Real Exchange Rate Adjustment In and Out of the Eurozone

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Abstract

It is often suggested that fixing nominal exchange rates unduly inhibits the efficient adjustment of real exchange rates. Recently, this has been seen as a key failure of the Eurozone. This paper presents some theory and evidence which throws doubt on this conclusion. Our empirical evidence suggests that real exchange rate movement within the Eurozone was at least as compatible with efficient adjustment as the behavior of real exchange rates for the floating rate countries outside the Eurozone. This interpretation is consistent with a model in which nominal exchange rate movements give rise to persistent deviations from the law of one price in traded goods.

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1 Introduction

In recent years, the viability of the Eurozone as a currency union has been called into question, at least partly on the grounds that the use of a common currency throughout Europe leads to real exchange rates that are more misaligned than would occur under freely floating exchange rates. Many of the arguments refer back to Milton Friedman's (1953) case for flexible exchange rates, based on the notion that nominal exchange rate flexibility will allow for efficient adjustment in terms of trade even when nominal goods prices are sticky.

There are many dimensions to the question of what set of countries or regions constitute an optimal currency area. We do not have the space to address here such key issues as the value of an independent monetary policy, the role of credibility of policy, the ability to borrow internationally in ones own currency, etc. Our sole focus is on the question of whether countries in a currency union, and specifically the Eurozone, have worse outcomes for real exchange rates than if they were to adopt freely floating exchange rates.

Friedman's argument in this dimension is based on two assumptions that are clearly violated in the world today, especially within Europe. The first is that final users of imported goods pay prices that are set and sticky in the exporter's currency, so that in the user's currency the price fluctuates constantly with changes in nominal exchange rates. Even if some traded goods prices are set in the exporter's currency, it is clear that many final users especially consumers face prices that are sticky in their own currency. Why is this important? If fluctuations in exchange rates do not affect the user currency price of imported goods, then the exchange rate no longer plays the allocative role in adjustment that was essential for Friedman's defense of flexible exchange rates[1].

The second, and critical, assumption of Friedman's is the complete immobility internationally of capital. In Friedman's exposition, demand for foreign exchange arises only to pay for imported goods. Exchange rate movements in turn lead to terms of trade adjustment (because of his assumption that prices are set in producers currencies), and equilibrium is achieved automatically when demand for imports equals the supply of exports. Complete capital immobility and balanced trade do not well characterize economies in the world today. On the contrary, financial capital flows

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[1]Devereux and Engel (2003) make this point within a specific theoretical framework.

display both a scale and volatility that dwarfs those of goods trade.

In section 2, we briefly review the recent literature that makes the case that freely floating exchange rates are not optimal. In section 3, we present a simple model along the lines of many modern New Keynesian models that illustrates how real exchange rates in a currency union might adjust more efficiently than under floating exchange rates. Section 4 uses a new source of data on consumer price levels to argue that indeed real exchange rates within the Eurozone adhere fairly closely to the efficient outcome. Countries with higher productivity in traded goods sectors, and also with higher relative non-traded goods prices have stronger real exchange rates. Section 5 presents some results from simulations from the model under alternative exchange rate regimes and shows that the simulations accord quite well with the data on exchange rate adjustment in the Eurozone.

A major caveat of our analysis is that we do not consider times of crisis, within either our model or our data. Stephanie Schmitt-Grohe and Martin Uribe (2011) demonstrate that fixed exchange rates will deliver much worse outcomes than floating exchange rates in the event of a crisis. We will return to this observation in Section 6.

2   Optimality of Flexible Exchange Rates

One of the key arguments in Friedman's (1953) case for flexible exchange rates is that nominal exchange rate movements can substitute for nominal price adjustment when nominal prices are sticky, to achieve optimal terms of trade changes. Consider a world of two countries, Home and Foreign. Let an asterisk represent prices denominated in the Foreign currency (while no asterisk indicates prices set in Home currency), with an F subscript referring to the export good of the Foreign country and H being the export good of the Home country. The terms of trade are given by SP_F^*/P_H, where S is the nominal exchange rate, expressed as the Home currency price of Foreign currency.

In Friedman's world all final buyers in both countries face a relative price of SP_F^*/P_H . He argues, first, that if nominal price adjustment is sluggish, and prices are set in each producer's currency (so P_F^* and P_H do not adjust freely), a freely floating exchange rate will still allow instantaneous adjustment of the terms of trade. Secondly, in his world, foreign exchange is traded only to obtain imports, so the

nominal foreign exchange rate is determined in the market for goods. In this case, S will be determined by the world supply and demand of Home and Foreign goods, and the terms of trade will adjust to an efficient level, barring any other market inefficiencies.

In the real world, there is much evidence that many final buyers face prices that are sticky in their own currencies, even for imported goods. This is especially true for consumer prices. The imported consumer good, when it reaches the dock, may have been priced in the exporters currency. But a distributor inevitably reprices the good in the consumers currency.

