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THE WELFARE EFFECTS FROM STABILIZING EUROPEAN EXCHANGE RATES

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Abstract

Europe is on the eve of a radical change: at most 15 national currencies will be replaced with a single European currency and monetary policies will be centralized at the European level. There is a large literature on the possible effects that this regime change may provoke. Examples are the reduced conversion costs and the costs attached to printing and getting used to a new currency. More importantly however may be the effects that EMU will exercise upon the conduct of economic policies. The optimum currency area literature focuses on the costs of giving up an instrument of economic policy by irrevocably fixing intra-European exchange rates. The optimal taxation literature stresses the loss of seigniorage revenues that may result for high-inflation countries. The political-economy literature recognizes the reputational effects of EMU with respect to monetary as well as fiscal policies.

Still, one argument seems to have been largely overlooked: EMU will abandon exchange rate risks that may have a potentially large impact upon the portfolios of international investors. Indeed, the large home bias that is apparent in most international portfolios suggests a major role for exchange rate risk. Consequently, its abandonment may seriously affect the portfolio-allocation decisions of international investors. On the other hand, the efficiency gains of exchange rate stabilization may be less large. By restructuring their portfolios, investors may be able to hedge against exchange rate risk. Moreover, variable exchange rates may give rise to speculative profits. Investors who realize that a currency is going to depreciate, may exploit this opportunity by directing their portfolios away from this currency. Exchange rate stabilization will deprive investors of these profit opportunities by shifting inwards their production frontiers.

This research memorandum explores the efficiency gains that international investors may reap from EMU. Analytically, it is shown that the effect may be positive or negative, depending on whether the benefit from risk reduction dominates the loss from reduction of speculative gains. Moreover, the gain from risk reduction is shown to depend on the amount of public debt and the imports of goods and services from abroad. Numerical calculations support this conclusion: some calculations point to a net gain, others to a net loss. Next, these calculations show that the welfare gains differ widely across the EU. In particular, the welfare gain tends to be larger for countries with small amounts of public debt and few imports from abroad. Finally, our numerical calculations suggest a minor role for exchange rate stabilization. The EU as a whole is calculated to gain at most 0.3 percent of initial wealth from the stabilization of exchange rates.

I Introduction[1]

[1] The author thanks W. Winkler for providing the data used in the paper.

The most eye-catching aspect of the third stage of EMU is the replacing of at most 15 national currencies with a single European currency. The resulting stabilization of intra-European exchange rates is viewed to promote trade and investment among European countries, thereby enhancing the prosperity of EU member states[2]. Apart from that, EMU may discipline monetary and fiscal authorities (Bovenberg and De Jong (1996)). In particular, the transferring of monetary policies to the European level may add to their credibility, especially in those countries with high inflation rates (Giavazzi and Pagano (1988)).

However, it is unclear whether exchange rate stabilization will improve welfare. Apart from the possible effects on trade and the discipline of policymakers, a single currency allows a saving on currency conversion costs. On the other hand, replacing the existing systems of national currencies with a single European currency involves transaction costs.[3] More important however is the argument made by the optimum currency area literature that exchange-rate stabilization deprives governments of an instrument of economic policy. Both the low labor mobility among European countries and the relative unresponsiveness of real wages to unemployment stress the relevance of this argument (Bean (1992), Eichengreen (1993)). Arguments that can be brought against the optimum currency area argument are that it holds true in case of asymmetric shocks only and that it assumes that countries exhibit homogeneous industries (Bofinger (1994)). Only when a shock hits all industries in only one country, can the exchange rate be a useful instrument to mitigate its effects. Furthermore, the openness of many European countries and the large degree of price indexation of nominal wages in Europe make devaluations less effective. This also suggests that the point made by the optimum currency area literature may not be the most relevant one.

Another way of looking at the attractiveness of a monetary union is to view exchange rates as a source of risk. Monetary policymakers may decide not to devalue a currency when it is advisable or decide not to devalue when inflation differentials suggest otherwise. By doing so, monetary authorities create real exchange rate risk which may harm risk-averse households. By fixing exchange rates, a monetary union may reduce this type of risk[4]. Also in this interpretation, the case for exchange rate stabilization is not clear-cut however. On the one hand, the literature on the gains from risk reduction through portfolio diversification suggests that exchange rate stabilization will yield

[2] The empirical evidence on the relationship between exchange rate volatility and trade is mixed. Some studies find a significantly negative relation (*e.g.* Cushman (1983)). Most studies however are unable to find a significantly negative effect of exchange rate variability upon trade flows (*e.g.* Hooper and Kohlhagen (1978)). Viaene and De Vries (1992) offer an explanation.

[3] To minimize this type of transaction costs, Buiter (1995) proposes to name the new European currency after the currency that is most widely used in Europe, *i.e.* the D-mark.

[4] The exogeneity of exchange rates is important. For if exchange rates respond endogenously to production shocks, fixing exchange rates may increase instead of decrease risk (Aizenman (1992), Westerhout (1994)).

significant welfare gains.[5] In particular, when exchange rates become irrevocably fixed by replacing national currencies with a new currency, the risk reduction may be substantial. On the other hand, it has been stressed several times that exchange rate risk can be diversified at no or little cost (Frankel (1979), Adler and Dumas (1983)). Consequently, the foreign exchange risk premium will be zero or small (Frankel (1979, 1982)).[6] Portfolio investors can structure their portfolios such that their wealth becomes immune to exchange rate fluctuations. Hence, exchange rate stabilization will have little efficiency effects.

In reality, hedging may be less than perfect. In particular, this is suggested by the portfolio model that predicts not only the hedging against exchange rate fluctuations, but also that a large share of wealth will be invested in foreign shares. The latter prediction is in conflict with economic reality, in which investors tend to concentrate their equity portfolios in their home countries.[7]

This paper therefore explores the effects of the stabilization of intra-European exchange rates under the assumption that hedging through foreign bonds does not occur. Since in the real world at least some hedging does occur, this will provide upper bounds on the welfare gains from exchange rate stabilization. It adopts a portfolio model for the OECD and calculates the effects upon portfolio-allocation, interest rates and welfare in EU countries. The model focuses on nominal exchange rate risk which - assuming price rigidities on goods markets - translates into real exchange rate risk.[8] Our analysis does not find a significant welfare gain. Instead, the maximum gain is found to be very modest. Moreover, it concludes that the EU may even lose from monetary integration. Whereas the reduction of exchange rate risks will enhance economic welfare, the vanishing of non-zero exchange rate appreciations deprives investors of gains from speculation. Our simulations indicate that the welfare gain for the EU as a whole has a maximum of 0.3 percent and a minimum of -1.5 percent of initial wealth.

The finding that the effects of exchange-rate stabilization are small or negative, throws a different light on the process of monetary integration. In addition, we conclude that the welfare effect of monetary integration is spread very unevenly over individual

5 A number of studies find that risk reduction through global diversification may yield substantial welfare gains (Grubel (1968), Levy and Sarnat (1970), Haavisto and Hansson (1992), Obstfeld (1994) and Van Wincoop (1994)), although there are exceptions (Cole and Obstfeld (1994)). See Devereux and Smith (1994) for the result that diversification of income risk may reduce welfare in a second-best world.

6 See also Svensson (1992) who demonstrates that under an exchange rate target zone the foreign exchange risk premium is likely to be small.

7 For evidence on the home bias in international portfolios see French and Poterba (1991), Tesar and Werner (1992, 1994), and Kang and Stulz (1995).

