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Abstract

This paper measures the welfare cost to consumers of the bloc of Central and Eastern European Countries (CEEC), plus Malta and Cyprus, of choosing a depreciated conversion rate when joining the European Monetary Union. For this, I present and solve an appropriately calibrated small open economy model where a euro-denominated bond and the equity on a traded goods sector are traded internationally. I show that the cost of depreciating the domestic currency against the euro by 20%, at the time of joining the European Monetary Union, entails a cost of approximately 1.65% in terms of lost lifetime utility (measured in equivalent units of consumption).

JEL classification: F31, F41, F47.

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1 Introduction

Since 2004, several countries from Central and Eastern Europe, as well as Malta and Cyprus, have joined the European Union (EU). One of the conditions for the accession was the commitment to join the European Monetary Union (EMU) and to drop its national currencies in favor of the euro sometime in the future. For this to be accomplished, the new members of the EU have to fulfil several requirements regarding macroeconomic stability, namely maintaining a managed float with the euro.[1]

However, several authors within the equilibrium exchange rate literature as well as advisors to policymakers have argued for a sizeable overvaluation of many of the currencies from the CEEC.[2] The results presented by Rähn (2003), Bulíř and Šmiídková (2005), and Égert *et al.* (2005), to name a few, seem to indicate that prior to entry to the EMU, the accession countries should depreciate their currencies as a way of preserving their competitiveness and smoothing the adjustment path.[3] Schadler *et al.* (2005), noting that these estimates are indeed very imprecise, argue that although there was no sign of significant over or undervaluation of the currencies of these countries as late as 2002, due to a perceived asymmetry between the risks of an overvaluation and the risks of an

[1] Aspiring members to the EMU must be members for two years to the Exchange Rate Mechanism (mark 2) where currencies are allowed to float against the euro within a $\pm 15\%$ band. Additionally, at the time of entry they must show: (1) a fiscal deficit below 3 percent of GDP and public debt of no more than 60 percent of GDP; (2) inflation rates not in excess of the average inflation rates in the EMU countries with the best price stability record by more than 1.5 percent points; and (3) long-term nominal interest rates not exceeding the average of the three preceding countries by more than 2 percentage points. See Schadler *et al.* (2005) for details.

[2] One problem with the equilibrium exchange rate literature is that its results seem to be very dependent on the chosen model specification and estimation technique. Rawdanowicz (2006) also raises concerns over this being the right set of methodologies to choose a conversion rate to the euro as it assumes the economy to be at or approaching some appropriately defined internal and external equilibrium. This is clearly not the case for these transition economies and is not contemplated in the model presented and solved ahead in this paper.

[3] A different stance on the topic is taken by De Broeck and Sløk (2006) who explain the continuous real appreciation of the CEEC, since the early nineties, with the correction of an initial exchange rate misalignment and the result of steady productivity growth due to a successful economic transition. This would thus preclude currency overvaluation.

undervaluation at the time of entry to EMU, it would be advisable to choose a parity at the weak end of the equilibrium range.

This concern has found its way to the press, as Christopher Swann noted, in 2002, in the *Financial Times*: "*Authorities in the Czech Republic and Hungary have already balked at a further rise of their exchange rates. Their sights may now turn to containing currency strength ahead of entering an exchange rate mechanism. With Germany suffering from having joined the euro at an uncompetitive rate, there would be resistance to any attempts by prospective members to depreciate their currencies shortly before locking into the euro.*" However, it is not at all clear that such a permanent depreciation is a positive thing and it surely entails costs.

The purpose of this paper is to quantify the costs accruing to consumers of Central and Eastern European countries of having a depreciated conversion rate for their domestic currencies when joining the EMU. This event is represented as a permanent shock to the exchange rate and not as a decision variable. The reason for this is that joining the EMU is not entirely (not even mostly) under the CEEC's control. In fact, although countries outside the EMU do have something to say as to when to join the Euro Area[4], the first and last word on this falls with its current members.

The costs of a permanent depreciation of a currency come from two sources: a trade effect and an asset effect. The trade effect means that the relative price of imports increases. The asset effect includes a valuation effect and a wealth effect. The valuation effect means that, at impact, a depreciation will make net foreign assets more valuable in terms of the domestic currency and consumption goods. Tille (2005) looks at a dollar depreciation from the US consumer perspective and argues for a positive and very large valuation effect that could overturn the negative impact of the increased relative price of imports. However, as follows from Marques (2007), if financial assets are traded

[4] Joining the EMU is mandatory for these countries even if the date for that is open.

internationally, a depreciation of the currencies of the CEEC against the euro means that these will be relatively poorer and that a portfolio rebalancing effect will be set in motion. The outcome is that the CEEC will be left with a smaller fraction of total claims on future dividends. Furthermore, since these countries, contrary to the US, do not have the privilege of borrowing from foreign creditors in their own currency, a depreciation causes a transfer of wealth from domestic debtors to foreign creditors.

The work in this paper relates to Mendoza (2001) where the impact of a dollarization in an emerging market economy is measured when there are endogenously binding credit constraints and the stabilization policy has imperfect credibility. Unlike Mendoza (2001), I have exogenous constraints on borrowing and short selling, by means of convex transaction costs. Additionally, I assume no money holdings but have equity and bonds being traded across borders. Finally, Mendoza (2001) models dollarization as an exogenous drop in the probability of a depreciation occurring whereas I treat it is as an absorbing state which agents are aware of. Thus, while Mendoza compares two economies with different probability distributions, I solve for a model where the chance of an exogenous regime change is part of the information set.

Cooley and Quadrini (2001) look at the issue of dollarization and find substantial costs for Mexico: almost 0.5% of annual consumption. In that paper, the cost is coming from Mexico no longer being able to choose its inflation rate optimally after dropping its currency. Higher inflation and nominal interest rates with monetary independence translate into a real currency appreciation, which is welfare improving through the trade channel. This mechanism is, to some extent, analogous to what I find in the current work: a nominal and permanent currency depreciation translates into a real depreciation because of price rigidity in the tradable sector, which in turns affects negatively consumers through a trade effect. However, Cooley and Quadrini abstract from asset trade considerations.

In the next section, I present a simple model of a small open economy with internationally traded equity and debt. In Section 3, I present the calibration and the method used to solve the model. I discuss the results obtained for three simulated experiments where the CEEC economy is allowed to join the EMU at an uncertain or certain date, at an appreciated or a depreciated rate, or even not at all, in Section 4. Section 5 concludes.

2 Model with Optimal Portfolio Choice

In this model there are two economies: a small open economy similar to a Central and Eastern European Country (CEEC) and a large economy that should represent the Euro Area (EU). The CEEC is assumed to have a domestic currency, while the EU has the euro as its currency, which serve as numeraires. The nominal exchange rate of this domestic currency with the EU is given by S_t and, as in Marques (2007), is exogenously defined.

