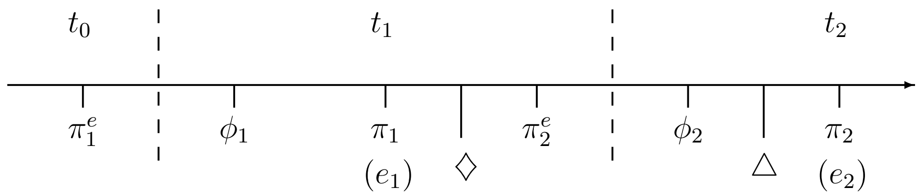

Figure 1: Sequence of the model

Expectations π_t^e have to be formed before the shock ϕ_t is observed. Actual inflation is determined by the purchasing power parity (equation 4) if the exchange rate is fixed, and it is optimally set by the policy maker in response to the shock if the exchange rate is flexible or the fixed exchange rate is abandoned. In our two-period model, the decision whether to repeal the currency board in the second period or not is announced in the first period at time $\diamondsuit$ before the private sector forms expectations π_2^e. In the case of a standard peg, the fixed exchange rate can be abandoned after observing the shock which would actually be possible in the first as well as in the second period. However, we assume that the fixed exchange rate is maintained in the first period and the decision whether to defend it or not is considered at time $\triangle$ in the second period. This could be justified by the fact that a standard peg has some commitment value, too, and cannot be abolished immediately after its adoption. The more important reason for making the assumption is, however, that a meaningful comparison of the credibility of a currency board and a standard peg has to be based on a *single* decision whether to give up the fixed exchange rate or not in both systems. If the currency board can only be abolished at one point of time, but for the standard peg abolition is considered both in period 1 and period 2, a statement that an abolition of the standard peg is more probable will be irrelevant.

3 Free Float Regime

In our model the process of repealing a currency board system takes time and has to be announced one period in advance. In this case, the policy maker will set the inflation rate (and thus the exchange rate) in period 2 optimally, and this policy will be taken into account when expectations are formed. This regime amounts to a free float in period 2 that will briefly be analysed in this section.

Consider the loss in period 2 (equation 6)

$$L_2 = (\gamma(\pi_2 - \pi_2^e) - k)^2 + \theta\pi_2^2 \ .$$

The monetary authorities can freely choose inflation. By minimizing L_2, inflation in period 2 equals

$$\pi_2 = \frac{\gamma(\gamma\pi_2^e + k)}{\gamma^2 + \theta} \ . \tag{7}$$

As the private sector's expectations are rational, it follows that

$$\pi_2^e = E(\pi_2) = \frac{\gamma^2\pi_2^e + \gamma k}{\gamma^2 + \theta} \ ,$$

and thus

$$\pi_2^e = \gamma\frac{k}{\theta} \ . \tag{8}$$

Using equations (1),(4) and (7) yields the equilibrium values for period t

$$\pi_2^f = \gamma\frac{k}{\theta}, \qquad e_2^f = \gamma\frac{k}{\theta} - \phi_2, \qquad y_2^f = 0 \ . \tag{9}$$

The superscript f denotes "free float". With flexible exchange rates, the PPP-shock ϕ_2 is fully absorbed by the change of the exchange rate e_2^f. The inflation rate π_2^f is independent of ϕ_2, but depends on the size of the time inconsistency problem k. In equilibrium, output equals natural output. The resulting loss in period 2 is given by

$$L_2 = \frac{1}{\theta}k^2(\gamma^2 + \theta) \ . \tag{10}$$

Note that L_2 does not depend on the shock ϕ_2, but only on k, hence $E(L_2) = L_2$.

4 Policy Options under a Currency Board

The policy maker has to announce one period in advance (at time $\diamondsuit$ in figure 1) whether to maintain or to abolish the currency board in the next period. Thus, the decision depends on the expected second period loss of the two cases, which are compared to each other in the following analysis.

4.1 Currency board maintained over both periods

First, we consider the case of a currency board regime that is kept over both periods; i.e. the monetary authorities do not announce the abolition of the currency board in period 1, implying that $e_2 = 0$ irrespective of the shock in period 2. Using equations (3) and (4), the second period's inflation rate is given by

$$\pi_2 = \phi_2 = \eta\phi_1 + u_2 \ , \tag{11}$$

meaning that inflation depends only on the shock ϕ_2. Thus the expected inflation π_2^e equals[5]

$$\pi_2^e = E_1(\phi_2) = \eta\phi_1 \ . \tag{12}$$

Expected and actual inflation differ by the new shock u_2. Substituting $\eta\phi_1$ for π_2^e in equation (6) yields a second period loss of [6]

$$L_2^{cc} = (\gamma(\phi_2 - \eta\phi_1) - k)^2 + \theta\phi_2^2 \ . \tag{13}$$

Equilibrium values are given by

$$\begin{aligned} e_2^{cc} &= 0 \\ \pi_2^{cc} &= \phi_2 = \eta\phi_1 + u_2 \ , \\ y_2^{cc} &= \gamma(\pi_2^{cc} - \pi_2^e) = \gamma(\eta\phi_1 + u_2 - \eta\phi_1) = \gamma u_2 \ . \end{aligned} \tag{14}$$