8 Helpman (1981), Helpman and Razin (1982) and Persson and Svensson (1989) share with our analysis the focus upon foreign portfolio investment. Persson and Svensson analyse the effect of exchange rate risk upon international asset trade whereas Helpman and Helpman and Razin compare welfare under different exchange rate regimes. Different from our analysis, the latter three analyses deal with nominal exchange rate variability only by assuming purchasing power parity.

countries. Indeed, the simulations in this paper indicate that the welfare gains to individual countries may differ a factor 10 and that it may be the case that a country loses from monetary integration, even when most of the other countries see their welfare increase. The reason is that the EU countries differ from each other in a number of aspects, like the openness of their economies, the indebtedness of their governments, the stochastic properties of the rates of return on capital installed in their countries and the stochastic properties of their exchange rates vis-à-vis other currencies. The upshot of this is that even when the EU gains on average, it may be not in the interest of individual countries to join EMU.

The paper is structured as follows. Section II develops the model. Section III discusses why the welfare effects of exchange rate stabilization may be larger if hedging through foreign bonds is not allowed. Section IV sets up an analytical version of the model for a two-country world. Section V uses this version to derive the effects of exchange rate risk and exchange rate expectations. Section VI and VII explore numerically the effects of exchange rate stabilization. Section VIII concludes.

II The Model

Consider a world of N countries in each of which an infinite number of households resides. The representative household in country n=1,..,N allocates his portfolio wealth over risky capital and riskless bonds in N countries such as to maximize a mean-variance utility function. This utility function is defined over his increase in portfolio wealth or his consumption in terms of initial wealth. Using $E(\cdot)$ and $Var(\cdot)$ as expectations and variance operators respectively, using a tilde to denote a variable's rate of change, and denoting utility with u, real portfolio wealth with w and the household risk aversion coefficient with β, the utility function of this household reads as follows:

$$u_n = E(\tilde{w}_n) - \frac{1}{2}\beta Var(\tilde{w}_n) \qquad \beta > 0, \quad n = 1,..,N \tag{1}$$

Defining w_n as W_n/p_n where W_n is the portfolio wealth in terms of the home-produced good and p_n is the price of the composite consumption good in terms of the home-produced good, and abstracting from second-order effects, $\tilde{w}_n$ can be expressed as

$$\tilde{w}_n = \tilde{W}_n - \tilde{p}_n \qquad n = 1,..,N \tag{2}$$

The household earns income from the holding of capital and bonds and pays part of this income as lump-sum taxes to the government in his country. Denoting the portfolio shares of domestic capital and bonds as s_n^d and b_N^D respectively and the portfolio shares of foreign capital and bonds as s_{jn}^f j=1,..,N,$j \neq n$ and b_{jn}^f j=1,..,N,$j \neq n$ respectively, and again abstracting from second-order effects, the increase in portfolio wealth in terms of the home good can be expressed as follows:

$$\tilde{W}_n = \left[s_n^d r_n + \sum_{j=1,j\neq n}^{N} s_{jn}^f (r_j + \tilde{z}_{jn}) + b_n^d i_n + \sum_{j=1,j\neq n}^{N} b_{jn}^f (i_j + \tilde{z}_{jn}) \right] - t_n \qquad n = 1,..,N$$

(3)

Here, t stands for the taxes paid by the household in terms of his initial portfolio wealth.

As expression (3) demonstrates, each country is assumed to be specialized in the production of a particular good, which is an imperfect subsitute for goods produced in other countries. The price of the good produced in country m in terms of the good produced in country n, *i.e.* the real exchange rate between countries m and n, is denoted as z_{mn}. Next, we assume households in country n to spend π_{jn}^f of their income on the good of country j. For any linear homogeneous utility function defined over the N consumption goods, the price of the composite consumption good, $\tilde{p}_n$, can then be expressed as

$$\tilde{p}_n = \sum_{j=1,j\neq n}^{N} \pi_{jn}^f \tilde{z}_{jn} \qquad \sum_{j=1,j\neq n}^{N} \pi_{jn}^f + \pi_n^d = 1 \qquad n = 1,..,N$$

(4)

The second expression in (4) shows that the consumption share of the domestic good, π^d, and the consumption shares of goods imported from abroad, add to unity. Combining (2), (3) and (4), the expression for the rate of return on financial wealth in terms of the composite consumption good reads as follows:

$$\tilde{w}_n = \left[s_n^d r_n + \sum_{j=1,j\neq n}^{N} s_{jn}^f (r_j + \tilde{z}_{jn}) + b_n^d i_n + \sum_{j=1,j\neq n}^{N} b_{jn}^f (i_j + \tilde{z}_{jn}) \right] - t_n$$

$$- \sum_{j=1,j\neq n}^{N} \pi_{jn}^f \tilde{z}_{jn} \qquad n = 1,..,N$$

(5)

The rates of return on capital, r_n n=1,..,N, are stochastic while the rates of return on bonds, i_n n=1,..,N, are riskless. The rates of return on capital in country m and country n, m,n=1,..,N $m \neq n$ are correlated with correlation coefficient ρ_{mn}, for which it is assumed that $-1<\rho_{mn}<1$. The rates of change of real exchange rates are also stochastic. They are uncorrelated with each other and with the productivity of any type of capital.

The latter two assumptions are specific but not necessarily ad hoc. In particular, we view exchange rates (prices of consumption goods) as set by governments.[9] As these exchange rates are relative prices, one can think of N-1 governments setting exchange rates and one government controlling the general price level. Postulating that governments act independently from each other, it is only natural to assume that different exchange rate shocks are uncorrelated. Next, we view the output of a typical consumption good to be the aggregate of the demand for that good exercised by the households in all N countries. It is a simplification then to assume that output shocks and real exchange rate shocks are uncorrelated. However, allowing for correlation between output shocks and exchange rate shocks will only reduce the effects of exchange rate shocks. In particular, if an exchange rate appreciation drives down output in the same country (and possibly boosts output in other countries), it will drive a smaller wedge between the returns in different countries than with zero correlation. As we are looking for the maximum effects of exchange rate stabilization, we can safely ignore this type of correlation.

Using expression (5) for the consumption of the composite commodity to derive expressions for $E(\tilde{w}_n)$ and $Var(\tilde{w}_n)$, we now have the following expression for u_n:

$$u_n = \left[s_n^d r_n + \sum_{j=1, j\neq n}^{N} s_{jn}^f (E(r_j) + E(\tilde{z}_{jn})) + b_n^d i_n + \sum_{j=1, j\neq n}^{N} b_{jn}^f (i_j + E(\tilde{z}_{jn})) \right]$$

$$- t_n - \sum_{j=1, j\neq n}^{N} \pi_{jn}^f E(\tilde{z}_{jn}) - \frac{1}{2}\beta \left[(s_n^d)^2 Var(r_n) + 2 s_n^d \sum_{j=1, j\neq n}^{N} s_{jn}^f Cov(r_n, r_j) \right]$$

$$- \frac{1}{2}\beta \left[\sum_{j=1, j\neq n}^{N} \sum_{k=1, k\neq n}^{N} s_{jn}^f s_{kn}^f Cov(r_j, r_k) + \sum_{j=1, j\neq n}^{N} (s_{jn}^f - \pi_{jn}^f)^2 Var(\tilde{z}_{jn}) \right] \quad n = 1,..,N$$

(6)

[9] Our analysis does not distinguish between nominal exchange rates and real exchange rates. This corresponds to the so-called neo-Keynesian view that prices on commodity markets are sticky so that the variability of real exchange rates stems from the variability of nominal exchange rates (Mussa (1982)).

where $Cov(.,.)$ denotes the covariance between two variables. We assume $Var(r_n)$ n=1,..,N to be strictly positive.

The problem of the household in country n is to maximize (6) under the following portfolio budget constraint:

$$s_n^d + \sum_{j=1,j\neq n}^{N} s_{jn}^f + b_n^d + \sum_{j=1,j\neq n}^{N} b_{jn}^f = 1 \qquad n = 1,..,N$$

(7)

The maximum for households of country n is described by a set of 2N-1 first-order conditions and a portfolio budget constraint. As there are N countries, this gives $2N^2$ equations. To complete the model, we must add conditions that state that the markets for bonds are in equilibrium:

$$B_j = b_j^d W_j + \sum_{n=1,n\neq j}^{N} b_{jn}^f W_n \qquad j = 1,..,N$$

(8)

where B_j is the amount of bonds issued by the government in country j. As the investment in capital is demand-determined, no further equilibrium conditions are required. This brings the number of equations up to $N(2N+1)$. The unknowns in the model are the portfolio shares of capital, s_n^d n=1,..,N and s_{jn}^f j,n=1,..,$N,j\neq n$, the portfolio shares of bonds, b_n^d n=1,..,N and b_{jn}^f j,n=1,..,$N,j\neq n$, and the interest rates i_n n=1,..,N.