The small open economy includes two sectors: a traded goods sector and a nontraded goods sector. The tradable goods sector is composed of two goods: a domestic or CEEC traded good and a foreign traded good. The CEEC is assumed to have a stochastic endowment of the domestic traded good, D_t, but has to import from the EU any amount it wants to consume of the foreign good. The EU is assumed to be able to supply any quantity of both goods, domestic and foreign, at given prices, P_{1t} and P_{2t}, respectively. These prices, too, are exogenously set and assumed to be rigid so that a changes in the nominal exchange rate translate into changes in the terms of trade. This is a required condition for the existence of welfare implications coming from the trade channel.

The assumption of endogenous production of tradables, not pursued here, is certainly not innocuous as in a stationary setting it means that a permanent depreciation causes a permanent competitiveness gain. However, this is no longer true in a production economy with growth, because a permanent competitiveness gain requires a continuous depreciation. For this reason, it is appropriate to consider the stochastic endowment setting for tradables in a model without growth.

In a small open economy, exchange rate movements cause important interactions between the output of tradables and nontradables, and work effort, which do not arise if one assumes stochastic endowments for both sectors. To include production in the nontradable goods sector is therefore an acceptable assumption.

The nontradable goods sector is a competitive industry with a large number of identical firms. These firms demand domestic labor , H_{dt}, to produce the nontradable good, Y_{Nt}, in order to maximize profits in units of the domestic traded good. No capital accumulation is assumed. Furthermore, there is no technological progress and the model is fully stationary. The firms choose H_{dt} to maximize

$$\Pi_t = P_{Nt}Y_{Nt} - W_t H_{dt} \tag{1}$$

subject to

$$Y_{Nt} = A_t H_t^{\gamma} \tag{2}$$

given P_{Nt} and W_t, the price of nontradables and the wage rate, respectively. In (2), A_t is a stochastic technology shock. Profit maximization yields

$$\gamma Y_{Nt}/H_{dt} - W_t = 0. \tag{3}$$

On the consumption side, there is a representative consumer from each economy, but the preferences and optimization problem are only explicitly stated for the CEEC consumer. The representative agent from the EU holds a fraction of the CEEC's equity on its tradable goods sector, θ_t^*. This investor is supposed to choose its holdings of the

CEEC tradable equity such that it amounts to a constant portfolio share:

$$a_t^* \equiv \frac{Q_t \theta_{t+1}^*}{S_t \Omega_t^*} = a^*, \tag{4}$$

where Q_t is the price of the equity in the CEEC expressed in domestic currency. The Euro Area's total portfolio wealth (in euros), Ω_t^*, is assumed to evolve according to an exogenous stochastic process. The assumption of a constant share for the CEEC equity on the European portfolio is reasonable as data from the European Central Bank (ECB) on the ratio of the international investment position in equity to the total stock of financial assets of households of the Euro Area shows that it can be reasonably approximated by constant fraction.

The CEEC's representative agent consumes the two traded goods (domestic and foreign) and one nontraded good, in amounts C_{1t}, C_{2t}, and C_{Nt}, respectively. It owns a fraction θ_t of the equity on the domestic traded good, and it sells its labor to local firms producing the nontradable good. It also owns the firms producing the nontradable good and receives the optimal profits, Π_t^*. Following Stockman and Dellas (1989), it is assumed that the equity on the firms that produce the non traded good is entirely domestically owned. To keep the model simple, it is assumed that the CEEC investor chooses not to own any foreign equity.

This consumers' problem is:

$$\max_{\{C_{1t}, C_{2t}, C_{Nt}, \theta_{t+1}, B_{t+1}, h_t\}} E_0 \sum_{t=1}^{\infty} U(C_{1t}, C_{2t}, C_{Nt}, H_{st})$$

subject to

$$P_{1t}C_{1t} + S_tP_{2t}C_{2t} + P_{Nt}C_{Nt} + Q_{\theta t}\theta_{t+1} + B_{t+1} \leq (Q_t + D_t)\theta_t + (1 + r_t)B_t + W_tH_{st} + \Pi_t^* + TC_t \quad (5)$$

where

$$\begin{aligned} U(C_{1t}, C_{2t}, C_{Nt}, H_{st}) &= \frac{\left(C_t - \frac{H_{dt}^{1+\rho}}{1+\rho}\right)^{1-\sigma}}{1-\sigma} \\ C_t &\equiv (\lambda^{1+\mu}C_{Tt}^{-\mu} + (1-\lambda)^{1+\mu}C_{Nt}^{-\mu})^{-\frac{1}{\mu}} \\ C_{Tt} &\equiv \left(\frac{C_{1t}}{\alpha}\right)^{\alpha}\left(\frac{C_{2t}}{1-\alpha}\right)^{1-\alpha}, \end{aligned}$$

given prices Q_t, P_{Nt}, W_t, and per capita aggregate asset holdings $\tilde{B}_t, \tilde{\theta}_t$.

The consumer pays convex transaction costs on bonds and equity:

$$TC_t \equiv \psi_2 S_t (B_t)^2 + \psi_3 Q_t (\theta_{t+1} - \theta_t)^2. \quad (6)$$

This condition is imposed to ensure that net foreign assets are stationary, as in Mendoza and Uribe (2000) and Schmitt-Grohe and Uribe (2003)[5].

As it is apparent from (5), it is assumed that the CEEC can only hold euro denominated bonds. Although a simplification, it is not too far from reality: Lane and Miles-Ferreti (2006b) calculate the share of foreign currency denominated issues in total international bond issues by the CEEC, in 2005, to range between 92% for Slovakia and 100% for Estonia, Hungary, Latvia, and Poland. According to the same source, the share

[5]This produces the same results as a debt elastic interest rate:

$$r_t = r^* + p(\tilde{B}_t),$$

where r^* is the prevailing world interest rate, $p()$ the interest rate premium paid by the CEEC.

of euro denominated issues for this group of countries is between 66% for Hungary and 100% for Latvia[6].

The way labor effort enters the instant utility index is taken from Greenwood et al. (1988), which is widely used in small open economy models (take Schmitt-Grohé and Uribe (2003), for instance). In this formulation, adopted for computational convenience, the labor effort choice is independent of the intertemporal consumption-savings choice.

The market clearing conditions are:

- in the labor market

$$H_{st} = H_{dt} \tag{7}$$

- in the equity market

$$\theta_t + \theta_t^* = 1 \tag{8}$$

- in the nontraded goods market

$$C_{Nt} = Y_{Nt}. \tag{9}$$

The exchange rate is assumed to follow a Markov chain with four possible states: an appreciated value for one period, a depreciated value for one period, a depreciated value forever, and an appreciated value forever. This means that the CEEC can join the EMU at two possible conversion rates and that joining or not is not something under their control. All other exogenous shocks (D_t, A_t, and Ω_t^*) are assumed to be Markov chains derived from AR(1) processes with two possible values each - a high and low one.