The relative price of the Foreign good in the Home country is given by P_F/P_H . Both prices may be set in the Home currency when the good is sold in the Home market. Under local currency price stickiness, the relative price of the two goods does not adjust instantaneously when the exchange rate changes. In the Foreign country, both prices are set in the Foreign currency, and again the relative price – P_F^*/P_H^* – does not adjust automatically when exchange rates change. Exchange rate flexibility does not substitute for price flexibility.

Because capital markets are open among advanced countries, the price of foreign exchange is determined as an asset price, not simply as the price that satisfies supply and demand for traded goods. Expectations of the future, and risk premiums, for example, may influence nominal exchange rates. When final prices are set in the buyer's currency, nominal exchange rate fluctuations by themselves contribute to deviations from price equality across countries. Expressed in the local currency, Home buyers pay P_F and P_H for Foreign and Home goods, while Foreign buyers pay SP_F^* and SP_H^* . Deviations from price equality that are not driven by differences in costs of delivering the goods to different locations inevitably lead to inefficient resource allocation. In the discussion of the model below, we will show exactly how this deviation from the 'law of one price' impedes efficient real exchange rate adjustment, and present evidence that this factor is much more important in the floating exchange rate countries of Europe than within the Eurozone itself.

For example, consider a depreciation of the Home currency (an increase in S), caused perhaps by a change in expectations of future monetary policy, and not by any real factor that determines the relative productivity of Home and Foreign firms. In the short run when prices are set in the buyers' currency, the Home firm finds that its profitability on Foreign sales increases with an increase in S, while the Foreign

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firm's margins on sales in the Home country are reduced. Owners of Home firms become wealthier, and owners of Foreign firms lose out. Likewise, Foreign lenders of debt denominated in Home currency lose while Home lenders of debt set in Foreign currency win. These changes in wealth do not reward gains in productivity, but instead are capricious reallocations that result from floating exchange rates. The recent New Keynesian open-economy literature has emphasized the desirability of controlling exchange rates as a goal of monetary policy[2].

In the next section, we describe a fairly standard dynamic macroeconomic model. We show how real exchange rates ought to adjust when there are no sticky-price inefficiencies, or financial market barriers. We then compare in this framework how real exchange rates behave when prices are sticky under a currency union, versus a system of independent currencies with floating exchange rates.

To be sure, we are not conducting a full-fledged welfare comparison of the two systems, which is the appropriate way to compare the systems. Our aim is to illustrate that the simplistic arguments against currency unions and for floating exchange rates based on the notion that a currency union delivers sub-par real exchange rate outcomes are not supported by standard macroeconomic models.

In a world with many distortions, it is quite possible that the constrained optimal movements in real exchange rates will be very different than those in an unconstrained optimum. It may indeed be the case that Greece would have been much better if they had not joined the eurozone because a floating exchange rate would allow them to adjust more quickly to a default on government debt though we raise some doubts about this claim in section 6. The relative merits of the currency arrangements need to be assessed in a rich and carefully calibrated macroeconomic framework.

3   A basic model

There are two countries, home and foreign. Let the utility of a representative infinitely lived home household evaluated from date 0 be defined as:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t (\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi}), \quad \beta < 1. \tag{3.1}$$

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[2]See, for example, Michael B. Devereux and Charles Engel (2003), Giancarlo Corsetti and Paolo Pesenti (2005), Corsetti, Luca Dedola, and Sylvain Leduc (2010), and Engel (2011).

where C_t is the composite home consumption bundle, and N_t is home labour supply. The composite consumption good is defined as:

$$C_t = \left(\varrho^{\frac{1}{\varphi}} C_{Tt}^{1-\frac{1}{\varphi}} + (1-\varrho)^{\frac{1}{\varphi}} C_{Nt}^{1-\frac{1}{\varphi}} \right)^{\frac{\varphi}{1-\varphi}} ,$$

where C_{Tt} and C_{Nt} represent respectively, the composite consumption of traded and non-traded goods. The elasticity of substitution between traded and non-traded goods is φ. Traded consumption in turn is decomposed into consumption of home retail goods, and foreign retail goods, as follows:

$$C_{Tt} = \left((\frac{v}{2})^{\frac{1}{\lambda}} C_{Ht}^{1-\frac{1}{\lambda}} + (1-\frac{v}{2})^{\frac{1}{\lambda}} C_{Ft}^{1-\frac{1}{\lambda}} \right)^{\frac{\lambda}{1-\lambda}} ,$$

where λ is the elasticity of substitution between the home and foreign traded good.