Next, we define aggregate investment in the risky technology of country j:

$$S_j = s_j^d W_j + \sum_{n=1,n\neq j}^{N} s_{jn}^f W_n \qquad j=1,..,N$$

(9)

By definition, S_j cannot be negative. If the interior solution for S_j, as given by expression (9), is negative for $j=j'$, we remove the first-order conditions that determine the portfolio shares $s_{j'n}$ from the model and fix $s_{j'n}$ and thus also $S_{j'}$ to zero. Note that there are no short-sales constraints. If households want to write contracts the terms of which depend on the return on a specific technology, they may do so, as long as the technology exists (*i.e.* the investment in that technology is positive).

Finally, we can use the solutions for the portfolio-allocation and the interest rates to derive welfare in the various countries. To this end, we must add the budget constraints of the governments that state that the governments tax their residents in order to finance their debt service:

$$t_n W_n = i_n B_n \qquad n = 1,..,N \qquad (10)$$

III Capital Market Imperfections

The model as presented in the previous section does not resemble economic reality in every respect. In particular, the model predicts that a significant part of wealth will be invested in foreign equity and that there will be substantial borrowing in foreign bonds markets. Studies on international capital flows however indicate that in reality the shares of foreign equity and bonds in financial wealth are amazingly small. For example, French and Poterba (1991) find that residents of the US, Japan and the UK invest only 6, 2 respectively 18 percent of their wealth in foreign equity. Similarly, Tesar and Werner (1992) calculate the foreign portfolio equity holdings of households in Canada, the UK and the US to amount to 3, 20 and 2 percent of domestic GDP respectively. Furthermore, the holdings of foreign equity and bonds of households in Canada, Germany, Japan, the UK and the US amount to 4, 10, 17, 33 and 4 percent of domestic GDP. Next, the evidence on the correlation between saving and investment flows as brought under discussion by Feldstein and Horioka (1980) suggests that in reality only a small part of household wealth is invested abroad.[10]

One might try to improve the model on this point by including various types of capital market imperfections, like transaction costs, capital controls, asymmetric information, biased investor expectations etc. However, it is not at all clear which form these capital market imperfections actually take. The process of deregulation of capital markets that took place in the eighties suggests only a minor role for capital controls nowadays. Next, Tesar and Werner (1992) find the turnover rate on foreign equity investments to be much higher than the turnover rate on domestic equity markets, suggesting that transaction costs are unlikely to be important deterrents to international investment. Gordon and Bovenberg (1994) argue that asymmetric information between countries provides the most plausible explanation for the lack of international portfolio diversification. In their model however, capital can flow in one direction only – a capital importing country cannot be a capital exporting country at the same time. This is in contrast with evidence on gross equity flows and net equity flows that indicates that the former can be several times bigger than the latter (for example, Tesar and Werner (1994) report that quarterly gross equity flows between the US and Japan in the period from 1978 to 1991 are 67 times quarterly net equity flows). Kang and Stulz (1995), in addition, show that non-Japanese investors that hold Japanese equity invest much more in large than in small firms. Consequently, if informational asymmetries are to be the

[10] See however Tesar (1991) who demonstrates that a variety of shocks can move domestic savings and investment in the same direction. Hence, the Feldstein-Horioka result does not necessarily imply that capital is immobile internationally.

explanation for the home bias effect, they must be smaller for large firms than for small firms.

These difficulties lead us to take a different route. In particular, we maintain, first, that there are two alternative models that are at least as good as the one in section II and, second, that the welfare effects of exchange rate risk in the second alternative exceed those in the other two models. Since the paper aims to calculate the maximum effects of exchange rate risk, attention can then be focussed exclusively on the second alternative.

The two alternative models distinguish from the model in section II in that they exclude hedging through foreign equity or through foreign bonds.[11] If trade in foreign equity is excluded, the share of foreign bonds turns positive. This might give a bettter explanation for international trade in bonds but is of course not very helpful in explaining the lack of foreign equity investment. Similarly, a model that forbids trade in foreign bonds does not help in explaining international bond holdings, but could be more capable of calibrating the portfolio share of foreign equity. None of the three models seems to describe economic reality adequately. In assuming that hedging in a particular type of assets may not occur at all, the two alternatives are as extreme as the model that assumes perfect hedging possibilities. Furthermore, by excluding certain trade possibilities, the two alternatives do not really *explain* the pattern of international asset trade. However, both the hedging properties and the portfolio allocations in the three models lead us to believe that economic reality corresponds to a specific mix of the three models. The next step then is to show that the welfare effects are largest in the model that excludes trade in foreign bonds.

The explanation for the difference in welfare effects is as follows. Absent exchange rate expectations, in the unconstrained model and in the model in which investors are forbidden to hold foreign equity, households hedge completely against exchange rate risk (Adler and Dumas (1983)). By matching the portfolio share of foreign securities to the consumption share of foreign goods, households achieve that real exchange rate shocks have no effect upon the real rate of return on the portfolio (the nominal rate of return minus the rate of CPI inflation). Then, a reduction of the variability of the exchange rate will have no welfare effects. In the model in which investors may not invest in foreign bonds, households can hedge also against exchange rate risk, but as these foreign investments must take the form of risky equity, hedging will increase the portfolio's output risk. Thus, hedging is costly and will be imperfect. The consequence is that in this model a reduction in exchange rate risk will lower total portfolio risk and boost economic welfare.

In case exchange rate expectations are non-zero, households may deviate from the portfolio that provides complete hedging in order to increase their expected portfolio return. This argument applies in any of the three models considered here. Hence, the neutrality result that holds in the first two models disappears when non-zero exchange

[11] Markets in these two models are incomplete. See Persson and Svensson (1989) for another analysis that assumes incomplete markets without explaining their non-existence.

rate expectations are taken into account. However, the idea that hedging is costly when it must be carried out through foreign equity instead of foreign bonds, remains. Therefore, we expect the welfare cost of exchange rate risk in general to be largest in the model where trade in foreign bonds is prohibited. As our purpose is to explore the maximum possible effects of exchange rate risk, we will therefore focus exclusively on the latter model from now on.

IV A Two-Country World

After having included the foreign bonds restriction in the model of section II, we are now able to calculate the welfare effects of exchange rate risk. This section derives analytical expressions in order to focus on the transmission channels along which exchange rate risk affects the interest rate, portfolio demand and welfare.

For the purpose of this section, we consider a stylized world that consists of two countries (two types of capital). Naturally, we will denote the portfolio shares of domestic and foreign capital as s_d and s_f respectively and their returns as r_d and r_f. The interest rate on (home) bonds will be denoted as i. Next, we will use π_d and π_f to refer to the consumption shares of home and foreign goods respectively and $\tilde{z}$ without subscripts to refer to the rate of exchange rate appreciation. Due to the exclusion of investment in foreign bonds, each of the two countries can be analysed separately. Therefore, we also omit the country subscript. Next, we assume that for each type of capital the aggregate investment as implied by the model's first-order conditions is non-negative, so that none of the non-negativity constraints on aggregate investment is binding.