Finally, since this is a representative agent economy, consistency conditions are im-

[6] Although these account for only 7.4% of external debt for this country, in May 15, 2007, the *Wall Street Journal* estimates that 75% of Latvia's borrowing is made in euros.

posed over individual and per capita aggregate bond and equity holdings:

$$\tilde{B}_t = B_t \text{ and } \tilde{\theta}_t = \theta_t. \tag{10}$$

Definition 1 *an Equilibrium in this economy is a set of allocations* $\{C_{1t}, C_{2t}, C_{Nt}, \theta_{t+1}, B_{t+1}, h_t\}_{t=1}^{\infty}$*, aggregate asset holdings* $\{\tilde{B}_{t+1}, \tilde{\theta}_{t+1}\}_{t=1}^{\infty}$ *and prices* $\{Q_t, P_{Nt}, W_t\}$ *such that consumers solve their utility maximization problem, markets clear, and consistency between individual and per capita aggregate asset holdings is verified, given* $A_0, D_0, \Omega_0^*, S_0,$ θ_0 *and* B_0*.*

The forcing variables are $\{D_t, A_t, \Omega_t^*, S_t\}$, the aggregate co-states are $\tilde{B}_t$ and $\tilde{\theta}_t$ and the individual co-states are B_t and θ_t. In this economy there are $N = 2^4 \times 2 = 32$ discrete states. We have then to solve this problem over a grid of M points for each co-state.

It is possible to derive analytically some of the equilibrium conditions, namely for the price indexes for traded and nontraded goods, optimal hours worked, and profit maximization wage rate. These are, respectively:

$$P_{Tt} = P_{1t}^{\alpha}(SP_{2t})^{1-\alpha} \tag{11}$$

$$P_{Nt} = \left(\frac{1-\lambda}{\lambda}\frac{C_{Tt}}{C_{Nt}}\right)^{1+\mu} P_{Tt} \tag{12}$$

$$H_{St} = W_t^{\frac{1}{\rho}} \tag{13}$$

and (3).

3 Calibration Strategy and Method

The CEEC economy is calibrated to match annual data for the countries in the European Union that may join the European Monetary Union in the near future: Cyprus, Czech

Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, and Slovakia.

The output of the tradable goods sector is measured as the value added of Agriculture, Hunting, Forestry, and Fishery and Industry, including Energy sectors over the period 1995-2006, in real terms. Data is from the *Statistical Data Warehouse* of the ECB. The prices of the two tradable goods, in respective local currencies, are assumed constant and equal to one.

The preference parameters are set so that they match the aggregate of the accession bloc. The share of the domestic traded good in the total consumption expenditure in traded goods, α, is set to 0.7, in line with Obstfeld and Rogoff (2005b). The share of traded goods in total consumption expenditure, λ, is assumed to be 0.296, which matches the decomposition of the gross value added for those countries between traded and nontraded goods sectors. This value is similar to the one used by Fagan and Gaspar (2007) for the same set of countries. The elasticity of substitution between traded and nontraded goods is set to 0.77, in accordance with Mendoza (2001), which yields $\mu = 0.316$. The value of the intertemporal elasticity of substitution of labor supply $(1+\rho)$ is taken from Greenwood et a. (1988), setting ρ to 0.6.

The share of the European investor's financial wealth invested in CEEC equity, given by the parameter a^*, is set to 0.01. This matches the average of the total stock of equity investment (direct investment and portfolio investment in equity) of the Euro Area in the CEE countries as a percentage of total household financial instruments of the Euro Area from 2002 to 2004, which was 0.91%.

The world interest rate, r, is set to $\frac{1}{\beta}-1$, as in Schmitt-Grohé and Uribe (2003). The exchange rate, S_t, can take two values: 1 (appreciated rate) or 1.2 (depreciated rate).

Finally, β is 0.96, and relative risk aversion,σ, is set to 2, which is standard in the real-business-cycle literature. A detailed list of the parameter values used in calibrating the model, as well as the persistence and volatility parameters used to generate the probability transitions matrices, can be found in Table 1.

The model presented in Section 2 can be stated recursively in a straightforward way. For this effect, let d be the set of control variables and x the set of state variables, excluding S, at time t (primes denote variables at $t+1$): $\{D_t, A_t, \Omega_t^*, \theta_t, B_t, \tilde{\theta}_t, \tilde{B}_t\}$. The recursive formulation of the problem, using the value function $\mathcal{V}(d, x, s)$ for $s \in \{\bar{s}, \underline{s}\}$, is the following:

$$\begin{aligned} \mathcal{V}(d, x, \bar{s}) =& \max_d \{u(d, x, \bar{s}) + \beta E^x[p_{13} v_1(d', x') + p_{14} v_2(d', x') + p_{11} \mathcal{V}(d', x', \bar{s}) + \\ & p_{12} \mathcal{V}(d', x', \underline{s})]\} \\ \mathcal{V}(d, x, \underline{s}) =& \max_d \{u(d, x, \underline{s}) + \beta E^x[p_{23} v_1(d', x') + p_{24} v_2(d', x') + p_{21} \mathcal{V}(d', x', \bar{s}) + \\ & p_{22} \mathcal{V}(d', x', \underline{s})]\} \end{aligned} \tag{14}$$

where

$$\begin{aligned} v_1(d, x) =& \max_d \{u(d, x, \bar{s}) + \beta E^x (v_1(d', x'))\}, \\ v_2(d, x) =& \max_d \{u(d, x, \underline{s}) + \beta E^x (v_2(d', x'))\}, \end{aligned} \tag{15}$$

with

$$\begin{aligned} p_{11} &\equiv \text{Prob}(I_{t+1}(\bar{s}) = 1 | s_t = \bar{s}), \\ p_{12} &\equiv \text{Prob}(I_{t+1}(\underline{s}) = 1 | s_t = \bar{s}), \\ p_{21} &\equiv \text{Prob}(I_{t+1}(\bar{s}) = 1 | s_t = \underline{s}), \text{ and} \\ p_{22} &\equiv \text{Prob}(I_{t+1}(\underline{s}) = 1 | s_t = \underline{s}), \end{aligned} \tag{16}$$

where $I_t = 1$ if the CEEC enter EMU at time t, and zero otherwise. The solution is given by the fixed point to the contraction mapping given by the first order conditions and market clearing conditions. Note that we can solve for the functions v_1 and v_2 separately from $\mathcal{V}$ and then proceed with value function iteration on the latter. Unfortunately, this method proved to be too computationally demanding to be used as it requires iterating over a very large state vector which includes the four forcing variables, the two aggregate co-states and the two individual co-states.

However, using the Envelope condition (see Stokey and Lucas (1989)), we can solve the problem using the Euler equations and a collocation method. This has a number of advantages since it allows one to use the equilibrium conditions for consumption and labor choices, market clearing and aggregate consistency, and then solve for asset holdings alone.

Specifically, I solve the Euler equations, stated in the appendix, for the policy functions for bond and equity holdings, using a Chebyshev approximation algorithm in R^2 (as in Judd (1998), pp. 238), subject to the budget constraint, market clearing for equity and nontraded good, the profit maximization condition for labor, and the aggregate consistency conditions for asset holdings. The prices of both goods and the labor decision are directly given by (11)- (13).