Retail consumption of traded goods requires the use of non-traded goods in order to facilitate consumption, however. This can be rationalized based on the costs of distribution of traded goods. Hence, we assume that the production of consumption retail goods in sectors H and F are assembled according to:

$$C_H = \left(\kappa^{\frac{1}{\phi}} I_H^{(1-\frac{1}{\phi})} + (1-\kappa)^{\frac{1}{\phi}} I_{HN}^{1-\frac{1}{\phi}} \right)^{\frac{1}{1-\frac{1}{\phi}}}$$

$$C_F = \left(\kappa^{\frac{1}{\phi}} I_M^{(1-\frac{1}{\phi})} + (1-\kappa)^{\frac{1}{\phi}} I_{MN}^{1-\frac{1}{\phi}} \right)^{\frac{1}{1-\frac{1}{\phi}}}$$

where I_H represents inputs of the home export good into the retail consumption of that good, and I_{HN} represents input of the home non-traded good into the retail consumption of the export good. The the elasticity of substitution between non-traded inputs and the export good itself is ϕ. The notation for the retail consumption of imports is similarly defined.

The consumption aggregates imply the following price index definitions:

$$P_t = \left(\varrho P_{Tt}^{1-\varphi} + (1-\varrho) P_{Nt}^{1-\varphi} \right)^{\frac{1}{1-\varphi}} ,$$

$$P_{Tt} = \left(\frac{v}{2} \tilde{P}_{Ht}^{1-\lambda} + (1-\frac{v}{2}) \tilde{P}_{Ft}^{1-\lambda} \right)^{\frac{1}{1-\lambda}} ,$$

where P_{Tt} and P_{Nt} represent traded and non-traded price levels, and P_{Ht} and P_{Ft} are retail prices of home exportables and foreign importables. Finally, these retail prices in turn depend on prices at the dock as well as the non-traded goods price. Hence:

$$\tilde{P}_H = \left(\kappa P_H^{(1-\phi)} + (1-\kappa)P_N^{1-\phi}\right)^{\frac{1}{1-\phi}}$$

$$\tilde{P}_F = \left(\kappa P_F^{(1-\phi)} + (1-\kappa)P_N^{1-\phi}\right)^{\frac{1}{1-\phi}}$$

We define the real exchange rate as:

$$RER_t = \frac{S_t P_t^*}{P_t}.$$

We assume that international financial markets are complete. As is well known, this implies a risk sharing condition given by: :

$$\frac{C_t^{-\sigma}}{P_t} = \frac{C_t^{*-\sigma}}{S_t P_t^*} \tag{3.2}$$

Households choose consumption of individual goods, and labor supply in each sector in the usual way. The implicit labor supply for home households is given by:

$$W_t = P_t C^\sigma N_t^\phi$$

where W_t is the nominal wage. Demand for goods is characterized as follows. The demand for traded and non-traded goods is described as:

$$C_{Tt} = \gamma\left(\frac{P_{Tt}}{P_t}\right)^{-\varphi} C_t, \qquad C_{Nt} = (1-\gamma)\left(\frac{P_{Nt}}{P_t}\right)^{-\varphi} C_t$$

Demand for home and foreign goods is in turn described by:

$$C_{Ht} = \kappa\omega\left(\frac{P_{Ht}}{\tilde{P}_{Ht}}\right)^{-\phi}\left(\frac{\tilde{P}_{Ht}}{P_{Tt}}\right)^{-\lambda} C_{Tt}, \qquad C_{Ft} = \kappa(1-\omega)\left(\frac{P_{Ft}}{\tilde{P}_{Ft}}\right)^{-\phi}\left(\frac{\tilde{P}_{Ft}}{P_{Tt}}\right)^{-\lambda} C_{Tt},$$

Firms in each sector produce using labor and a fixed capital stock[3] . A typical

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[3]The implications for real exchange rates would not differ materially were we to allow for endogenous capital accumulation.

firm in the non-traded (traded) sector has production function $Y_{Nt}(i) = A_{Nt}N_{Nt}(i)^\alpha$, $Y_{Ht}(i) = A_{Ht}N_{Ht}(i)^\alpha$. Thus, there are two technology shocks - shocks to the non-traded sector A_{Nt}, and to the traded sector A_{Ht}. These shocks the the key fundamental driving forces of efficient equilibrium real exchange rates in the model.

Firms in each sector set prices following a Calvo price adjustment specification, using domestic household's nominal marginal utilities as stochastic discount factors. Following Engel (2011), we assume local currency pricing (LCP), which is more consistent with evidence of low pass-through to prices of retail goods. Thus, exporters set prices in the currency of the buyer. This means that for each variety of home goods, there are two prices set by the producer; one for sale in the domestic market, and one for sale in the foreign market. When exchange rates vary, this can give rise to deviations from the law of one price. These deviations may have substantial short run effects on the real exchange rate, as we see below. Given this pricing assumption, the optimal pricing, employment, and investment policy for firms is standard.

Monetary policy is set as follows. The home country monetary authority follows a Taylor rule adjusted for nominal exchange rate changes, except that it targets the consumer price inflation so that the nominal interest rate in the home economy is $r_t = \rho + \gamma_\pi \pi_t + \delta(s_t - s_{t-1}) + m_t$ where $\pi_t = p_t - p_{t-1}$. is the domestic inflation rate of the CPI (where $p_t = log(P_t)$), and δ is the weight that it puts on exchange rate stability in its monetary policy rule. In addition, we allow for a shock to the interest rate rule m_t. Under flexible exchange rates, this shock may cause changes in real exchange rates. The foreign monetary rule is given by $r_t^* = \rho + \gamma_\pi \pi_t^* + m_t^*$. It would make no material difference to the results if we assumed that the foreign monetary authority also targeted exchange rate changes.