As the exchange rate cannot be changed, e_2^{cc} equals zero. Thus, π_2^{cc} is independent of k and the time inconsistency problem of monetary policy is solved at the cost of having no policy option to counteract ϕ_2. Equilibrium output depends on the realization of the unexpected part of ϕ_2, the new shock u_2. The expectation of period 2 loss, contingent on first period information, is given by

$$\begin{aligned} E_1(L_2^{cc}) &= E_1\left((\gamma u_2 - k)^2 + \theta\phi_2^2\right) \\ &= (\gamma^2 + \theta)\sigma_u^2 + k^2 + \theta\ (\eta\phi_1)^2 \ . \end{aligned} \tag{15}$$

The threat of a large expected second period shock, represented by a high variance σ_u^2 and a high inherited shock ϕ_1, leads to a high expected second period loss, as the policy maker has no options to counteract the shock. This effect is reinforced by a large time inconsistency problem of monetary policy, represented by a high level of k.

[5] In the following analysis, we use E_1 as the abbreviation for the expectation contingent on available information in the first period I_{t_1}, i.e. $E_1 = E(\cdot|I_{t_1})$.

[6] The superscript cc stands for the case in which the currency board is maintained over both periods and cf denotes the situation of abolishing the currency board in the second period.

4.2 Currency board being abolished after the first period

In this subsection, we consider the case that the government has adopted a currency board regime, but announces its abolition at the end of the first period and introduces a free float system for period 2. Note that e_1 equals zero and the monetary authorities can set π_2 (and therefore e_2) optimally after observing ϕ_2.

The monetary authorities optimise the period 2 social loss according to the flexible exchange rate case. The equilibrium values of e_2^{cf}, y_2^{cf} and π_2^{cf} are identical to those of a flexible exchange rate system. Hence, L_2^{cf} and also $E_1(L_2^{cf})$ are given by equation (10) plus the political costs c^{cf} of abandoning the currency board, yielding

$$E_1(L_2^{cf}) = L_2^{cf} = \frac{1}{\theta}k^2(\gamma^2 + \theta) + c^{cf} \ . \tag{16}$$

4.3 Maintaining or leaving the currency board arrangement

The decision whether to maintain or abandon the currency board takes place in the first period before the private sector forms its inflation expectations for the second period. The policy maker will decide to maintain the currency board, if the expected second period loss of leaving it exceeds the expected second period loss of perpetuating the currency board, i.e. if

$$E_1(L_2^{cf}) - E_1(L_2^{cc}) > 0 \ . \tag{17}$$

Using equation (15) and (16), this condition is equivalent to

$$\phi_1^2 \ < \ \frac{1}{\theta\eta^2}\left(\frac{1}{\theta}k^2\gamma^2 - (\gamma^2+\theta)\sigma_u^2 + c^{cf}\right) \ . \tag{18}$$

The inequality shows that the decision whether to keep the currency board after the first period or not depends on the absolute value of the shock realization ϕ_1. The currency board is maintained for small shocks, whereas a large shock ϕ_1 prompts the policy maker to announce its abolition. A large time inconsistency problem of monetary policy – reflected by a high target output k – makes the inequality more likely to hold. The policy maker will continue the currency board in spite of a large shock requiring an adjustment of the real exchange rate, as an abolition of the currency board will revive a huge inflation bias. This effect is reinforced by the political costs c^{cf} of abolishing the currency board.

In contrast, a high variance σ_u^2 of the *PPP*-shock makes the interval in which the fixed exchange rate is defended smaller, and it is possible that the right hand side of inequality (18) becomes negative which would mean that the currency board would be abolished irrespective of the shock (or it would not be a suitable system from the very beginning and would never be introduced). The higher σ_u^2, the more important it is for the policy maker to be able to react to a large possible shock ϕ_2. A high autocorrelation of the shocks ϕ_t, represented by a large η, decreases the range of shock realizations for which the currency board is maintained. In this case, the first period shock contains much information about the second period shock, implying that a large first period shock makes the need for large further adjustments in the second period more likely. If η is interpreted as a degree of price stickiness (see footnote 4), a currency board is more likely to be maintained in case of a high price flexibility, whereas a relatively large η increases the probability of announcing its abolition.

5 Standard Peg

To ensure an unbiased comparison of a standard peg and a currency board, only the policy maker's decision of the second period is considered (see section 2). After observing the shock ϕ_2, monetary authorities decide whether to maintain or to abandon the peg. In this section, the range of realizations of ϕ_2 in which monetary authorities would defend the peg is derived. Multiple equilibria for π_2^e may occur in this case. However, we will derive conditions sufficient for the uniqueness of the equilibrium.