The derivation of the equilibrium conditions used is detailed in the appendix. The policy functions for the absorbing states can be obtained separately and then used to solve for the rest.

4 Results

The first task of this section is to quantify how much the CEEC has to sacrifice of aggregate consumption if it joins the EMU immediately, at the depreciated conversion rate. This is not a realistic scenario as the accession of most of the CEEC to EMU is still far from eminent and, in some cases, is not at all certain. However, the exercise is useful to show how the main variables in the model behave and provides an upper bound to the welfare cost.

A more realistic scenario is to have the CEEC joining the EMU in the future, but the date for this to happen not to be known beforehand. It matters then to see if postponing entry to EMU has any impact on the welfare cost of the permanent depreciation.

Finally, understanding the value of uncertainty regarding the date and conversion rate for joining the EMU is important in itself. Specifically, does it make a difference to know in advance that the CEEC will enter EMU in five years?

For this effect, I conduct the following experiments that compare the average utility of the representative agent of the CEEC economy assuming that:

1. they either will never adhere to the euro or they join today at either a depreciated (S=1.2) or an appreciated rate (S=1);

2. they will join the Euro Area at a (uncertain) later date at either a depreciated or an appreciated conversion rate;

3. they either switch to the euro with certainty in exactly five years, or they will join at a future uncertain date.

For the first experiment I solve the model economy with and without exchange rate variability. This requires solving, in the first place, the model of Section 2 with the exchange rate varying between 1 and 1.2, the appreciated and depreciated values, respectively. This is a simplified version of the model because there are no absorbing states (under it, the CEEC never join the EMU). The outcome is then compared to what is obtained when, everything else equal, the exchange rate is fixed at either 1 or 1.2.

For the second experiment, I solve the model exactly as presented in Section 2, that is, with the possibility of the economy entering one of the absorbing states at some point. In this experiment, the probability of the CEEC joining the EMU in any given year is 0.05, which means that the cumulative probability of joining after thirteen and half years is 0.50. This was how long it took Portugal and Spain to join the EMU after having entered the European Union.[7]

For the last experiment, I solve the model with immediate entry in EMU at either conversion rate. With these solutions, I solve a model where the exchange rate changes in the current period but will remain fixed at one of the mentioned levels from the next period onwards. I use the solutions obtained here to solve the model backwards four more times, yielding five policy functions for each asset (conditional on the discrete state), one for each year before the schedule entry to the EMU. I compare these results with the ones obtained from the model of Section 2 using a conditional probability of not joining the EMU of 0.871, which yields a 50% chance of adopting the euro after 5 years.

Each simulation is conducted as follows. The CEEC economy is assumed to start at a level of debt and equity holdings close to what we observe nowadays. I set initial bond holdings to be symmetric to the average output of the tradable goods sector, roughly one third of total output. This is not far from the 1993-2005 average of foreign debt over GDP for the accession countries (excluding Malta and Cyprus, data from the World Bank's World Development Indicators), around 42%. The fraction of domestic equity owned by foreign investors for these countries averaged 19.7% for the period 1997-2006,[8] so I set equity holdings by domestic investors to 0.8. I then simulate the path for this

[7]These two countries joined the European Economic Community in January 1st, 1986 and the irrevocable conversion rates to the euro of the currencies of the eleven original countries of the European Monetary were announced May 2nd, 1998.

[8]This is given by total equity liabilities with the rest of the world (International Financial Statistics, IMF, line 79 ldd) divided by total stock market capitalization, in US dollars (World Development Indicators, World Bank).

economy for one hundred years, one thousand times and take averages.

The results for each of the experiments are to be found in Tables **??** through **??**. Lifetime utility is presented in equivalent units of consumption calculated as in Cocco *et al* (2005).[9]

In experiment 1, I compare the average lifetime utility accruing CEEC consumers when they join the EMU immediately at either conversion rate or they do not join at all. From Table 2, it is apparent that adopting the euro today at a 20% depreciated rate deprives the representative consumer of 1.92% of lifetime utility when compared to the adoption at the appreciated rate. This loss is only of 1.01% when the scenario is compared to not joining the EMU at all.

In Table 3, I show the average asset holdings for the three possible outcomes of experiment 1. The results show that following the adoption of the euro the CEEC will increase their borrowing and buy domestic equity from foreign investors if the conversion occurs at the appreciated exchange rate. On the other hand, if there is a depreciation of the currency at the time of joining the EMU, then one observes debt repayment and a sale of domestic equity to foreign investors. In this situation, repayment of debt makes sense as it is denominated in euros, not in the domestic currency. Furthermore, the permanent depreciation sets in motion a portfolio rebalancing, as in Hau and Rey (2004) and also found in Marques (2007), in a setting with two large economies. This portfolio rebalancing means that the representative investor of the CEEC will sell equity on its tradable sector to foreign investors (who now find CEEC relatively more attractive) and permanently reduce its claims on future dividends and its future consumption.

Note that the initial asset holdings used for this experiment are indeed very far away from the bond and equity holdings that one observes in this economy at a stochastic

[9]For each draw, I solve for the level of aggregate consumption that matches the discounted utility for the one hundred periods while setting hours worked equal to the average for the length of the simulation.

steady state. Given that the CEEC economies are still undergoing a significant economic transition, I see this as a realistic feature of the model and simulations.

In Figure 1, I show the average path for the trade balance under the various scenarios of experiment 1. To abstract from the adjustment induced by the fact that the initial asset holdings are outside the ergodic set, the simulations shown in figures 1 and 2 take as starting points asset holdings within or close to that set. From the second and third panels of this figure, it is apparent that the trade balance exhibits the J-curve pattern stated by Backus *et al.* (1994). Furthermore, since the consumption of nontradables decreases following the depreciation (in this case, equivalent to a terms of trade deterioration), as shown in figure 2, we have that the trade balance improvement that eventually comes about is countercyclical, an empirical regularity noted by Leonard and Stockman (2002). Cardi (2007) explains this using habit formation and capital adjustment costs in a small open economy model where only a bond can be internationally traded.

It is interesting to see that the same behavior can be obtained with less complicated preferences and fewer restrictions on the menu of internationally traded assets. There are two mechanisms at play here, one being the slow adjustment of portfolio holdings due to transaction costs. The other mechanism, that explains the trade balance being countercyclical is the low degree of substitutability between consumption of tradables and nontradables. If one assumes constant asset holdings, zero bond holdings, and $S = 1$, a currency depreciation causes a drop in consumption (and output) of nontradables if $\mu > 0$, which is to say an elasticity of substitution between tradables and nontradables, $1/(1 + \mu)$ of less than one. This way, the gradual improvement in the trade balance caused by the depreciation takes place as output decreases. This result is analogous to what is found in Cooley and Quadrini (2001) and is detailed at the end of the appendix.