Finally, goods market clearing conditions are given as:

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\begin{aligned}
Y_{Ht} &= I_{Ht} + I_{Ht}^* & (3.3) \\
Y_{Ft}^* &= I_{Mt} + I_{Mt}^*, \\
Y_{Nt} &= C_{Nt} + I_{HNt} + I_{MNt}, \\
Y_{Nt}^* &= C_{Nt}^* + I_{HNt}^* + I_{MNt}^*.
\end{aligned}
$$

In addition, we must have labor market clearing in each country, so that:

$$
N_t = N_{Nt} + N_{Ht} \tag{3.4}
$$

$$N_t^* = N_{Nt}^* + N_{Ht}^* \tag{3.5}$$

The definition of equilibrium is standard and we omit it to save space.

3.1 The Real Exchange Rate Decomposition

The real exchange rate in the model is influenced by structural differences across countries and shocks that cause relative prices to move over time. Following Engel (1999), we can write a log linear approximation of the real exchange rate in terms of differences in the relative price of non-traded to traded goods across countries, and differences across countries in the price index of traded goods. Thus:

$$q_t = (1 - \varrho)q_n + q_T \tag{3.6}$$

where $q_n \equiv (p_{Nt}^* - p_{Tt}^* - (p_{Nt} - p_{Tt}))$, and $q_T \equiv_{Tt}^* + s_t - p_{Tt}$. Note that the first expression on the right hand side does not contain the nominal exchange rate; it is the difference across countries in the relative local currency price of non-traded to traded goods. A rise in the foreign relative price relative to the home relative price causes a home real exchange rate depreciation. The second expression on the right hand side is the traded goods real exchange rate at the retail level. But in our model, due to distribution costs in retail, this should also be affected by the relative price of non-traded goods. To see this, we may further decompose the second expression as follows:

$$q_T = \frac{1 - \kappa}{\kappa}(p_{Nt}^* - p_{Tt}^* - (p_{Nt} - p_{Tt})) + (v - 1)\tau_t + p_{Ht}^* + s_t - p_{Ht} \tag{3.7}$$

where $\tau_t = p_{Ft}^* - p_{Ht}^* = p_{Ft} - p_{Ht}$ is the terms of trade of the home country, [4], and $p_{Ht}^* + s_t - p_{Ht}$ represents the deviation from the law of one price in home traded goods. This expression tells us that the traded goods real exchange rate is driven by a) differences in relative non-traded goods prices across countries - again a rise in this relative-relative price will cause a real exchange rate depreciation, b) the terms of trade, when there is home bias in preferences (i.e. $v > 1$), and c) deviations from the law of one price - a higher foreign price of equivalent goods relative to the home

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[4]This definition uses the fact that up to a first order approximation, the terms of trade facing foreign and home purchasers is the same. An identical equivalence up to a first order holds for the deviation from the law of one price for home and foreign goods. See Engel (2011).

price is associated with a real exchange rate depreciation.

Putting together these two previous expressions, we see that the exchange rate directly enters the real exchange rate decomposition explicitly only to the extent that there are deviations from the law of one price. In the model described above, deviations from the law of one price will occur only when the exchange rate is uncertain. Thus, in comparing real exchange rate determination within and outside the Eurozone, we should expect to see a closer connection between the traded goods real exchange rate and the relative-relative non-traded goods price in the former than in the latter. Of course expression (3.6) and (3.7) do not say that the only difference between real exchange rate behavior across fixed and flexible exchange rate regimes is due to deviations in the law of one price. To the extent that the exchange rate regime affects real variables through monetary non-neutrality, then the other components of the real exchange rate will be different across fixed and flexible exchange rates. But we can highlight the comparison between the two regimes by comparing the behavior of the real exchange rate under fixed and flexible regimes with the implied real exchange rate in the model where prices were perfectly flexible and there were no monetary non-neutralities at all.

While this decomposition stresses the time series movement in the real exchange rate, we want to emphasize that a similar decomposition can be done in terms of the *level* of the real exchange rate between any two countries. A country may have a high real exchange rate (or a high relative price) due to productivity differentials which drive the relative-relative price of non-traded goods, a high terms of trade, or a market structure that leads to higher relative prices of identical traded goods. In our data, we see considerable persistent differentials in relative prices among Eurozone members as well as in the floating exchange rate group. Again however, our aim is to determine to what extent the exchange rate regime itself can facilitate the attainment of an efficient real exchange rate, either in levels or in movements over time.