Elaborating the first-order conditions $\partial u/\partial s_d = 0$ and $\partial u/\partial s_f = 0$ produces the following set of demand equations:

$$s_d = \frac{1}{\beta\Delta}(Var(r_f) + Var(\tilde{z}))(E(r_d) - i) - \frac{1}{\beta\Delta}Cov(r_d, r_f)(E(r_f) + E(\tilde{z}) - i)$$

$$- \frac{1}{\Delta}Cov(r_d, r_f)\pi_f Var(\tilde{z})$$

(11)

$$s_f = \frac{-1}{\beta\Delta}Cov(r_d, r_f)(E(r_d) - i) + \frac{1}{\beta\Delta}Var(r_d)(E(r_f) + E(\tilde{z}) - i)$$

$$+ \frac{1}{\Delta}Var(r_d)\pi_f Var(\tilde{z})$$

(12)

where Δ, the determinant of the coefficient matrix of the demand equations, reads as $Var(r_d)(Var(r_f)+Var(z))-(Cov(r_d,r_f))^2$. Our assumptions on $Var(r_d)$ and $Var(r_f)$ and on ρ imply that Δ is positive, ensuring that the portfolio described by (11) and (12) corresponds with a strictly global maximum.

Demand for each of the two types of capital consists of two speculative components and a component that corresponds to a minimum-variance portfolio (Kouri and De Macedo (1978), Dornbusch (1983)). Exchange rate variability is seen to lower the speculative components in absolute value. Hence, the riskier the exchange rate, the less responsive is the portfolio to changes in rate-of-return expectations.

The minimum-variance portfolio only consists of bonds if foreign consumption is zero ($\pi_f = 0$). In this case, bonds are riskless and the variance of returns on the minimum-variance portfolio is zero. However, if $\pi_f Var(\tilde{z})>0$, households cannot bring about a zero variance of the portfolio return. Exchange rate variability renders the price of the composite consumption good stochastic, so that bonds, like capital, are a risky investment. As (12) demonstrates, households respond to exchange rate risk by increasing their investment in foreign equity. By going abroad, they match the variability of nominal returns with the variability of the composite consumption price. As expressed in (11), the sign of the correlation between domestic and foreign output determines whether this foreign investment is financed by moving out of domestic equity or by reducing bond holdings.

Bonds market equilibrium implies the following condition:

$$s_d + s_f = 1 - b \tag{13}$$

where b is a shorthand notation for B/W, the share of bonds in household portfolio wealth. Substituting the two asset demand equations (11) and (12) into this equilibrium condition yields the reduced-form expression for the interest rate:

$$i = \frac{(Var(r_f) + Var(\tilde{z}) - Cov(r_d,r_f))E(r_d) + (Var(r_d) - Cov(r_d,r_f))(E(r_f) + E(\tilde{z}))}{Var(r_d) + Var(r_f) + Var(\tilde{z}) - 2Cov(r_d,r_f)}$$

$$- \frac{\beta\Delta(1-b)}{Var(r_d) + Var(r_f) + Var(\tilde{z}) - 2Cov(r_d,r_f)}$$

$$+ \frac{\beta(Var(r_d) - Cov(r_d,r_f))\pi_f Var(\tilde{z})}{Var(r_d) + Var(r_f) + Var(\tilde{z}) - 2Cov(r_d,r_f)} \tag{14}$$

The RHS of (14) contains three terms. The first amounts to a weighted average of the expected rates of return on domestic and foreign capital, both denominated in home-produced goods. The more risky the returns on a given type of capital, the lower the weight of this capital's expected return. The second term reflects that, due to its riskiness, capital must yield a higher average return than bonds. That this term is negative, can be verified by rewriting the denominator of this term as $(\sigma_{rd}-\sigma_{rf})^2+Var(\tilde{z})+2(1-\rho)\sigma_{rd}\sigma_{rf}$ where we use σ_{rd} and σ_{rf} to denote the standard deviations of r_d and r_f respectively. The third term reflects that, with $\pi_f > 0$, exchange rate variability makes bonds a risky investment, which leads households to move into foreign equity. As discussed above, the demand for bonds may as well increase as decrease. Consequently, the third term may be positive or negative.

Having derived the solution for the interest rate, we can substitute it into the asset demand equation (12) to obtain the reduced-form expression for the portfolio share of foreign capital. The portfolio share of domestic capital can then be obtained by using the bonds market equilibrium condition $s_d=1-s_f$.

$$s_f = \frac{E(r_f)+E(\tilde{z})-E(r_d)}{\beta\,(Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))} + \frac{(Var(r_d)-Cov(r_d,r_f))(1-b)}{Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f)} + \frac{\pi_f Var(\tilde{z})}{Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f)} \tag{15}$$

(15)

The first term at the RHS of (15) reflects how a change in the vector of expected rates of return on domestic and foreign capital redistributes wealth over the two types of capital. The second term corresponds with the portfolio that minimizes the variance of output risks. This portfolio is concentrated in the type of capital whose rate of return is relatively stable. Finally, the third term reflects the effect of consumption price variability. As discussed above, households match their portfolio composition to the composition of their consumption basket by investing in foreign equity.

V The Effects of Exchange Rate Risk and Exchange Rate Expectations

We are now ready to derive the effects of exchange rate risk and exchange rate expectations by taking derivatives of i, s_f and u with respect to $Var(\tilde{z})$ and $E(\tilde{z})$. The following expression describes the effect of exchange rate variability upon the interest rate:

$$\partial i/\partial Var(\tilde{z}) = \frac{-(Var(r_d)-Cov(r_d,r_f))(E(r_f)+E(\tilde{z})-E(r_d))}{(Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))^2}$$

$$-\frac{\beta(Var(r_d)-Cov(r_d,r_f))^2(1-b)}{(Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))^2}$$

$$+\frac{\beta\pi_f(Var(r_d)-Cov(r_d,r_f))(Var(r_d)+Var(r_f)-2Cov(r_d,r_f))}{(Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))^2}$$

(16)

The RHS of (16) reflects three effects. The first is that, depending on the value of the rate-of-return differential $E(r_f)+E(\tilde{z})-E(r_d)$, exchange rate variability changes the average rate of return on capital. Second, exchange rate risk increases the riskiness of capital, which is reflected in a higher equity premium or lower interest rate. Thirdly, exchange rate risk renders the price of the composite consumption good stochastic which, according to the minimum variance portfolio, decreases or increases the demand for bonds and raises or lowers the interest rate. Hence, the total of the second and third term may be positive or negative. Alternatively, exchange rate risk raises the risk on equity as well as on bonds so that the equity premium which compensates for the risk differential between equity and bonds may as well increase as decrease.

The effect upon the portfolio share of foreign capital can be derived in a similar manner:

$$\partial s_f/\partial Var(\tilde{z}) \;=\; \frac{-(E(r_f)+E(\tilde{z})-E(r_d))}{\beta(Var(r_d)+\;Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))^2}$$

$$-\;\frac{(Var(r_d)-Cov(r_d,r_f))(1-b)}{(Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))^2}$$

$$+\;\frac{\pi_f(Var(r_d)+Var(r_f)-2Cov(r_d,r_f))}{(Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f))^2}$$

(17)

The first term at the RHS of (17) shows that a higher exchange rate risk reduces the impact of the rate-of-return differential upon the portfolio allocation. The second term demonstrates that exchange rate variability may necessitate a switch away from foreign capital if households are to minimize the variability of the nominal rate of return. The third term reflects that the matching of nominal rate-of-return variability to price variability induces a switch to foreign capital. Again, the total of the second and third term may have any sign.