In experiment 2, I compute the average lifetime utility of joining the EMU after thirteen and a half years (median waiting period) attained at either exchange rate. The results for this experiment, in Table 4, show that the welfare loss stemming from a 20% depreciation at the time of entry to the EMU is of 1.65% of lifetime utility. The asset holdings for the simulation of this experiment are in Figure 4, which shows the expected pattern of decreased borrowing and equity holdings once the accession to the EMU happens at the depreciated conversion rate. The magnitude of the portfolio rebalancing is, nonetheless, small (about 1 percentage point). This is most likely because of the assumption of large transaction costs for equity (in this scenario, almost 2% of aggregate consumption). By inspection of Figure 3, both the trade balance and the output of non-tradables behave as expected, with the depreciation causing a protracted improvement in the trade balance and a decrease in output.

Finally, in experiment 3, I compare the outcomes when joining the EMU at either conversion rate under certainty or at an uncertain future. The results, in Table 5, show that joining the EMU with certainty five years from today, with a depreciated currency (as opposed to joining at the appreciated rate), entails a slightly lower cost to consumers (of 1.41%) than what can be found under the scenario of uncertain accession date to the EMU (in this case, 1.98%). However, the average utilities and consumptions under certainty (regarding date of entry to EMU and conversion rate) are lower than what is found under uncertainty, at the appreciated conversion rate (under the depreciated conversion rate, the welfare results are very close).

An explanation for this is the different level of transaction costs implied by the adjustment of the asset holdings under the two possible paths (certainty vs. uncertainty). Specifically, knowing the date and parity for entry in the EMU should set in motion an immediate portfolio adjustment, whereas with uncertainty the adjustment should be more gradual. If the initial asset holdings are very far away to what they will be under a stochastic steady state, the adjustment costs that the investor has to pay are very high and could outweigh the benefits coming from the removal of uncertainty.

To test this hypothesis, I simulate the economy under certainty and uncertainty regarding the timing and conversion rate to the euro for an initial level of asset holdings very close to the average holdings under the former scenario for the last 50 years of the sample.[10] The results, in Table 6, show that this is a plausible explanation for the anomaly. In fact, if one removes the impact of the initial portfolio holdings, lifetime consumption is slightly higher when it is known in advance the timing of joining EMU and the conversion rate than when this is not known.

5 Conclusions

This paper presents an estimate for the costs for the new member countries of the EU to adopt the euro as its currency at a depreciated conversion rate. I find that these costs, in terms of lifetime utility measured in equivalent units of consumption, can be as high as 1.65% of lost aggregate consumption, for a 20% depreciation. In this scenario, joining the EMU is portrayed as an uncertain event with a 50% chance of happening within 13.5 years. The cost increases to almost 2% if the median date for EMU entry is only five years. This value is somewhat lower if the date of entry to the Euro Area is known with certainty.

The costs of the permanent exchange rate depreciation come from the increased relative price of imports (trade channel), and the adverse valuation and wealth effects stemming from the foreign asset positions. Contrary to what is found in Marques (2007) and in Tille (2005), there is a wealth transfer to foreign creditors because the CEEC hold only euro denominated foreign debt. On the other hand, since foreign investors want to keep a constant portfolio share for CEEC equity, there is a clear portfolio rebalancing effect moving against the consumers in these countries.

[10] In tables 5 and 6, I call this versions 1 and 2 of experiment 3, respectively.

Finally, the model used in the paper, which assumes transaction costs for both equity and bonds, and a low elasticity of substitution between tradables and nontradables, provides an explanation for the J-curve pattern observed for the trade balance and its countercyclical movement.

An immediate extension to the current work is to have the exogenous interest rate that the CEEC face on international borrowing to include a pre-EMU accession premium. In fact, Fagan and Gaspar (2007) argue that a decrease in the interest rates after adopting the euro was a major contributor to increased consumption in Italy, Spain, Portugal, and Greece and therefore should be included in welfare calculations for the prospective EMU members. This is modeled, following Blanchard and Giavazzi (2002), as a drop in the exogenous interest rate risk premium and does not pose a significant technical challenge. However, unless there is a tradeoff between the conversion exchange rate and the increased access to finance for domestic agents, this addition should not matter for comparative welfare calculations.

One other extension is to consider the effect of fiscal policy. This is a potentially important extension as fiscal discipline is one of the most stressed (and often most difficult to comply with) criteria of accession to EMU and, under the Growth and Stability Pact, remains a permanent constraint after the adoption of the common currency.

Two important and lengthier extensions to this work are to include capital accumulation in the nontradable goods' sector and production in the traded goods sector. This can be achieved at the expense of a sizeable expansion of the state space and increase of the computational burden and for this reason it is left for future work.

A perhaps more challenging extension is to consider the political economy aspects of currency depreciations and EMU accession. Specifically, considering population heterogeneity (be it investor heterogeneity or firm heterogeneity) adds a new and important dimension to the issue at hand as, while most people may lose from such movements in the exchange rate and the terms of trade, others may win. Owners of firms that are very dependent on export markets or investors that have a low degree of home bias in their portfolio holdings (and thus own more foreign currency denominated assets) may benefit and even lobby for weak currency policies and that way influence policy outcomes at the expense of others. Furthermore, since there are powerful wealth effects in action, the impact on the distribution of wealth (within a country) of currency movements is certainly important and remains unaccounted for.

Appendix: Equilibrium Conditions

Here I present the Euler equations and other equilibrium conditions that can be used to solve the problem via policy function iteration. I then detail on how the policy functions are derived. I finally derive the conditions under which, in equilibrium, the consumption of nontradables declines after a currency depreciation.

1. Equilibrium conditions:

The policy functions for the assets (bond and equity) are given by Chebyshev polynomial fitting over a $M \times M$ grid of bond and equity holdings, for each state. Regarding the exchange rate, there are four possible states: join the Euro Zone at the appreciated exchange rate, join the Euro Zone at the depreciated rate, have a appreciated exchange rate and not joining the Euro Zone, and have a depreciated exchange rate and not joining the Euro Zone. For each possible state for the exchange rate there are eight possible combinations for the other exogenous state variables, $x_t \equiv \{D_t, A_t, \Omega_t^*\}$ (the shock to dividends of traded goods, the technology shock in the nontraded goods sector, and the shock to foreign financial wealth). I call these sets of states 1, 2, 3, and 4, respectively.