3.1.1   Relative Productivity and Real Exchange Rates

The decomposition above tells us what the channels of real exchange determination will be, but it is silent on the underlying determinants of real exchange rates. The theory outlined in the previous section allows for shocks to productivity and to monetary policy rules. In a fully flexible price equilibrium, the real exchange rate will be affected only by shocks to productivity. Under plausible restrictions on elasticities,

a rise in the productivity in a country's traded goods sector will generate a real exchange rate appreciation. This will come about through an increase in the relative price of non-traded goods, as in the standard Balassa-Samuelson model. As we see below, the positive co-movement between real exchange rates and productivity in the traded goods sector continues to hold both under fixed and floating exchange rates, when prices are sticky.

4   Features of European Real Exchange Rates: in and out of the Eurozone

We describe the features of European real exchange rates. The data are constructed by Eurostat, based on the Eurostat PPP project. The frequency is annual, over 1995-2009 and the data are comprised of prices of 146 consumer goods, expressed as a ratio of the European average price of each good[5]. Hence the prices are in levels, so that both cross section and time series real exchange rate variation can be examined[6]. Over the sample period, we have 11 countries that entered the Eurozone in1999 [7], one that entered in 2001 (Greece), and six countries that remained outside the Eurozone for the whole sample [8]. We construct aggregate and sectoral real exchange rates from the underlying price series. Let p_{it} be the average overall (log) price level for country i at time t, and let p_{iTt} (p_{iNt}) represent the average price level of the subset of traded (non-traded) goods. Some descriptive statistics for p_{it} are reported in Table 1. The first panel illustrates the average relative price over the sample for each country in the Eurozone. A higher number in this Table refers to a higher relative price (an appreciated real exchange rate). Thus, Belgium, with an average of 1 is representative in the sense that its average price over the sample is equal to the European average. Over the sample, the Southern European Countries of Greece Spain and Portugal had lower prices. The second panel illustrates the real exchange rates for the floating countries. On average they have significantly higher prices than those of the Eurozone.

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[5]The average is taken over the central 15 European countries given by; Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Spain, Sweden, Portugal, Finland, and the United Kingdom.

[6]See Berka and Devereux (2011) for a more complete description of the data.

[7]These are Belgium Germany Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, and Finland.

[8]These are Denmark, Sweden, UK, Iceland, Norway, and Switzerland.

Note in addition, that the standard deviation of the (log) of the real exchange rate for the floaters is considerably higher than that of the Eurozone countries. The exception is Denmark, which has the lowest standard deviation of all countries, in or out of the Eurozone.

We are interested in exploring the behavior of European real exchange rates through the lens of the real exchange rate decomposition presented above. Accordingly, we construct a real exchange rate for each bilateral pair of countries. Thus we define $q_{ijt} = p_{jt} - p_{it}$ to be country $i's$ bilateral real exchange rate against country j, $q_{ijRt} = (p_{jNt} - p_{jTt}) - (p_{iNt} - p_{iTt})$ to be the 'relative-relative' component of the bilateral real exchange rate (i.e. the relative price across countries of the internal relative price of non-traded goods), and finally, $q_{ijTt} = p_{jTt} + s_{ijt} - p_{iTt}$ to be the relative price of traded goods between country i and j, evaluated in a common currency, where s_{ijt} is the currency i price of currency j at time t. Of course, for the Eurozone countries for $t > 1999$, this is equal to unity.

Table 2 presents some features of bilateral real exchange rates for these decompositions. The Table reports the average standard deviation for each component of the real exchange rate across countries, over time, and for the full panel (time and country). This is done separately for the Eurozone countries, the floating exchange rate countries, and the group of bilateral pairs in which one of the country pairs contains a floating exchange rate country. We note that for all groupings, there is substantial cross country variability in bilateral real exchange rates, for all different components of the real exchange rate. Over time, the average variability is a lot less. This is to be expected; as pointed out by other authors (e.g. Berka and Devereux (2011), Engel and Rogers (2004)), there are large differences in average prices across European countries that shows no clear tendency to diminish over time.

The time-pattern of real exchange rate variability is determined by differences in country inflation rates and by movements in nominal exchange rates. Here we see a clear difference between the Eurozone members and the floating exchange rate countries (or the Eurozone-floating combination). The overall real exchange rate and each component is substantially more volatile for the floaters and the Eurozone-float combination that for the Eurozone members.

We are interested in the degree to which the separate components of the real exchange rate facilitate equilibrium adjustment of the exchange rate. As discussed above, under fully flexible prices, there should be no deviations from the law of one

price across countries. In this case, the traded goods component of the real exchange rate should principally reflect movement in the relative-relative non-traded goods price (we proceed by assuming that the terms of trade effect through home bias in preferences is small, as it will be in our calibration below), and thus, there should be a high correlation between q_{ijt} and q_{ijRt}, and also between q_{ijTt} and q_{ijRt}. Table 2 indicates that these features are observed for the Eurozone, but not for the floating exchange rate countries, and not very strongly for the Eurozone-float combination. In particular, there is a correlation of 0.77 between q_{ijt} and q_{ijRt}, and 0.53 between q_{ijTt} and q_{ijRt} for Eurozone countries. But for floating countries, the analogous correlations are -.14 and -.39 respectively. Thus, for the floating countries, there is scant evidence that real exchange rates are driven by internal relative prices, via the distribution channel. This is the reason we make the argument that fixed exchange rates may facilitate better real exchange rate adjustment[9].