The welfare effect of exchange rate risk can be linked to the portfolio share of foreign capital:

$$\partial u/\partial Var(\tilde{z}) \;=\; -\frac{1}{2}\beta\,(s_f-\pi_f)^2$$

(18)

As (18) demonstrates, the welfare effect of exchange rate variability is negative, except when s_f happens to equal π_f, in which case the welfare effect is zero. Using the solution for s_f, the welfare effect can be shown to be related to b and π_f:

$$\partial u/\partial Var(\tilde{z}) \;=\; -\frac{1}{2}\beta\left(\frac{m}{Var(r_d)+Var(r_f)+Var(\tilde{z})-2Cov(r_d,r_f)}\right)^2$$

$$m \;=\; \frac{1}{\beta}(E(r_f)+E(\tilde{z})-E(r_d))$$

$$+\;(Var(r_d)-Cov(r_d,r_f))(1-b)\;-\;\pi_f(Var(r_d)+Var(r_f)-2Cov(r_d,r_f))$$

(19)

The interesting thing about (18) is that exchange rate variability is not a zero-sum game. Riskiness of the exchange rate between two countries harms both countries. Furthermore, note from (19) the common role played by government bonds and foreign consumption goods. Both factors tend to reduce the welfare effect of exchange rate risk. Intuitively, exchange rate risk entails a distortion that relates to the gap between the portfolio that minimizes nominal-rate-of-return risk and the portfolio that minimizes consumption price risk. The portfolio shares of foreign equity corresponding to the two portfolios relate to the share of equity in portfolio wealth and to the share of foreign goods in consumption respectively. Therefore, a higher portfolio share of bonds and a higher consumption share of foreign goods both reduce the welfare effect of exchange rate risk.

The following expressions describe the effects of the expectation of an exchange rate appreciation upon the interest rate, the portfolio share of foreign capital, and welfare:

$$\partial i / \partial E(\tilde{z}) = \frac{Var(r_d) - Cov(r_d, r_f)}{Var(r_d) + Var(r_f) + Var(\tilde{z}) - 2Cov(r_d, r_f)}$$

(20)

$$\partial s_f / \partial E(\tilde{z}) = \frac{1}{\beta(Var(r_d) + Var(r_f) + Var(\tilde{z}) - 2Cov(r_d, r_f))}$$

(21)

$$\partial u / \partial E(\tilde{z}) = s_f - \pi_f = \left(\frac{m}{Var(r_d) + Var(r_f) + Var(\tilde{z}) - 2Cov(r_d, r_f)} \right)$$

(22)

where m is defined in equation (19).
The expectation that the exchange rate of the foreign currency will appreciate may raise or lower the interest rate, depending on the correlation between the returns on domestic and foreign capital. It unambiguously raises the share of wealth that households invest in foreign capital. Finally, it may put households on a lower or higher utility level, depending on the gap between the portfolio share of equity and the consumption share of foreign goods. This appreciation expectation looks like a zero-sum game, as $E(\tilde{z})$ has different sign for residents of country 2 and country 1. However, inspection of the expression for s_f, (15), reveals that s_f - π_f is a positive function of $E(\tilde{z})$. Hence, the removal of exchange rate expectations tends to harm the total of the two countries and, if $E(\tilde{z})$ is sufficiently large, will even cause both countries to lose from exchange rate stabilization.

Thus far, the analysis does not tell us anything about the effects of N, the number of countries in the model. As this variable will be seen to play a crucial role in the numerical analysis in sections VI and VII, we now extend the model in this section to the case of *N* countries. As one can imagine, this makes it extremely difficult to derive analytical expressions. Therefore, we make a number of simplifying assumptions. First, we assume all rates of return to be uncorrelated with each other. Second, we assume the rates of return on all types of capital to have identical probability distributions, *i.e.* $E(r_j)=E(r)$ $j=1,..,N$ and $Var(r_j)=Var(r)$ $j=1,..,N$. Thirdly, we assume the expectations of exchange rate changes to be zero: $E(\tilde{z}_{jn})=0$ $j,n=1,..,N,j\neq n$. Finally, we assume households to consume equal amounts of goods imported from any of the foreign countries: $\pi_j^f=(1-\pi^d)/(N-1)=\pi_f$ $j=1,..,N,j\neq n$. Under these assumptions, investment in foreign capital is spread equally over all foreign countries: $s_j^f=s_f$ $j=1,..,N,j\neq n$. Then, the following equations contain the expressions for the interest rate and the portfolio share of investment in any foreign country:

$$i = E(r) - \frac{\beta Var(r)(Var(r) + Var(\tilde{z}))(1-b)}{N Var(r) + Var(\tilde{z})} + \frac{\beta(N-1)\pi_f Var(r)Var(\tilde{z})}{N Var(r) + Var(\tilde{z})}$$

(23)

$$s_f = \frac{\pi_f Var(\tilde{z}) + Var(r)(1-b)}{N Var(r) + Var(\tilde{z})}$$

(24)

Combining expression (23) with $\pi_f=(1-\pi_d)/(N-1)$, it can be seen that an increase in the number of countries increases or decreases the interest rate. However, the share of wealth invested in any foreign country's capital is unambiguously declining in the number of countries. The same holds true for the share of portfolio wealth, invested in home capital, which can be derived from applying the equilibrium condition $s_d=1-b-(N-1)s_f$.

Despite the simplifications made above, it is still difficult to derive anything from the corresponding expression for welfare. Therefore, we evaluate $\partial u/\partial N$ for two very simple cases only, namely when either there is zero exchange rate risk or there is zero rate-of-return risk.

$$\lim_{Var(\tilde{z})\downarrow 0} \partial u/\partial N = \frac{1}{2}\frac{\beta Var(r)(1-b)^2}{N^2}$$

(25)

$$\lim_{Var(r)\downarrow 0} \partial u/\partial N = \beta\pi_f Var(\tilde{z})$$

(26)

Both expressions are unambiguously positive, thereby confirming the intuition that an increase in the number of investment possibilities increases the gain from portfolio diversification. Note that in both cases, the size of the welfare gain decreases with the number of countries ($\partial^2 u/(\partial N)^2<0$). For the second case, this can be seen by rewriting π_f as $(1-\pi_d)/(N-1)$. However, given that these results are established for two special cases only, no general conclusions can be attached to them.

VI Numerical Simulations

This section performs a numerical analysis of the effects of exchange rate stabilization. We adopt the model for the set of OECD countries.[12] As we are primarily interested in the effects of exchange rate stabilization for EU countries, we calculate welfare effects for those countries only.

Before being able to make simulations, we must develop the empirical counterparts of the variables in the model. First, we approximate $r_{j,t}$, the rate of return on capital invested in country j in period t, with the rate of GDP growth, $\tilde{y}_{j,t}$.[13] To calculate the various expectations and covariance variables, we use a sample with historical data, running from 1976 to 1994.[14] The expected value of r_j is calculated as the average of $r_{j,t}$, or $E(r_j)= (1/19)\sum r_{j,t}$ where the summation index t runs from 1976 to 1994. Similarly, the covariance between r_j and r_k, $Cov(r_j,r_k)$, is calculated as $(1/19) \sum (r_{j,t}-E(r_j))(r_{k,t}-E(r_k))$.

Analogously, expected values and variances of rates of real exchange rate appreciation are calculated as $E(\tilde{z}_{jk})=(1/19) \sum \tilde{z}_{jk,t}$ and $Var(\tilde{z}_{jk})=(1/19) \sum (\tilde{z}_{jk,t}-E(\tilde{z}_{jk}))^2$ respectively. The level of the real exchange rate is defined as $(e_{jk,t}q_{k,t})/q_{j,t}$ where e_{jk} is the nominal exchange rate between countries j and k, and q_j is the GDP deflator in country j.

Values for b_j are obtained by multiplying 1994 debt-output ratios with 0.5, which represents the average output-to-financial-wealth ratio. Values for π^f_{jk} are obtained from figures on import shares for OECD countries in 1994. We exclude imports from non-OECD countries and multiply all remaining import shares with the same factor so as to bring the total of import shares for each OECD country to a value of unity. By multiplying these converted import shares with the corresponding ratio of imports to domestic expenditure, we arrive at consumption shares, measuring the share of foreign goods in domestic expenditure.

[12] We exclude Mexico from the dataset. Further, as data on import shares are available only for the total of Belgium and Luxembourg, we take the two countries together. Consequently, N equals 23.

[13] This choice reflects that we wish to approximate the rates of return as they hold on a nation-wide basis. Stock market data are less representative in this respect, as only a subset of firms in countries is listed on the stock markets.