After the CEEC adopts the euro, that is, once the economy enters one of the absorbing states (1 or 2), the equations to be solved, for $S \in \{\underline{S}, \bar{S}\}$ are:

$$\beta E_t \left(\frac{Q_{t+1} + D_{t+1} + 2Q_{t+1}\psi_3(\theta_{t+2} - \theta_{t+1})}{Q_t + 2\psi_3 Q_t(\theta_{t+1} - \theta_t)} \frac{u_T(C_{T,t+1}, C_{N,t+1}, H_{t+1})}{u_T(C_{Tt}, C_{Nt}, H_t)} \frac{P_{T,t}}{P_{T,t+1}} \right) = 1, \quad \text{(A-1)}$$

$$\beta E_t \left(\frac{1 + r + 2\psi_2(B_{t+2} - B_{t+1})}{1 + 2\psi_2(B_{t+1} - B_t)} \frac{u_T(C_{T,t+1}, C_{N,t+1}, H_{t+1})}{u_T(C_{Tt}, C_{Nt}, H_t)} \frac{P_{T,t}}{P_{T,t+1}} \right) = 1, \quad \text{(A-2)}$$

where:

$$
\begin{aligned}
H_t &= \left(\gamma A_t^{-\mu}(\frac{1-\lambda}{\lambda}C_{Tt})^{1+\mu}P_{Tt}\right)^{\frac{1}{\rho+1+\mu\gamma}}, & \text{(A-3)}\\
Q_t &= a^*\frac{S_t\Omega_t^*}{1-\theta_{t+1}}, & \text{(A-4)}\\
C_{Tt} &= \frac{1}{P_{Tt}}\left(-S_tB_{t+1}-Q_t\theta_{t+1}+(Q_t+D_t)\theta_t+S_t(1+r)B_t-TC_t\right), & \text{(A-5)}\\
C_{Nt} &= A_tH_t^{\gamma}, & \text{(A-6)}\\
P_{Tt} &= P_{1t}(P_{2t}S_t)^{1-\alpha}, & \text{(A-7)}
\end{aligned}
$$

and

$$
P_{Nt} = \left(\frac{1-\lambda}{\lambda}\frac{C_{Tt}}{C_{Nt}}\right)^{1+\mu}P_{Tt}, \quad \text{(A-8)}
$$

where the transaction costs, TC_t, are given by (6).

2. Solving for the policy functions:

In the conditions above, the consistency conditions between individual and per capita aggregate asset holdings already have been imposed, before solving for the policy functions. I can do this because I am only interested in analyzing solutions for this economy along the equilibrium path.

The solution to this problem yields four policy functions for assets, conditional on the set of observed prices, $\Pi_t \equiv \{P_{T,t}, P_{N,t}, Q_t\}$: $b_1(B,\theta,x,\bar{S}\,|\Pi)$, $b_2(B,\theta,x,\underline{S}\,|\Pi)$, $f_1(B,\theta,x,\bar{S}\,|\Pi)$, and $f_2(B,\theta,x,\underline{S}\,|\Pi)$. With the probabilities for joining the Euro Zone given by (16) and (17) and the solutions for the absorbing states, I just have to solve the following system of Euler equations (where the expectation operator is taken with respect to x_t only):

$$\beta E_t \sum_{i=1}^{4} \left(\frac{(Q_{t+1} + D_{t+1} + 2Q_{t+1}\psi_3(f_i(B_{t+1}, \theta_{t+1}) - \theta_{t+1}))u_T(C_{T,t+1}, C_{N,t+1}, H_{t+1})}{P_{T,t+1}} \right)$$
$$= \frac{(Q_t + 2\psi_3 Q_t(\theta_{t+1} - \theta_t))(u_T(C_{Tt}, C_{Nt}, H_t))}{P_{T,t}}, \tag{A-9}$$

$$\beta E_t \sum_{i=1}^{4} \left(\frac{(1 + r + 2\psi_2(b_i(B_{t+1}, \theta_{t+1}) - B_{t+1}))(u_T(C_{T,t+1}, C_{N,t+1}, H_{t+1}))}{P_{T,t+1}} \right)$$
$$= \frac{(1 + 2\psi_2(B_{t+1} - B_t))(u_T(C_{Tt}, C_{Nt}, H_t))}{P_{T,t}}, \tag{A-10}$$

together with (A-3)-(A-8). The solutions are then used to build the policy functions for the non absorbing states (3 and 4): $b_3(B, \theta, x, \bar{S}\,|\Pi)$, $b_4(B, \theta, x, \underline{S}\,|\Pi)$, $f_3(B, \theta, x, \bar{S}\,|\Pi)$, and $f_4(B, \theta, x, \underline{S}\,|\Pi)$.

3. Impact of currency depreciation on consumption of nontradables:

From (A-3) and (A-6) one can derive the impact on the output of nontradables of a change in the exchange rate. This is given by:

$$\frac{\partial C_N}{\partial S} = a_1 \left(\frac{(1+\mu)\gamma}{1+\rho+\mu\gamma} \frac{\partial C_T}{\partial S} C_T^{\frac{(1+\mu)\gamma}{1+\rho+\mu\gamma}-1} P_T^{\frac{\gamma}{1+\rho+\mu\gamma}} + \frac{(1-\alpha)\gamma}{1+\rho+\mu\gamma} C_T^{\frac{(1+\mu)\gamma}{1+\rho+\mu\gamma}} P_T^{\frac{\gamma}{1+\rho+\mu\gamma}-1} \right), \tag{A-11}$$

where a_1 is an exogenous term and it is implicit the assumption that $P_{1t} = P_{2t} = 1$. The output of nontradables decreases following a depreciation if (A-11) is less than zero, which means:

$$(1+\mu)\frac{\partial C_T}{\partial S}\frac{1}{C_t} + (1-\alpha)\frac{1}{S} < 0$$
$$\Leftrightarrow$$
$$\frac{\partial C_T}{\partial S}\frac{S}{C_T} < \frac{1-\alpha}{1+\mu}. \tag{A-12}$$

On the left hand side of (A-12) one has the elasticity of consumption of tradables with respect to the exchange rate, which is highest in absolute value, the costlier it is to adjust portfolios. If one assumes that the transaction costs are so high that asset holdings are constant (making it more likely for (A-12) to be verified), then we can rewrite the above elasticity as:

$$\frac{\partial C_T}{\partial S}\frac{S}{C_T} = -(1-\alpha)S^{\alpha-1} - \frac{S^\alpha}{C_t}\psi_2 B^2 < -(1-\alpha)S^{\alpha-1} \tag{A-13}$$

For zero bond holdings and $S = 1$, (A-12) becomes $\mu > 0$. This is to say that for a low degree of substitutability between tradables and nontradables, a depreciation will lower the output and consumption of the latter. For non zero bond holdings, this remains true but requires a lower elasticity of substitution between the two consumption bundles.