The argument is seen more clearly using Figures 1 and Figures 2. These show the scatter plots of q_{ijt} and q_{ijRt}, q_{ijTt} and q_{ijRt}, and q_{ijt} and q_{ijRt}, respectively, for each grouping of countries. For the Eurozone, we see a tight upward sloping relationship between the real exchange rate and internal relative prices, and also between the traded goods real exchange rate and internal relative prices. For the floating countries, the relationship is negative, but also much less tight. For the Eurozone floating combination, there is a positive relationship, but again much less tight than for the Eurozone.

Note that there is a very clear positive relationship between q_{ijt} and q_{ijTt} for all country groupings. This is to be expected, since for both fixed and floating exchange rates, q_{ijTt} directly enters as a component of the exchange rate. But the Figure seem to indicate that for the floating countries, q_{ijT} is not driven by internal relative prices, but rather by deviations for the law of one price (again assuming that the terms of trade component is small).

4.1 Productivity and Real Exchange Rates in the data

To see the link between productivity and real exchange rates, we obtained data on sectoral productivity from the OECD STAN data-base. We constructed measures of labor productivity in each sector, and from this, derived a measure of relative

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[9]We should emphasize on important caveat about this comparison. Our sample of floating exchange rate countries is small, and contains some special cases, such as Iceland and Norway.

productivity in the traded to non-traded goods sector, denoted A_T. Table 3 gives descriptive statistics for this measure for each country[10]

Table 4 shows the relationship between real exchange rates and relative productivity in traded goods, for the Eurozone countries as well as for the floating exchange rate countries. The Table reports results of panel regression for all the Eurozone countries over the whole sample, (except Greece, which does not have productivity data prior to 2000) of the real exchange rate on relative productivity in traded goods. We see that there is a significant positive coefficient equal to 0.12.

For the floating exchange rate countries (without Iceland) we report the analogous regression. Again here, there is a positive relationship. But the relationship is only half as big as in the Eurozone sample, and it is only marginally significant. Moreover the R^2 is half that in the Eurozone.

Figure 3 illustrates the bilateral relationship between real exchange rates and relative traded good productivity for the country groupings as before. We note that within the Eurozone there is a clear positive relationship between relative productivity in the traded goods sector and the real exchange rate. For the floating exchange rate countries, this positive relationship is there also, although considerably more diffuse. The Eurozone-floating exchange rate mix of bilateral relationships is, as before, somewhere in between.

The implication is that, based on these observations, we cannot easily make the case that the Eurozone impeded efficient real exchange rate adjustment necessitated by productivity differentials across Eurozone countries.

5   Model Determined Real Exchange Rates under Alternative Exchange Rate Regimes

We now return to the model. The aim is to describe the determination of the real exchange rate under fixed and flexible exchange rate regimes, comparing the properties of the simulated real exchange rates to those we observe for the European sample of countries within and outside the Eurozone.

To construct a valid comparison, we need to appropriately calibrate and simulate the model. The calibration is described in Table 5 (to be added). The model is

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[10]There are no sectoral productivity data for Iceland, so this is left out of the floating sample when looking at the relationship between real exchange rates and relative productivity.

relatively parameter intensive, but we follow the literature quite closely in setting parameters. We choose an inter-temporal elasticity of substitution equal to 2, a consumption constant elasticity of labor supply equal to unity, a share of non-traded retail goods in consumption equal to 0.5, a home preference parameter $v = 1.3$, which together with the non-traded goods gives an import share of GDP equal to about 30 percent, which is a reasonable average for European countries. We follow Corsetti et al. (2010) in choosing a very low elasticity of substitution between intermediate imports and non-traded distribution services[11]. The elasticity of substitution between home and foreign retail goods is set at 8, which is Corsetti et al. choice [12]. The elasticity of substitution between traded and non-traded goods is set equal to 0.7. Labor share in GDP is assumed to be 0.7. The discount factor is set at 0.99. Finally, the Calvo price setting parameter is set so that prices adjust on average every four quarters.

We construct two panel samples of real exchange rates to match the size of the panels in the data. That is, for the fixed exchange rate case, we compute a panel of 12 countries over 15 periods, while for the floating group we construct a panel of 6 countries over 15 periods. Countries differ based on their steady state real exchange rates. We assume differences in productivity in traded goods and non-traded goods is such that the range of real exchange rates within the panel matches the standard deviation across countries within the observed panel, both for the fixed and floating panels.

Finally, we assume shocks to productivity in traded goods and monetary rules in each country are independent, and persistent with an AR(1) coefficient of 0.9. We set the variance of shocks the same, and choose the variance so that the standard deviation of exchange rates in the floating exchange rate case is the same as observed over the panel for the floaters (6 percent).