[14] Data are taken from the WILDCAT database, described in Winkler (1996).

A value for β, the coefficient of absolute risk aversion, is obtained by noting that it equals the coefficient of relative risk aversion divided by the argument of the household utility function, $\tilde{w}_n$. The usefulness of this definitional relationship is that some research has been done on estimating the coefficient of relative risk aversion. Mehra and Prescott (1985) for example conclude from a survey of the literature that estimates of the coefficient of relative risk aversion usually lie in the range from zero to two and that the value of unity is a useful benchmark case. Combining this value of unity with the rate of increase of financial wealth, averaged over all countries and all years in the sample (0.024), we arrive at a value of about 40 for β. However, as the various estimates of the degree of risk aversion differ a great deal, we will also explore the consequences of adopting much lower and higher values for β.

Table 1 first provides some basic characteristics of individual OECD countries.[15] The first column gives for each country n=1,..,23 the value of ρ_n, which is defined as the unweighted average of the correlation coefficients of that country's rate of return with the rates of return of the other 22 countries. All correlation coefficients are lower than one and although negative coefficients are present, positive correlation coefficients are the rule. On average, the coefficient of correlation equals 0.25. This suggests that there are substantial gains from portfolio diversification.

The second to fourth column demonstrate that the OECD countries differ widely from each other in terms of the openness of their economies, the burden of public debt and the average rate of return on capital in their countries. $E(\tilde{z})$ in column 5 refers to the unweighted average of the average exchange rate change of country n vis-à-vis all other countries in the sample. It shows that the largest values for the average rate of exchange rate appreciation obtain for countries outside the EU. The same holds true for the variances of the rate of exchange rate appreciation (not shown here). This suggests that Europe has had some success in pursuing exchange rate stability in the period under consideration.

[15] In the following, we use the following codes to refer to the countries in the sample: AT=Austria, AU=Australia, BL=Belgium-Luxembourg, CA=Canada, DK=Denmark, FI=Finland, FR=France, GE=Germany, GR=Greece, IC=Iceland, IR=Ireland, IT=Italy, JP=Japan, NL=The Netherlands, NO=Norway, NZ=New-Zealand, PT=Portugal, SP=Spain, SW=Sweden, SZ=Switzerland, TR=Turkey, UK=United Kingdom, US=United States.

Table 1 *Main characteristics of individual OECD countries*[16]

n	ρ_n	π_n^d	b_n	$E(r_n^d)$[a]	$E(\tilde{z}_n)$[a]	s_n[a]
AT	0.27	0.63	0.65	2.16	1.59	11.77
AU	0.21	0.80	0.13	2.79	-1.60	0.50
BL	0.33	0.32	0.75	1.98	-0.08	0.00
CA	0.36	0.70	0.45	2.65	-0.93	0.00
DK	0.20	0.71	0.78	1.75	0.14	0.00
FI	0.23	0.71	0.73	1.62	-0.82	0.00
FR	0.40	0.79	0.50	2.08	-0.12	0.00
GE	0.10	0.79	0.51	2.75	0.52	6.37
GR	0.31	0.71	1.21	1.89	-0.24	0.00
IC	0.15	0.69	0.39	2.74	-0.03	1.23
IR	0.14	0.37	0.89	3.99	0.12	9.17
IT	0.44	0.79	1.24	2.36	0.82	3.81
JP	0.40	0.93	0.57	3.64	2.85	13.99
NL	0.39	0.52	0.78	2.12	-0.41	0.00
NO	0.20	0.61	0.22	2.94	-1.25	0.00
NZ	-0.12	0.71	0.60	1.44	-0.19	0.00
PT	0.29	0.68	0.70	3.10	0.37	3.35
SP	0.36	0.80	0.64	2.30	0.81	4.16
SW	0.30	0.70	0.88	1.07	-1.53	0.00
SZ	0.15	0.67	0.22	1.33	1.27	1.93
TR	0.07	0.81	0.34	4.25	-2.99	0.57
UK	0.28	0.74	0.50	1.77	0.33	3.45
US	0.32	0.89	0.53	2.53	1.36	8.80
OECD	0.25	0.70	0.62	2.40	0.00	69.10

[a] Defined as percentages.

[16] We do not present the corresponding figures for $\overline{E(r_n^f)}$ as these can easily be derived from the figures for $E(r_n^d)$.

The last column in Table 1 presents the portfolio held by the world investor. This is a hypothetical investor, defined as the unweighted average of the investors in the 23 OECD countries in our dataset. Hence, the shares of this investor's portfolio are calculated as $s_n = S_n / \sum W_j$ where the summation index j runs from 1 to N. As indicated, the investor allocates his wealth over 13 types of capital. For the other 10 types of capital, the world investor finds it optimal to hold negative amounts, but as aggregate investment cannot be negative, his holdings are zero.[17]

On inspection, it appears that investment takes place in countries that have grown relatively fast on average. Examples are Ireland, Japan and Turkey. The average rate of exchange rate appreciation explains why investors hold capital in Austria and, again, Japan. Correlation properties play a role too. Canada, for example, has performed only little worse than the United States on the mean and variance of its rate of growth and its exchange rate. However, as the growth processes in these two countries are heavily correlated ($\rho = 0.89$), there is no reason for investors to hold Canadian dollars next to US dollars and Canadian investment drops to zero.[18]

Table 2 presents the portfolio and welfare effects for EU countries from a complete elimination of intra-EU exchange rate risk. Here, and in all other simulations, it is assumed that exchange rate stabilization implies that all EU countries peg to the Deutschmark. Hence, the properties of the exchange rates of the Deutschmark carry over to the exchange rates of the other EU countries. As to the portfolio allocation, it appears that the elimination of intra-EU exchange rate risk reduces the number of technologies which the world investor chooses to hold from 13 to 8.[19] The reduction of exchange rate risk makes households more willing to speculate on expected-rate-of-return differentials. As this implies an increased demand for borrowing in some technologies, a reduction in portfolio risk will generally increase the number of technologies in which investment is forced to zero.

[17] This result must not be taken literally. A number of factors not included in the model will induce countries to maintain industries, even if portfolio investment would withdraw. To describe investment levels in each and every country, the model therefore is inadequate. However, as it is unclear how the excluded factors affect the results of our analysis on the effects of exchange rate stabilization, it is better to leave them out (see Obstfeld (1994) for a similar approach).

[18] Interestingly, Levy and Sarnat (1970), using a very different dataset, draw the same conclusion.

[19] A note on our method of calculation may be interesting. Calculations of baseline simulations take the whole set of OECD countries as a starting point. The capital markets in those countries in which aggregate investment turns out negative, are subsequently closed and a second iteration is run. This process continues until aggregate investment in all types of capital is non-negative. Calculations of alternative simulations are analogous, except that they take the set of countries of the corresponding baseline simulation as a starting point. Drawback of this procedure is that the ultimate solution is not necessarily unique. Furthermore, different solutions may feature different numbers of technologies or correspond with different welfare levels. Alternative simulations (not included) suggest that the errors introduced by this procedure are small. Moreover, to find all possible solutions, one would have to let the computer make 2^{23} simulations at most. Even when one simulation would take 1 minute (which it mostly exceeds), this would require 15 years of computer time (working night and day).

The fifth column of Table 2 provides the welfare effects of the elimination of intra-EU exchange rate risk. On average, the welfare of EU countries rises with 0.26 percentage points, which corresponds to a 0.26 percent increase in financial wealth. This welfare gain consists of two components. The average rate of increase in financial wealth increases with 0.38 percentage points, reflecting that the reduction of exchange rate risk makes households more willing to take risky positions in order to increase the average return on their portfolios. Second, the welfare equivalent of the variance of the rate of increase in wealth falls with 0.11 percentage points. Apparently, the reduction of exchange rate risk reduces the risk aversion of households to such an extent that they choose to increase the variance of their consumption! As the fourth column of Table 2 shows, this effect is not a curiosity, but holds for all EU countries.