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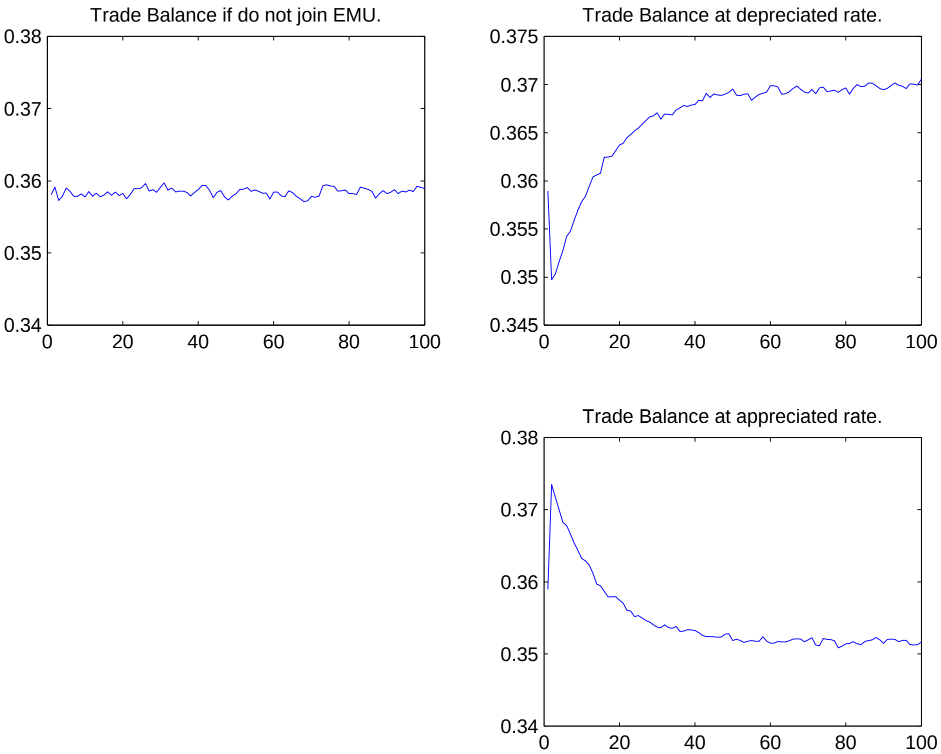

Figure 1: Trade balance in experiment 1.

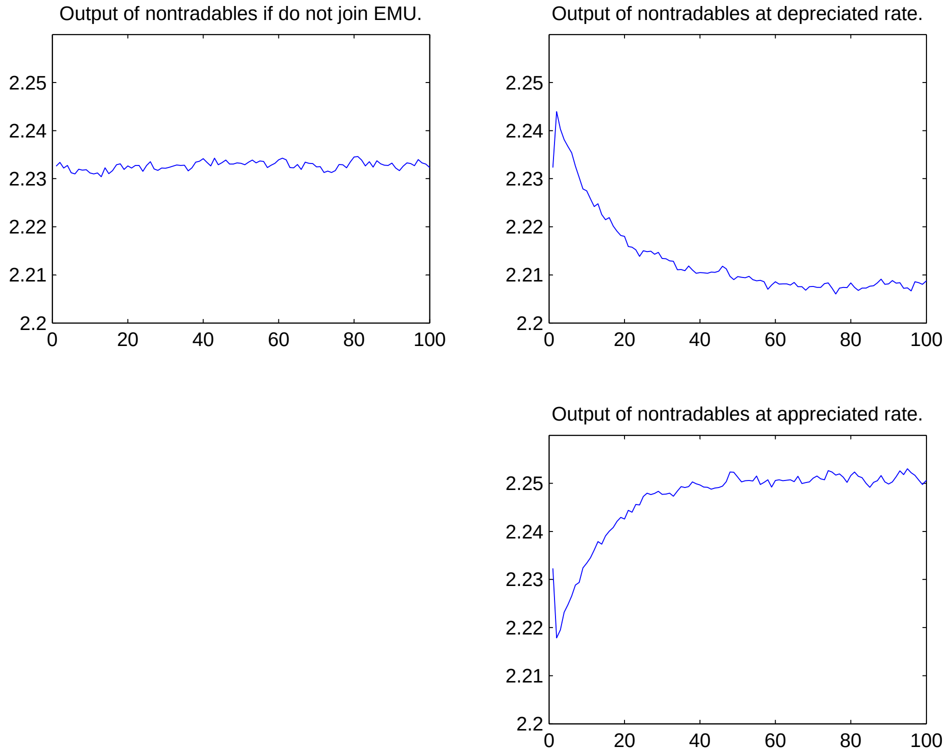

Figure 2: Output of nontraded goods in experiment 1.

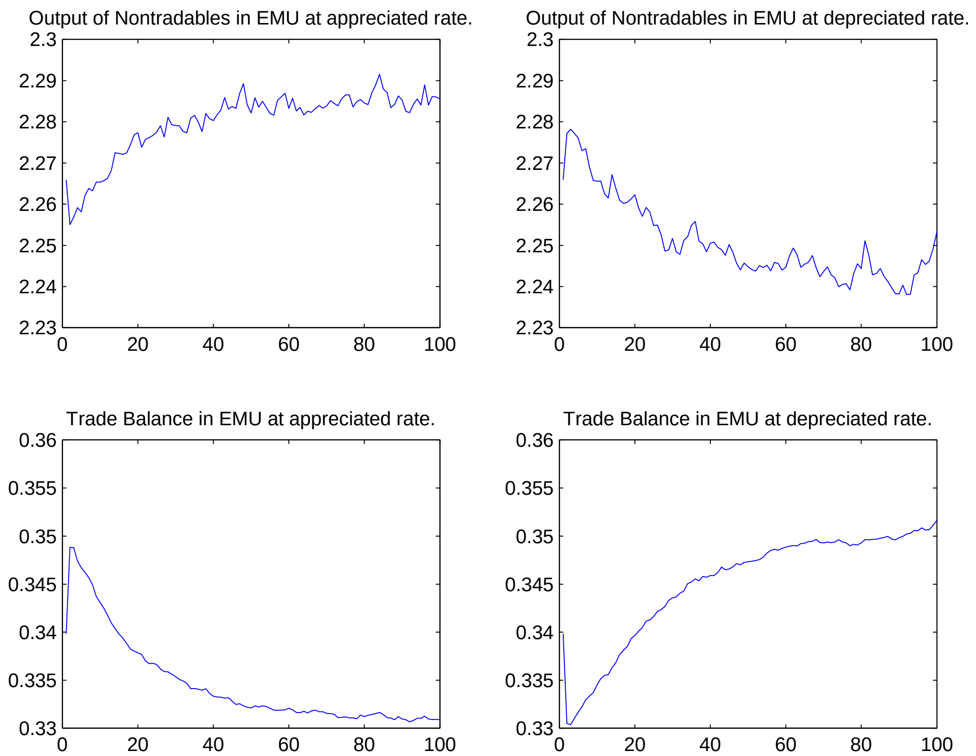

Figure 3: Output of Nontradables and Trade balance in experiment 2.