5.1 Policy decisions under a peg

The second period loss when leaving the peg L_2^{pf} is given by the term[7]

$$L_2^{pf} = \theta \frac{(\gamma \pi_2^e + k)^2}{\gamma^2 + \theta} + c^{pf} \ , \tag{19}$$

which equals the second period loss in a free float system (equation 10) plus the political costs c^{pf}. If the monetary authorities decide to maintain the peg after observing ϕ_2, L_2^{pp} equals

$$L_2^{pp} = (\gamma(\phi_2 - \pi_2^e) - k)^2 + \theta \phi_2^2 \ . \tag{20}$$

The fixed exchange rate is defended if the second period loss in case of leaving exceeds the loss in case of maintaining the peg, i.e. if

$$L_2^{pf} - L_2^{pp} = \left(\theta \frac{(\gamma \pi_2^e + k)^2}{\gamma^2 + \theta} + c^{pf} \right) - (\gamma(\phi_2 - \pi_2^e) - k)^2 - \theta(\phi_2)^2 > 0 \ . \tag{21}$$

[7]The superscript *pf* denotes the situation of leaving the peg in the second period and *pp* stands for the case of maintaining the peg in both periods.

Isolating ϕ_2 in the above equation yields the result that the exchange rate remains fixed if and only if

$$\underbrace{\Gamma(\pi_2^e, k) - \sqrt{\frac{c^{pf}}{\gamma^2+\theta}}}_{\phi_2^l} < \phi_2 < \underbrace{\Gamma(\pi_2^e, k) + \sqrt{\frac{c^{pf}}{\gamma^2+\theta}}}_{\phi_2^u} , \tag{22}$$

where $\Gamma(\pi_2^e, k) = \gamma \dfrac{(\gamma\pi_2^e + k)}{\gamma^2+\theta}$.

The peg is maintained if the shock ϕ_2 lies in an interval of length $2\sqrt{\frac{c^{pf}}{\gamma^2+\theta}}$, which is increasing in the political costs c^{pf}. Without political costs, this interval vanishes and monetary authorities will always abandon the fixed exchange rate and respond optimally to shocks. If $\phi_2 < \phi_2^l$, the monetary authorities will devalue; if $\phi_2 > \phi_2^u$, they will revalue. Using equation (3), the lower and upper boundary of the interval in which the peg is defended can be expressed in terms of the new shock u_2,

$$u_2^l = -\eta\phi_1 + \Gamma(\pi_2^e, k) - \sqrt{\frac{c^{pf}}{\gamma^2+\theta}} \tag{23}$$

$$u_2^u = -\eta\phi_1 + \Gamma(\pi_2^e, k) + \sqrt{\frac{c^{pf}}{\gamma^2+\theta}} . \tag{24}$$

The policy maker devalues, if the new shock u_2 is below u_2^l and revalues the currency if $u_2 > u_2^u$. In the following, it is assumed that the new shock u_t is uniformly distributed with $u_t \sim U[-A, A]$. Note that for certain parameter values, the boundaries u_2^u and u_2^l may lie outside the support of u_2.

It is assumed that political costs c^{pf} are small enough to ensure that $\sqrt{\frac{c^{pf}}{\gamma^2+\theta}} \leq A$, i.e. the (maximum) length of the interval in which the policy maker maintains the fixed exchange rate is smaller than the length of the support of u_2. Thus, independent of the realization of ϕ_1, the probability of abandoning the peg is always positive. The probability of defending the fixed exchange rate is a measure of the credibility of the exchange rate system. In case that the whole interval $[u_2^l, u_2^u]$ is contained in the support $[-A, A]$, the probability of maintaining the peg equals $\frac{1}{A} \cdot \sqrt{\frac{c^{pf}}{\gamma^2+\theta}}$, which is an upper boundary of the credibility of the fixed exchange rate system in all cases.

We use this upper boundary for the comparison of the credibility of a currency board and a standard peg in section 6. This way, the standard peg appears in a favorable light, and the credibility gains of a currency board can only be underestimated. Therefore, when pointing out situations in which a currency board has a credibility advantage, we will remain on the safe side.

5.2 Unique and multiple equilibria

The focus of this subsection is the position of the interval in which the peg is defended. The centre of that interval depends on π_2^e, which is determined by rational expectations, i.e. $\pi_2^e = E_1(\pi_2)$.

The expected value of π_2 is given by

$$\begin{aligned} E_1(\pi_2) &= \mathrm{P}(u_2 < u_2^l)E_1(\pi_2|u_2 < u_2^l) + \mathrm{P}(u_2^l < u_2 < u_2^u)E_1(\pi_2|u_2^l < u_2 < u_2^u) \\ &\quad +\mathrm{P}(u_2 > u_2^u)E_1(\pi_2|u_2 > u_2^u)\ , \end{aligned} \tag{25}$$

which is of course a function of the expected inflation π_2^e.

As in Obstfeld (1996), the existence of an equilibrium is ensured, but multiple equilibria may occur when determining π_2^e from equation (25)[8]. However, multiplicities can be excluded for certain parameter sets (see appendix). The condition $\theta > \frac{\gamma^2}{2}$, which means that the weight on inflation θ in the policy maker's loss function is high relative to γ, the parameter in the Lucas supply function, is sufficient for a unique equilibrium to exist. Moreover, if there is a solution for equation (25) for which $[u_2^u, u_2^l] \subset [-A, A]$ (corresponding to case (iii) in the appendix), the equilibrium is unique.