We first describe the characteristics of the real exchange rate under completely flexible prices, where the exchange rate regime itself is irrelevant, using the same parameterization and the same shock processes. Of course in this case, the monetary

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[11]Corsetti et al. set this equal to zero. We choose $\phi = 0.05$. The argument for a low elasticity of substitution is that wholesale goods have to be purchased in fixed supply to obtain a given amount of retail goods, so there is almost no ability to substitute between the distribution services and the wholesale goods themselves in retail production.

[12]Corsetti et. al. (2010) show that this translates into a lower elasticity of substitution between traded wholesale goods, due to the presence of distribution services.

policy shocks have no effect on any components of the real exchange rate.

As in the discussion of data, we focus on the properties of the overall real exchange rate, and the components of the real exchange rate driven by the internal relative prices and by the relative price of traded goods across countries.

Figure 4 illustrates the case with purely flexible prices, while Figure 5 contrasts the case under fixed exchange rates with that under flexible exchange rates. Under flexible prices, there is a very tight positive co-movement between q_t and q_{Rt}, between q_{Tt} and q_{Rt}, and between q_t and q_{Tt}. This is because, when monetary disturbances have no effect on real exchange rates or their components, the real exchange rate is driven only by shocks to traded goods productivity. This drives the real exchange rate, the relative internal price of non-traded goods, and the relative price of traded goods across countries in the same way.

Figure 5 shows that there is a significant difference in the behavior of real exchange rates and their components in the fixed and flexible exchange rate case. Under fixed exchange rates, monetary policy shocks have no impact on exchange rates, up to a first order approximation. Then, the component of the real exchange rate attributable to deviations from the law of one price plays no role at all in real exchange rate determination. In fact, the first three panels of Figure 5 are strikingly similar to those of Figure 4. The relationship between the components of the real exchange rate under fixed exchange rates is basically the same as that under completely flexible prices.

But under floating exchange rates, monetary policy shocks play a key role in real exchange rate determination. Moreover, they drive the real exchange rate fundamentally by creating deviations from the law of one price across countries. This affects the traded goods component of the real exchange rate in a completely different manner than that under flexible prices, or indeed that under fixed exchange rates. Deviations from the law of one price dilute the positive co-movement between the real exchange rate and the relative internal price of non-traded goods and between the relative price of traded goods across countries and the relative internal price of non-traded goods. Thus, whereas there is a high positive co-movement between q_t and q_{Rt} and between q_{Tt} and q_{Rt} under fully flexible prices and under fixed exchange rates, there is no clear relationship (in fact a slightly negative co-movement) in these two relationships under floating exchange rates. Moreover, this property of Figure 5 is strikingly similar to that seen in Figure 1 for the floating exchange rate countries of Europe.

5.0.1 Real Exchange Rates and Productivity in the model

In the European data, we observed a positive relationship between real exchange rates and productivity in the traded goods sector. We see the same relationship in the model. Figure 6 illustrates the scatter plots of bilateral relationships for each simulated panel of countries as in Figure 4 and 5. For both sets of simulations, the trendline is positive, but slightly more positive for the fixed exchange rate case. In addition, the relationship is less diffuse for the fixed exchange rate simulations than for the floating exchange rate case.

6 Discussion

We have seen that the real exchange rates in the Eurozone closely reflect differences in the relative prices of nontraded to traded goods across countries, and in turn differences in the relative productivity levels in the traded versus nontraded sectors. The actual pattern of prices and real exchange rates mirrors the pattern produced in the simulations from our model. Moreover, we see in the model simulations that the distribution of real exchange rates in the currency union matches the pattern produced under flexible prices.

Intuitively, there are three main reasons why the real exchange rates in the currency union are so nearly in line with the real exchange rates under flexible prices. First, the initial accession rates in the Eurozone were set in effect to minimize deviations in traded goods prices across countries. So in 1999, the real exchange rates within the Eurozone were effectively initialized at levels that reflect the differences in their nontraded goods prices and differences in distribution costs.

Second, relative productivity shocks over time within the Eurozone simply are not that big. That is, the equilibrium or flexible-price real exchange rate within the Eurozone does not change very much over time. If the initial real exchange rates are near the equilibrium level then even with no further adjustment of the actual real exchange rates, they will not differ too much from the equilibrium rates simply because the equilibrium rates do not stray very far from the initial levels. In a sense, this observation merely restates the point made by Rogoff (1995) in the context of the puzzling behavior of real exchange rates under floating nominal rates. He said that real exchange rate volatility we observe among floating rate countries is impossible

to explain if only real productivity shocks drove real exchange rates - that monetary and financial factors must play a role: existing models based on real shocks cannot account for short-term exchange rate volatility (p. 648). Equilibrium real exchange rates are not very volatile, and since the currency union eliminates relative monetary shocks, the real exchange rate under a currency union is also not very volatile.