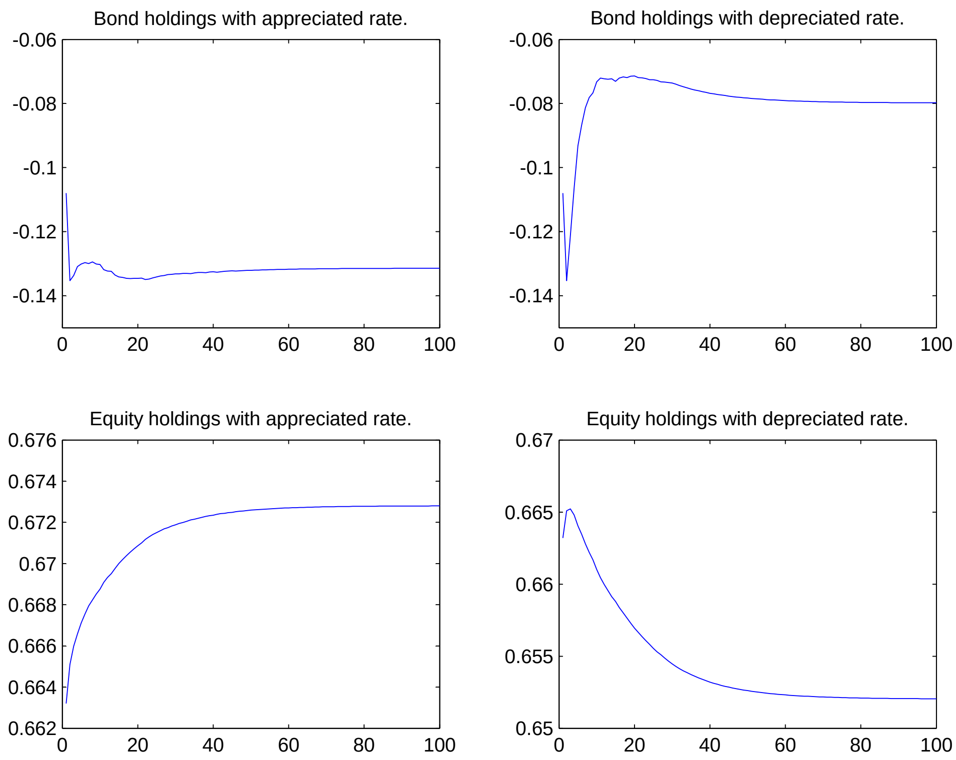

Figure 4: Asset Holdings in experiment 2.

Table 1
Calibration parameters

The table shows the parameter values used to solve the model and perform the numerical simulations.

Parameter	Value	Definition
α	0.7	Share of tradable good 1 in total consumption of traded goods.
μ	0.316	Share of US debt owed to EU.
λ	0.296	Share of traded goods in total consumption spending.
σ	2	Coefficient of relative risk aversion.
ρ	0.6	Intertemporal elasticity substitution of labor supply.
γ	0.636	Share of wages on nontradable sector's income.
β	0.96	Discount factor.
$\bar{D}_1$	1	Steady state endowment of domestic tradable good.
$\bar{A}$	2.382	Steady state output of nontradable good.
Ω^*	779.304	Steady state European investor's financial wealth.
P_1	1	Price of tradable good 1 in domestic currency.
P_2	1	Price of tradable good 2 in euros.
ψ_2	0.05	Transaction costs for bonds.
ψ_3	0.2	Transaction costs for equity.
a^*	0.01	Share of European portfolio invested in CEEC equity.
σ_D	0.043	Standard deviation of shock to traded good endowment.
ρ_D	0.820	Persistence of shock to traded good endowment.
σ_A	0.158	Standard deviation of shock to nontraded good technology.
ρ_A	0.567	Persistence of shock to nontraded good technology.
σ_Ω	21.224	Standard deviation of shock to European financial wealth.
ρ_Ω	0.854	Persistence of shock to European financial wealth.

Table 2
Welfare results in experiment 1

The first row in the table shows lifetime utility(U), in equivalent units of aggregate consumption, total consumption of traded goods (CT), and total consumption of non traded goods (CN), when the CEEC permanently opt out entering the Euro Zone. The second and third rows of the table show lifetime utility when the CEEC adopt the euro at the current period, at either the normal or the depreciated exchange rate. The last column shows the correlation between the output of nontradables and the trade balance. The initial bond and equity holdings are -1 and 0.8, respectively.

	U	in %	CT	in %	CN	in %	$r_{TB,CN}$
no euro	3.2257	100.00	0.6783	100.00	2.3144	100.00	0.0231
depreciated rate	3.1932	98.99	0.6564	96.77	2.3020	99.46	-0.9924
appreciated rate	3.2550	100.91	0.6974	102.81	2.3245	100.44	-0.9931

Table 3
Asset holdings in experiment 1

The first row in the table shows average bond and equity holdings, when the CEEC permanently opt out entering the Euro Zone. The second and third rows of the table show bond and equity holdings when the CEEC adopt the euro at the current period, at either the normal or the depreciated exchange rate. Percent variations in bond holdings mean increases in borrowing.

	Bond	Δ in %	Equity	in %
no euro	-0.1538	-	0.6608	-
depreciated rate	-0.1220	-20.68	0.6529	-1.20
appreciated rate	-0.1864	21.96	0.6696	1.33

Table 4
Welfare results in experiment 2

The first row in the table shows lifetime utility(U), total consumption of traded goods (CT), and total consumption of non traded goods (CN), when the CEEC adopt the euro in an uncertain future at the normal exchange rate, with a median waiting period of 13.5 years. The second rows in the table shows lifetime utility when the CEEC joins the Euro Zone at the deppreciated conversion rate. The initial bond and equity holdings are -1 and 0.8, respectively.

	U	in %	CT	in %	CN	in %
uncertain date depreciated rate	3.2145	98.35	0.6699	94.39	2.3248	99.00
uncertain date appreciated rate	3.2685	100.00	0.7097	100.00	2.3482	100.00

Table 5
Welfare results in experiment 3 (version 1).

The first row in the table shows lifetime utility(U), total consumption of traded goods (CT), and total consumption of non traded goods (CN), when the CEEC adopt the euro in an uncertain future, at either the normal or the depreciated exchange rate, with a median waiting period of 5 years. The second and third rows in the table show lifetime utility when the CEEC join the Euro Zone after 5 years with certainty, at either conversion rate. The initial bond and equity holdings are -1 and 0.8, respectively.

	U	in %	CT	in %	CN	in %
uncertain date at depreciated rate	3.2097	98.02	0.6678	93.95	2.3251	98.94
uncertain date at appreciated rate	3.2747	100.00	0.7108	100.00	2.3500	100.00
certain date at depreciated rate	3.2105	98.59	0.6703	95.40	2.3272	99.72
certain date at appreciated rate	3.2565	100.00	0.7026	100.00	2.3337	100.00

Table 6
Welfare results in experiment 3 (version 2).

The first row in the table shows lifetime utility(U), total consumption of traded goods (CT), and total consumption of non traded goods (CN), when the CEEC adopt the euro in an uncertain future, at either the normal or the depreciated exchange rate, with a median waiting period of 5 years. The second and third rows in the table show lifetime utility when the CEEC join the Euro Zone after 5 years with certainty, at either conversion rate. The initial bond and equity holdings are -0.1803 and 0.6666, respectively.

	U	in %	CT	in %	CN	in %
uncertain date at depreciated rate	2.9323	97.60	0.6200	93.21	2.2486	98.64
uncertain date at appreciated rate	3.0045	100.00	0.6651	100.00	2.2795	100.00
certain date at depreciated rate	2.9355	97.66	0.6237	94.64	2.2556	99.40
certain date at appreciated rate	3.0059	100.00	0.6590	100.00	2.2693	100.00