In this case

$$\pi_2^e = E_1(\pi_2|u_2^l > -A \wedge u_2^u < A) = \Gamma(\pi_2^e, k), \tag{26}$$

implying that[9]

$$\pi_2^e = \frac{\gamma k}{\theta}\ . \tag{27}$$

The same expected inflation $\pi_2^e = \frac{\gamma k}{\theta}$ would result, if the interval $[u_2^l, u_2^u]$ lay completely outside the support of $[-A, A]$, meaning that the peg would be abolished in any case (case (i) and (v) in the appendix). If the interval $[u_2^l, u_2^u]$ lies partly in the support of u_2 and partly outside on the left hand (case ii), it follows that $\pi_2^e > \frac{\gamma k}{\theta}$, whereas $\pi_2^e < \frac{\gamma k}{\theta}$ if a part of $[u_2^l, u_2^u]$ lies outside $[-A, A]$ on the right hand (case iv). In the latter case it is not excluded that expected inflation π_2^e is negative. However, a non-negative inherited shock $\eta\phi_1$ continues to ensure that the expected inflation rate is positive. A negative

[8] Obstfeld (1996) discusses the possibility of multiple equilibria in the private sector's expectations under fixed exchange rate regimes. In contrast to our model, the random shock occurs in the Lucas supply curve.

[9] The inflation rate expected by the private sector is the same as in the free float system. This result is a consequence of the assumption of a uniform distribution.

π_2^e may occur if ϕ_1 is sufficiently negative, the persistence parameter η is high, the time inconsistency problem is small and case (iv) is the relevant one. The intuition is that in this situation the conditional expectation on the inflation rate given that the peg is defended may be negative (reflecting that on average, a real depreciation is required), and due to the small k inflation will be low if the peg is abandoned.

If π_2^e is negative, $\Gamma(\pi_2^e, k)$, the centre of the interval of period 2's shocks ϕ_2 in which the peg is defended (equation 22) may also be negative[10]. Nevertheless, a positive $\Gamma(\pi_2^e, k)$ may be considered as the normal case.

6 Comparison of peg and currency board

In the previous sections, we derived the ranges of the *PPP*-shock in which the particular regimes are maintained. In section 4 (see equation 18), the condition to keep the currency board was derived as

$$\phi_1^2 < \frac{1}{\theta\eta^2}\left(\frac{1}{\theta}k^2\gamma^2 - (\gamma^2+\theta)\sigma_u^2 + c^{cf}\right) .$$

Assuming as in section 5, that the new shock u_t is uniformly distributed on $[-A, A]$, the length of the interval is proportional to the probability of maintaining the currency board and can also be interpreted as a measure of credibility. This probability is given by[11]

$$P(\text{maintain CB}) = \frac{1}{A}\sqrt{\frac{1}{\theta\eta^2}\left(\frac{1}{\theta}k^2\gamma^2 - (\gamma^2+\theta)\sigma_u^2 + c^{cf}\right)} . \tag{28}$$

From section 5 (equation 22 and 27), we know that the fixed exchange rate is defended in the second period, if

$$\Gamma(\pi_2^e, k) - \sqrt{\frac{c^{pf}}{\gamma^2+\theta}} < \phi_2 < \Gamma(\pi_2^e, k) + \sqrt{\frac{c^{pf}}{\gamma^2+\theta}} ,$$

leading to the upper boundary for the probability of defending the peg given by

$$P(\text{maintain peg}) \leq \frac{1}{A}\sqrt{\frac{c^{pf}}{\gamma^2+\theta}} , \tag{29}$$

[10]The case of $\pi_2^e < 0$ and $\Gamma(\pi_2^e, k) < 0$ occurs for example for the parameter values $A = 1$, $\eta = -0.3$, $\phi_1 = 0.9$, $k = 0.05$, $\gamma = 0.3$, $c = 0.5$ and $\theta = 0.6$.

[11]Of course, the probability must be contained in [0,1]. If the expression exceeds one, the probability equals one; if the term under the square root is negative, the probability equals zero. Note that $\sigma_u^2 = A^2$.

where equality holds for $[u_2^l, u_2^u] \subset [-A, A]$.

A comparison of the intervals in which the particular exchange rate system is maintained shows that the interval is symmetric around zero in case of a currency board but shifted by $\Gamma(\pi_2^e, k) = \frac{\gamma^2 \pi_2^e + \gamma k}{\gamma^2 + \theta}$ in case of a peg. When $\Gamma(\pi_2^e, k)$ is positive, which can be considered as the normal case[12], this shift amounts to an inflation bias under a standard peg that does not exist in a currency board system. A standard peg will rather be abolished in case of a negative ϕ_2 requiring a real depreciation than in case of $\phi_2 > 0$ which leads to a positive inflation when the exchange rate remains fixed.