The results for the individual countries are equally interesting. Common to all countries is that they increase both the variance and the mean of their return on financial wealth. Quantitatively, there are enormous differences among the countries however. Some countries gain substantially from risk reduction while others are hardly affected. One country – Sweden – even loses from monetary unification. Countries that reap large benefits from the experiment, like Portugal, Spain and the United Kingdom, typically have a high consumption share of domestic goods or a low portfolio share of public debt. In addition, the currencies of these three countries appreciated against other currencies in the period of analysis. The three factors combine to produce a high welfare gain from exchange rate stabilization, as suggested by the analysis in section V. On the other hand, countries that gain little or nothing, like Sweden and the Netherlands, combine low consumption shares of domestic goods with high portfolio shares of public debt, while their currencies depreciated against other currencies in the period under consideration.

Table 2 *Welfare effects from elimination intra-EU exchange rate risk*[a]

n	(1)	(2)	(3)	(4)	(5)
AT	11.77	0.00	0.59	-0.20	0.38
BL	0.00	0.00	0.37	-0.08	0.29
DK	0.00	0.00	0.23	-0.11	0.11
FI	0.00	0.00	0.15	-0.01	0.15
FR	0.00	0.00	0.14	-0.11	0.03
GE	6.37	4.51	0.42	-0.19	0.23
GR	0.00	0.00	0.36	-0.13	0.24
IR	9.17	32.26	0.40	-0.06	0.34
IT	3.81	0.00	0.46	-0.15	0.31
NL	0.00	0.00	0.23	-0.14	0.08
PT	3.35	4.36	0.50	-0.09	0.40
SP	4.16	0.00	0.80	-0.21	0.60
SW	0.00	0.00	0.02	-0.06	-0.04
UK	3.45	0.00	0.65	-0.06	0.58
Non-EU	27.03	27.98			
EU	42.08	41.12	0.38	-0.11	0.26

[a] Defined as percentages.
(1): Portfolio held by the world investor in the baseline simulation (B)
(2): Portfolio held by the world investor in the alternative simulation (A)
(3): $E(\tilde{w}_n)_A - E(\tilde{w}_n)_B$
(4): $-1/2\beta(Var(\tilde{w}_n)_A - Var(\tilde{w}_n)_B)$
(5): $(u_n)_A - (u_n)_B$ ((5) = (3) + (4))

VII Alternative Simulations

To explore to what extent the effects of the exchange rate stabilization program must be attributed to the removal of non-zero exchange rate expectations, $E(\tilde{z})$, and to the elimination of exchange rate risks, $Var(\tilde{z})$, Table 3 gives the results if only one of the two parts of the stabilization program could be carried out. To compare the results with those of the full program, the last column of Table 3 repeats the welfare effects from Table 2.[20]

[20] Table 3 demonstrates the nonlinearity of the model. The figures in columns (3) and (5) in Table 3 do not add up to those in column (6), which would have been the case if the model had been linear. On average, the non-linearities are large. Furthermore, in most cases they are positive. Hence, the combination of reducing

The figures in Table 3 demonstrate two things. First, the removal of exchange rate risk leads investors to hold capital in two EU-countries only. The vanishing of exchange rate expectations, on the other hand, leaves unaffected the number of countries in which investment occurs. This demonstrates that it is the vanishing of risk and not the vanishing of non-zero exchange rate expectations that makes households more willing to exploit expected-rate-of-return differentials and that causes the closing of some capital markets.

Secondly, households benefit from exchange rate risk reduction but lose from the removal of non-zero exchange rate expectations. This holds for the EU as a whole and for most individual EU countries. Clearly, this reflects the results from section V. Exchange rate risk distorts the optimal allocation of portfolios so that households may benefit from its removal. However, exchange rate expectations create profit opportunities for speculators to borrow in currencies that are expected to depreciate and lend in currencies that are expected to appreciate. Hence, the removal of non-zero exchange rate expectations may put households on a lower utility level.

To assess the robustness of these results, we replicate the analysis of Table 2 with values for the coefficient of absolute risk aversion that differ a factor 4 from the value of 40 used in Table 2 (10 and 160 respectively). Tables 4 and 5 provide the results. With β=160, households invest in more countries than with β=40 (19 instead of 15). With β=10, the opposite holds true: investors hold capital in 5 countries only. These results are as expected: A higher risk aversion makes households more willing to speculate on expected-rate-of-return differentials which increases the probability that some capital markets must be closed.

exchange rate risk and reducing exchange rate expectations adds to the benefits from exchange rate stabilization.

Table 3 *Welfare effects; decomposition in risk and expectation components*[a]

n	(1)	(2)	(3)	(4)	(5)	(6)
AT	11.77	21.93	0.09	0.69	0.00	0.38
BL	0.00	0.00	0.38	0.00	-0.20	0.29
DK	0.00	0.00	0.25	0.00	-0.29	0.11
FI	0.00	0.00	0.77	0.00	-0.52	0.15
FR	0.00	0.00	0.32	0.00	-0.37	0.03
GE	6.37	0.00	0.19	10.31	-0.23	0.23
GR	0.00	0.00	0.21	0.00	-0.10	0.24
IR	9.17	18.62	0.24	13.09	0.14	0.34
IT	3.81	0.00	0.19	3.05	0.02	0.31
NL	0.00	0.00	0.20	0.00	-0.25	0.08
PT	3.35	0.00	0.44	4.31	-0.07	0.40
SP	4.16	0.00	0.40	2.77	-0.01	0.60
SW	0.00	0.00	0.48	0.00	-0.61	-0.04
UK	3.45	0.00	0.57	3.88	-0.08	0.58
Non-EU	27.03	28.56		31.00		
EU	42.08	40.55	0.34	38.11	-0.18	0.26

[a] Defined as percentages.
(1): Portfolio held by the world investor in the baseline simulation (B).
(2): Portfolio held by the world investor in the first alternative simulation (A1), in which only the variances of intra-EU exchange rates vanish.
(3): $(u_n)_{A1}$-$(u_n)_B$
(4): Portfolio held by the world investor in the second alternative simulation (A2), in which only the means of intra-EU exchange rates vanish.
(5): $(u_n)_{A2}$-$(u_n)_B$
(6): $(u_n)_A$-$(u_n)_B$ where A denotes the simulation in which both the means and variances of intra-EU exchange rates van-ish (equal to column (5) of Table 2).

Table 4 *Welfare effects from elimination of intra-EU exchange rate risk ($\beta = 160$)*[a]

n	(1)	(2)	(3)	(4)	(5)
AT	7.76	0.00	0.13	0.15	0.28
BL	0.00	0.00	0.14	0.25	0.39
DK	2.43	11.72	0.02	0.11	0.13
FI	0.38	0.00	-0.04	0.31	0.27
FR	2.68	0.00	-0.03	0.19	0.17
GE	6.61	5.43	0.08	0.16	0.24
GR	0.00	0.00	0.14	0.01	0.16
IR	4.39	14.75	0.08	0.18	0.26
IT	3.48	0.00	0.17	0.03	0.20
NL	0.00	0.00	-0.06	0.09	0.03
PT	1.88	4.33	0.16	0.35	0.52
SP	3.55	0.00	0.34	0.24	0.58
SW	0.00	0.00	-0.21	0.19	-0.02
UK	5.17	1.56	0.36	0.29	0.65
Non-EU	30.77	31.33			
EU	38.34	37.78	0.09	0.18	0.28

[a] Defined as percentages.
(1): Portfolio held by the world investor in the baseline simulation (B).
(2): Portfolio held by the world investor in the alternative simulation (A).
(3): $E(\tilde{w}_n)_A - E(\tilde{w}_n)_B$
(4): $-1/2\beta(Var(\tilde{w}_n)_A - Var(\tilde{w}_n)_B)$
(5): $(u_n)_A - (u_n)_B$ ((5) = (3) + (4))