Moreover, the credibility of the peg hinges on the political costs c^{pf} of abandoning it, as without these costs, the probability of maintaining the peg shrinks to zero (equation 29). In contrast, the credibility of a currency board system is not exclusively based on the political cost c^{cf} (equation 28). A large time inconsistency problem k, that would lead to a high future inflation in case of leaving the currency board system, may prevent the policy maker from announcing its abolition even if $c^{cf} = 0$. Conversely, the probability of maintaining the currency board may be zero in spite of positive political costs c^{cf} of abolishing it if σ_u^2 is large and the expression under the square root in equation (28) becomes negative. In this case, the ability to offset shocks promptly is more important for the policy makers than avoiding the inflation that results from the time inconsistency problem.

Moreover, the credibility of the currency board depends negatively on η, the parameter representing the autocorrelation of the PPP-shocks as the decision of abolishing the currency board is based on the expectation on the second period shock $E_1(\phi_2) = \eta\phi_1$. In contrast, the credibility of a standard peg does not depend on η, as the decision whether to abolish the peg is made after observing ϕ_2 and does not depend on the degree of shock persistence.

For further comparison of the credibility of the two exchange rate regimes, it is assumed that the political costs are equal in both regimes[13] which means that $c = c^{cf} = c^{pf}$.

A currency board system is more credible, if $P(\text{maintain CB}) > P(\text{maintain peg})$,

[12] See the discussion at the end of section 5.2. In particular, $\Gamma(\pi_2^e, k)$ is always positive if there is no inherited shock or if ϕ_1 is positive. The case $\Gamma(\pi_2^e, k) < 0$ may occur only if ϕ_1 is sufficiently negative.

[13] Intuitively, the political costs of giving up the fixed exchange rate are higher under a currency board than under a standard peg as assumed by Irwin 2004. Higher political costs would give the currency board an additional credibility advantage.

which is the case if

$$\frac{1}{A}\sqrt{\frac{1}{\eta^2\theta}\left(\frac{1}{\theta}(\gamma k)^2-(\gamma^2+\theta)\sigma_u^2+c\right)}>\frac{1}{A}\sqrt{\frac{c}{\gamma^2+\theta}}\ , \tag{30}$$

i.e., if the length of the interval of maintenance is larger in the case of a currency board than under a fixed exchange rate regime[14]. The expression can be rewritten as

$$\frac{\gamma^2k^2}{\theta}-\sigma_u^2(\gamma^2+\theta)+c\left(1-\frac{\theta\eta^2}{\gamma^2+\theta}\right)>0\ . \tag{31}$$

This inequality shows that when the time inconsistency problem of monetary policy is large (as represented by a high k) a currency board is more credible than a standard peg regime. In the case of a currency board arrangement, the monetary authorities are tied by law to keep the fixed parity, when its abolition was not announced in the previous period and it is not possible to create surprise inflation. Thus, the time inconsistency problem of monetary policy is solved, which is not the case in a standard peg system. High political costs c also increase the credibility of a currency board relative to a standard peg, as $1-\frac{\theta\eta^2}{\gamma^2+\theta}>0$.

The peg regime achieves a credibility advantage vis-a-vis a currency board, when σ_u^2 becomes so high that the ability to react to shocks is more relevant than solving the time inconsistency problem of monetary policy – higher shock variances lead to a higher probability that large shocks may hit the economy, and hence it can be important to be able to react immediately to the shock by choosing an optimal e_2 (and thus π_2), instead of having to keep a misalignment over one period.

7 Conclusion

In this paper we have addressed the issue of whether a currency board arrangement is indeed more credible than a standard peg system, and what exactly may make it more credible. The essential feature of a currency board captured in our model is its longer-term nature. The currency board can only be abolished if this has been announced one period in advance – reflecting the fact that a currency board can only be abandoned after a time-consuming political process. As a result, it is not possible to create surprise inflation, and the time-inconsistency problem of monetary policy is solved completely. In

[14]As discussed at the end of section 5.1, we use the upper boundary of P(maintain peg) for the comparison of the two regimes. Therefore the credibility of the standard peg appears in a favorable light.

contrast, a standard peg does not solve the time inconsistency problem, because of the permanently existing escape clause from the fixed exchange rate. The policy maker can abandon the peg overnight, and he is only deterred from doing so by the political costs of exiting the exchange rate system.

The comparison of both exchange rate regimes in section 6 shows that the currency board is more credible – in the sense of having a higher probability of being maintained – if the time inconsistency problem is the dominant one in the economy considered. The threat of high future inflation will prevent the policy maker from starting the process of abolishing the currency board unless there is a large persisting misalignment. In contrast, the currency board is more likely to be abandoned than a standard peg if shocks with a high volatility constitute the dominant problem, i.e. if the flexibility to be able to react immediately to future shocks is of paramount importance. Summarizing, its capability of solving the time inconsistency problem makes the currency board credible, but only as long as this advantage is not outweighed by the need for stabilization of shocks occurring with a high volatility.

Appendix (to section 5.2)

In the following analysis, we investigate thoroughly the expected inflation rate in the case of a fixed exchange rate system and derive sufficient conditions under which multiple equilibria can be excluded.

As mentioned in section 5.2, for certain parameter values the boundaries u_2^u or u_2^l may lie outside the support of the new shock u_2 which is uniformly distributed. In that case, we can replace the boundaries by $-A$ or A, respectively. To determine π_2^e, we thus define $\tilde{u}_2^l$ and $\tilde{u}_2^u$ as

$$\begin{aligned} \tilde{u}_2^l &= \min\{\max\{u_2^l, -A\}, A\} \\ \tilde{u}_2^u &= \min\{\max\{u_2^u, -A\}, A\} \ . \end{aligned} \tag{32}$$

For instance, $u_2^u > A$ implies $\tilde{u}_2^u = A$.

Using (32), we can rewrite (25) as

$$\begin{aligned} E_1(\pi_2) &= \frac{\tilde{u}_2^l + A}{2A} \cdot \Gamma(\pi_2^e, k) + \frac{A - \tilde{u}_2^u}{2A} \cdot \Gamma(\pi_2^e, k) + \left(\eta\phi_1 + \frac{\tilde{u}_2^u - \tilde{u}_2^l}{2A}\right) \frac{\tilde{u}_2^u - \tilde{u}_2^l}{2A} \\ &= \left(\eta\phi_1 + \frac{\tilde{u}_2^u - \tilde{u}_2^l}{2}\right) \frac{\tilde{u}_2^u - \tilde{u}_2^l}{2A} + \left(1 - \frac{\tilde{u}_2^u - \tilde{u}_2^l}{2A}\right) \Gamma(\pi_2^e, k) \ . \end{aligned} \tag{33}$$

$E_1(\pi_2)$ is a continuous function of π_2^e. The equilibrium condition is given by $\pi_2^e = E_1(\pi_2)$. To solve for the expected inflation π_2^e, we consider the following five different cases:

- **Case (i):** $u_2^u < -A$, i.e. the interval $[u_2^l, u_2^u]$ lies outside the support of u_2.

$$\begin{aligned} E_1(\pi_2 | \tilde{u}_2^u = -A) &= \frac{\eta\phi_1 - 2A}{2} \cdot \frac{-A + A}{2A} + \frac{1 - (-A + A)}{2A} \cdot \Gamma(\pi_2^e, k) \\ &= \Gamma(\pi_2^e, k) \end{aligned} \tag{34}$$

  The solution equals the free-float equilibrium rate, as monetary authorities will always revalue.

- **Case (ii):** $u_2^u > -A$ and $u_2^l < -A$, i.e. $[u_2^l, u_2^u]$ lies partly in the support of u_2. In this case the expected value of π_2 is given by

$$\begin{aligned} E_1(\pi_2 | u_2^u > -A \ \wedge \ u_2^l < -A) = & \left(\eta\phi_1 + \frac{u_2^u - A}{2}\right) \frac{u_2^u + A}{2A} + \left(1 - \frac{u_2^u + A}{2A}\right) \cdot \Gamma(\pi_2^e, k) \\ = & \ \Gamma(\pi_2^e, k) + \frac{u_2^u + A}{2A} \left[\eta\phi_1 + \frac{u_2^u - A}{2} - \Gamma(\pi_2^e, k)\right] \\ = & \ \Gamma(\pi_2^e, k) - \frac{1}{4A} \left(-\eta\phi_1 + \Gamma(\pi_2^e, k) + \sqrt{\frac{c}{\gamma^2 + \theta}} + A\right) \\ & \cdot \left[-\eta\phi_1 + \Gamma(\pi_2^e, k) - \sqrt{\frac{c}{\gamma^2 + \theta}} + A\right] \ . \end{aligned} \tag{35}$$

- **Case (iii):** $-A \leq u_2^l < u_2^u \leq A$, i.e. $[u_2^l, u_2^u]$ is a subset of the support interval $[-A, A]$. This leads to

$$\begin{aligned} E_1(\pi_2|u_2^l > -A \quad \wedge \quad u_2^u < A) &= \left(\eta\phi_1 + \frac{u_2^u + u_2^l}{2}\right)\frac{u_2^u - u_2^l}{2A} + \left(1 - \frac{u_2^u - u_2^l}{2A}\right) \cdot \Gamma(\pi_2^e, k) \\ &= (\eta\phi_1 - \eta\phi_1 + \Gamma(\pi_2^e, k))\frac{C}{A} + \left(1 - \frac{C}{A}\right)\Gamma(\pi_2^e, k) \\ &= \Gamma(\pi_2^e, k) \ . \end{aligned} \tag{36}$$

- **Case (iv):** $u_2^l < A$ and $u_2^u > A$, i.e. the interval $[u_2^l, u_2^u]$ lies partly in $[-A, A]$.

$$\begin{aligned} E_1(\pi|u_2^l < A \quad \wedge \quad u_2^u > A) &= \frac{\left(\eta\phi_1 + \frac{1}{2}A + \frac{1}{2}u_2^l\right)(A - u_2^l)}{2A} \\ &\quad + \left(1 - \frac{A - u_2^l}{2A}\right) \cdot \Gamma(\pi_2^e, k) \\ &= \Gamma(\pi_2^e, k) + \frac{1}{4A}\left[A + \eta\phi_1 - \Gamma(\pi_2^e, k) + \sqrt{\frac{c}{\gamma^2 + \theta}}\right] \\ &\quad \cdot \left(A + \eta\phi_1 - \Gamma(\pi_2^e, k) - \sqrt{\frac{c}{\gamma^2 + \theta}}\right) \ . \end{aligned} \tag{37}$$

- **Case (v):** If $u_2^l > A$, i.e. the interval $[u_2^l, u_2^u]$ lies also outside of the support interval of u_2, the policy maker will always devalue.