Table 5 *Welfare effects from elimination of intra-EU exchange rate risk ($\beta=10$)*[a]

n	(1)	(2)	(3)	(4)	(5)
AT	7.14	0.00	0.33	0.16	0.49
BL	0.00	0.00	-0.06	0.22	0.17
DK	0.00	0.00	-0.14	0.18	0.04
FI	0.00	0.00	-0.22	0.24	0.02
FR	0.00	0.00	-0.12	0.14	0.02
GE	0.00	0.00	0.21	0.12	0.33
GR	0.00	0.00	0.07	0.10	0.16
IR	19.45	31.98	-0.05	0.24	0.20
IT	0.00	0.00	0.14	0.08	0.22
NL	0.00	0.00	-0.36	0.30	-0.05
PT	2.93	0.00	0.28	0.13	0.41
SP	0.00	0.00	0.49	0.20	0.69
SW	0.00	0.00	-0.25	0.14	-0.11
UK	0.00	0.00	0.28	0.28	0.56
Non-EU	39.59	37.13			
EU	29.52	31.98	0.04	0.18	0.22

[a] Defined as percentages.
(1): Portfolio held by the world investor in the baseline simulation (B).
(2): Portfolio held by the world investor in the alternative simulation (A).
(3): $E(\tilde{w}_n)_A - E(\tilde{w}_n)_B$
(4): $-1/2\beta(Var(\tilde{w}_n)_A - Var(\tilde{w}_n)_B)$
(5): $(u_n)_A - (u_n)_B$ ((5) = (3) + (4))

On average, the welfare gain is higher (lower) with a higher (lower) degree of risk aversion. Quantitatively however, the welfare effects in Tables 4 and 5 hardly deviate from those in Table 2. In particular, the average welfare gain for the EU equals 0.28 and 0.22 respectively, compared to 0.26 in Table 2. At the individual country level, non-neutralities are present, but these non-neutralities largely net out in the aggregate. Different from our first simulation is that in the simulations with higher and lower values for β households reduce the variance of the return on their financial wealth. In most cases, they are still able to raise the average return on their wealth, but sometimes they are willing to accept a lower average return.

We also explore how sensitive our results are to the assumption that households take the whole sample period into account when calculating the moments of the probability distributions of rate-of-return variables and exchange-rate variables. Indeed, it may be somewhat unrealistic to assume that the realizations of more than ten years ago influence the expectations of next year's outcomes. On the other hand, it must be recognized that expectations are necessarily subjective so that basing expectations on historical realizations will always involve some error.

Bearing this in mind, Table 6 replicates the analysis in Table 2 in case expectations are based upon the period 1986-1994 and 1990-1994 respectively. The results are illuminating. In the first case, all except two EU countries and in the second case all countries lose from exchange rate stabilization. Compared to the benchmark simulation in Table 2, the effects are enormous. For the 1986-1994 case, the EU as a whole suffers a decline of 0.55 percent of its initial wealth. For the 1990-1994 case, the figure is almost three times as high: 1.52.

Table 6 *Welfare effects; different time periods to form expectations*[a]

n	(1)	(2)	(3)	(4)	(5)	(6)
AT	8.15	0.00	0.06	16.48	41.12	-0.55
BL	0.00	0.00	-0.55	0.00	0.00	-1.08
DK	0.00	0.00	-0.42	0.00	0.00	-1.37
FI	0.00	0.00	-1.00	0.00	0.00	-3.99
FR	0.00	0.00	-0.75	0.00	0.00	-1.23
GE	16.31	15.32	0.05	0.00	0.00	-0.37
GR	0.00	0.00	-0.29	0.00	0.00	-0.86
IR	0.00	0.00	-0.50	0.00	0.00	-1.16
IT	0.00	0.00	-0.45	0.00	0.00	-1.31
NL	0.00	0.00	-0.50	0.00	0.00	-0.95
PT	23.44	37.81	-1.23	26.35	0.00	-1.21
SP	6.23	0.00	-0.06	0.00	0.00	-2.15
SW	0.00	0.00	-0.97	0.00	0.00	-2.41
UK	0.00	0.00	-1.04	0.00	0.00	-2.64
Non-EU	14.99	15.98		26.28	27.99	
EU	54.12	53.13	-0.55	42.83	41.12	-1.52

[a] Defined as percentages.
(1): Portfolio held by the world investor in the first baseline simulation (B1), in which the period 1986-1994 is used to form expectational variables.
(2): Portfolio held by the world investor in the first alternative simulation (A1), in which the period 1986-1994 is used to form expectational variables.
(3): $(u_n)_{A1}-(u_n)_{B1}$
(4): Portfolio held by the world investor in the second baseline simulation (B2), in which the period 1990-1994 is used to form expectational variables.
(5): Portfolio held by the world investor in the second alternative simulation (A2), in which the period 1990-1994 is used to form expectational variables.
(6): $(u_n)_{A2}-(u_n)_{B2}$

Theoretically, the negative sign of the welfare effects is not surprising. Countries benefit from exchange rate risk reduction and lose from the elimination of exchange rate expectations so that the net effect is ambiguous. Inspection of the data learns that the shortening of the time period used to form expectations raises the second effect. In particular, when the expected rates of exchange rate appreciation are calculated with fewer data, they typically are larger in absolute value. To illustrate, the cross-country standard deviation of the expected rate of exchange rate appreciation,[21] increases from 1.20% for the 1976-1994 period via 2.25% for the 1986-1994 period to 3.61% for the 1990-1994 period. Such an increase in the spread of the expected rate of exchange rate appreciation across countries may have little effect on the average effect of exchange rate risk reduction, but boosts the average effect of the reduction of non-zero exchange rate expectations. As the former effect is positive and the latter effect is negative, the shortening of the time period for expectations formation reduces the average welfare gain from exchange rate stabilization.[22]

VIII Concluding Remarks

Although we have presented a range of simulations, uncertainties remain. In particular, this holds true for the value of the degree of risk aversion and the values of the expectational variables. Furthermore, wealth differences across countries − not included in the analysis − may play a role as the portfolio demand in a small number of countries may cause aggregate investment in a typical technology to turn negative.

It is also useful to reflect on our technology assumption. All technologies earn a stochastic rate of return that is independent of the amount invested in that technology. It may be not too unreasonable to assume a decreasing marginal return to capital instead. This could have a stabilizing effect on the number of countries in which investment occurs as portfolio reallocations would be followed by changes in rates of return. This is an interesting issue for further research.

Despite these uncertainties, this paper provides evidence that suggests that exchange rate stabilization is a risky strategy. Even in the extreme case in which hedging by investors is not allowed, the welfare gains from exchange rate stabilization are small − bounded by imports of foreign goods and borrowing by governments. Moreover, the gains may be negative since exchange rate stabilization deprives investors from positive speculation gains. In addition, the welfare gains are spread very unevenly over different countries. Hence, even when on average the EU was to benefit from monetary integration, there would be a group of countries that would in all probability lose.

[21] Calculated as the square root of $(1/N)\sum_{n=1}^{N}(\overline{E(\tilde{z}_n)} - \overline{E(\tilde{z})})^2$ *where* $\overline{E(\tilde{z})} \equiv (1/N)\sum_{i=1}^{N}\overline{E(\tilde{z}_n)}$ *and* $\overline{E(\tilde{z}_n)} \equiv (1/(N-1)) \sum_{j=1, j\neq n}^{N} E(\tilde{z}_{nj})$.

[22] In addition, the number of countries in which households invest, decreases with the shortening of the time period (the 1976-1994 simulation starts with 13 countries, the 1986-1994 simulation starts with 7 countries and the 1990-1994 simulation starts with 4 countries). As suggested in section 5, this may boost the drop in welfare that results from a decline in the number of countries as $\partial u/\partial N$ may be decreasing in the number of countries.

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