Using $C := \sqrt{\frac{c}{\gamma^2+\theta}}$, we can rewrite the results for the different cases as

$$\begin{aligned} E_1(\pi_2|\text{case (i)}) &= \Gamma(\pi_2^e, k) \\ E_1(\pi_2|\text{case (ii)}) &= \Gamma(\pi_2^e, k) - \frac{1}{4A}\left(-\eta\phi_1 + \Gamma(\pi_2^e, k) + C + A\right)\left[-\eta\phi_1 + \Gamma(\pi_2^e, k) - C + A\right] \\ E_1(\pi_2|\text{case (iii)}) &= \Gamma(\pi_2^e, k) \\ E_1(\pi_2|\text{case (iv)}) &= \Gamma(\pi_2^e, k) + \frac{1}{4A}\left(-\eta\phi_1 + \Gamma(\pi_2^e, k) + C - A\right)\left[-\eta\phi_1 + \Gamma(\pi_2^e, k) - C - A\right] \\ E_1(\pi_2|\text{case (v)}) &= \Gamma(\pi_2^e, k) \ . \end{aligned}$$

Graph of $E_1(\pi_2)$ as a function of π_2^e

The function $E_1(\pi_2)$ is defined by cases. As u_2^l and u_2^u depend positively on π_2^e (equations 23 and 24), the sequence of the respective intervals corresponds to the numbering of the cases (i) to (v).

The graph of $E_1(\pi_2)$ lies on the straight line $\Gamma(\pi_2^e, k)$ with the slope $\frac{\gamma^2}{\gamma^2+\theta} < 1$ in the three cases (i), (iii) and (iv). By investigating the second derivative of $E_1(\pi_2)$, it follows that the function is concave in case (ii) and convex in case (iv). Thus $E_1(\pi_2)$ is a straight line with two convexities – one above (case ii) and one below (case iv) the line as illustrated in figure 2. The position of the line and the convexities depend on the parameters, in particular on k and $\eta\phi_1$.

Conditions for a unique equilibrium under a peg

In the following section, we derive two conditions excluding the possibility of multiple equilibria under a peg.

A) From the description of the graph of $E_1(\pi_2)$ it is clear that the equilibrium is unique, if the function $E_1(\pi_2)$ cuts the bisecting line in the range of case (iii).

B) Moreover, we can exclude the existence of multiplicities if the slope of $E_1(\pi_2)$ does not exceed one in the two cases (ii) and (iv), too. We take up case (iv) for further examination, the argument in case (ii) is analogous.

The first derivative of $E_1(\pi_2|\text{case (iv)})$ is given by

$$\begin{aligned}\frac{dE_1(\pi_2|\text{case (iv)})}{d\pi_2^e} &= \frac{1}{2}\frac{\gamma^2(\gamma^2\pi_2^e + \gamma k + A\gamma^2 + A\theta - \eta\phi_1\theta - \eta\phi_1\gamma^2)}{A(\gamma^2+\theta)^2} \\ &= \frac{1}{2A}\frac{\gamma^2}{\gamma^2+\theta}\left[\Gamma(\pi_2^e, k) - \eta\phi_1 + A\right] \ . \end{aligned} \tag{38}$$

The expression in equation (38) equals one if[15]

$$\pi_2^e = A + \eta\phi_1 + \frac{2A\theta^2 + 3\gamma^2 A\theta - \gamma^3 k + \gamma^2\eta\phi_1\theta}{\gamma^4} \ . \tag{39}$$

The boundary between the ranges of the cases (iv) and (v) is given by

$$\pi_2^e = \left(A + \eta\phi_1 + \sqrt{\frac{c}{\gamma^2+\theta}}\right)\frac{\gamma^2+\theta}{\gamma^2} - \frac{k}{\gamma} \ . \tag{40}$$

If that boundary lies left of the point where $\frac{dE_1(\pi_2)}{d\pi_2^e} = 1$, the slope of $E_1(\pi_2)$ is smaller than one also in the range of case (iv) because the function is convex in that

[15] Note, that we first determine the point where the slope equals one and check afterwards, if the point is in the range of case (iv).

interval. Thus, the following condition excludes multiplicities

$$
\begin{aligned}
& A+\eta\phi_1+\frac{2A\theta^2+3\gamma^2 A\theta-\gamma^3 k+\gamma^2\eta\phi_1\theta}{\gamma^4} \\
& \qquad -\left[\left(A+\eta\phi_1+\sqrt{\frac{c}{\gamma^2+\theta}}\right)\frac{\gamma^2+\theta}{\gamma^2}-\frac{k}{\gamma}\right]>0 \\
\Leftrightarrow\ & \frac{1}{\gamma^4}\cdot\left(2A\theta^2+2\gamma^2 A\theta-\gamma^4\sqrt{\frac{c}{g^2+\theta}}-\gamma^2\theta\sqrt{\frac{c}{g^2+\theta}}\right)>0 \\
\Leftrightarrow\ & 2A\theta(\gamma^2+\theta)-\gamma^2\sqrt{\frac{c}{\gamma^2+\theta}}(\gamma^2+\theta)>0 \\
\Leftrightarrow\ & 2A\theta-\gamma^2\sqrt{\frac{c}{\gamma^2+\theta}}>0\ . \qquad (41)
\end{aligned}
$$

As by assumption $\sqrt{\frac{c}{\gamma^2+\theta}} \leq A$,

$$2A\theta-\gamma^2 A>0 \qquad (42)$$

is sufficient for (41). Thus, multiplicities can be excluded, if $\theta > \frac{\gamma^2}{2}$.

Figure 2 depicts $E(\pi_2)$ as a function of π_2^e for a set of parameters satisfying this condition (i.e. $\gamma = 0.7,\ k = 1,\ c^{pf} = 1.2,\ A = 1.5,\ \eta = 0.5,\ \phi_1 = \frac{-2}{5}A$ and $\theta = 0.5$). The unique equilibrium is denoted by E.

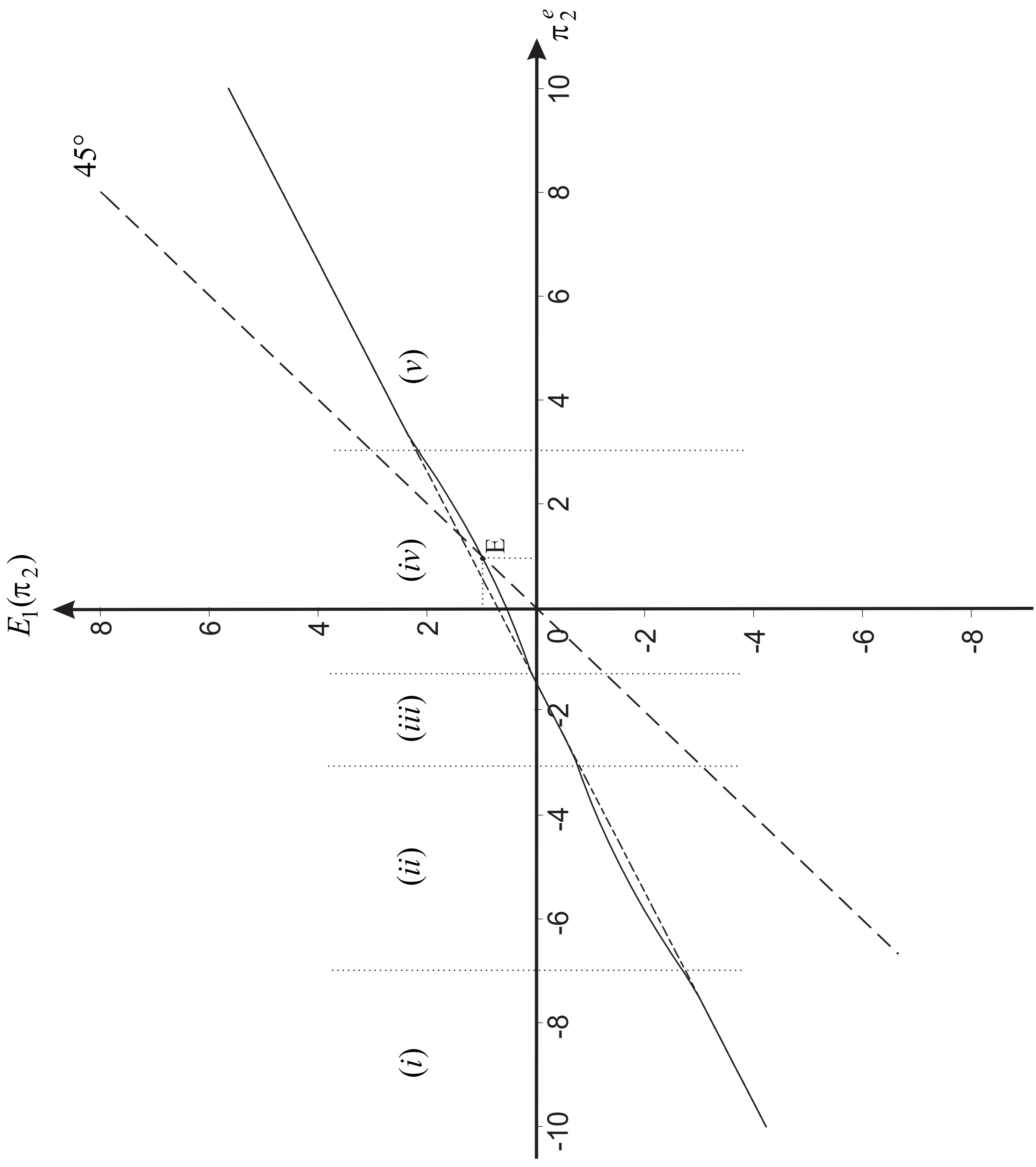

Figure 2: Expected value of second period inflation under a peg

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