Third, nominal prices do adjust over time, so even in a currency union there is real exchange rate adjustment. It is worth emphasizing that the choice of exchange rate regime only matters for real exchange rate adjustment because nominal prices are sticky. The speed of adjustment of real exchange rates is limited only by the speed of adjustment of nominal prices. While the point is obvious, it still is often overlooked. For example, it is frequently argued that the Eurozone is a poor candidate for a currency union because labor is not very mobile within the Eurozone. But the degree of labor mobility can only matter for the choice of exchange-rate regime if mobility can substitute for nominal wage and price adjustment. That is, labor immobility may well mean that adjustment to real shocks in the Eurozone is slower than in the U.S. where labor is more mobile. However, this refers to an equilibrium adjustment – the problem would exist in the Eurozone even if prices and wages were flexible. Put another way, labor mobility can substitute for nominal exchange rate adjustment only if labor moves at higher frequencies than prices and wages adjust.

Finally, we should emphasize that our empirical analysis does not include the period of the sovereign debt crisis in Europe, and our model does not consider real exchange rate adjustment in crises situations. It might well be the case that under a crisis, the real exchange rate adjustment that occurs under floating rates is more desirable than what occurs in a currency union. The point has been made in the popular press that Greece could have adjusted much more quickly under floating rates. We would like to add, however, a couple of thoughts. First, exchange rate adjustment is a second-best response to the underlying distortions in the system in a financial crisis. In the case of this recent crisis, one of the main problems has been the sovereign country's inability to commit to repayment of debt coupled with inadequate fiscal rules within the Eurozone. Second, the case made for exchange rate flexibility in a crisis ignores the hard fact that countries that are subject to debt crises generally cannot borrow abroad in their own currency. As we have seen in the Latin American debt crises in the 1980s, the Asian crisis in the late 1990s, and many other recent instances, currency depreciation magnifies the crisis, rather than ameliorating

it, because it increases the local currency value of foreign debt.

In the end, we have not presented a full-blown welfare analysis of currency unions versus floating exchange rates. Our point is that real exchange rate adjustment in a currency union might be superior to that under floating rates. There is no evidence that real exchange rates under floating rates adjust in a desirable way. A currency union might deliver superior performance because it reduces the deviations from price equality for traded goods that occurs under a floating regime. However, there are many other dimensions to consider. A currency union does not allow for independent monetary policy among countries within the union. On the other hand, currency unions might enhance the credibility of monetary policy for some countries, they might allow countries to overcome "original sin" and borrow internationally in their own currency, and currency unions might spur closer fiscal cooperation. The Friedman argument, however, that floating rates allow efficient real exchange rate adjustment, is spurious.

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Table 1: Descriptive Statistics												
EZ	BE	GER	GRE	SPA	FRA	IRE	ITA	LUX	NET	AUS	POR	FIN
Mean	1	1.01	.87	.87	1.02	1.07	.97	1.02	.97	1.03	.86	1.16
Std	.02	.03	.04	.03	.03	.06	.04	.02	.02	.04	.02	.02
Float	DEN	SWE	UK	ICE	NOR	SWI						
Mean	1.3	1.17	1.04	1.3	1.4	1.23						
Std	.01	.05	.09	.12	.05	.06						

Table 2: Real Exchange Rate Bilateral Pairs				
		RER	RER(pn)	RER(T)
EZ	Std-C	.13	.16	.1
	Std-T	.04	.05	.04
	Std	.13	.16	.1
	Corr	1.0	-	-
		.77	1.0	-
		0.95	0.53	1.0
Float	Std-C	.16	.14	.18
	Std-T	.09	.06	.07
	Std	.17	.14	.18
	Corr	1.0	-	-
		-.14	1.0	-
		.96	-.39	1.0
EZ-Float	Std-C	.18	.14	.17
	Std-T	.08	.06	.07
	Std	.18	.15	.17
	Corr	1.0	-	-
		.3	1.0	-
		0.97	.04	1.0

Notes: Std-C is the time-averaged cross-country standard deviation. Std-T is the country-averaged time-series standard deviation. Std. is the time and country standard deviation. RER(pn) is the real exchange rate expressed as the relative value across countries of the internal relative price of non-traded to traded goods. RER(T) is the real exchange rate expressed as the relative price across countries of the traded good, expressed in a common currency.

Table 3: Descriptive Statistics: Relative Productivity											
EZ	BE	GER	SPA	FRA	IRE	ITA	LUX	NET	AUS	POR	FIN
Mean	1	1.04	.96	0.89	1.67	.97	.65	1.24	1.0	.74	1.46
Std	.04	.05	.03	.04	.18	.01	.06	.06	.08	.03	.14
Float	DEN	SWE	UK	NOR	SWI						
Mean	1.02	1.12	1.43	2	1.07						
Std	.07	.03	.07	.25	.30						

Table 4: Real Exchange and Productivity				
		Coeff	p-val	t-stat
EZ	a	.87	.02	34.34
	b	.12	.02	5.16
	R^2	0.14		
Float	a	1.11	.05	21.19
	b	.08	.04	2.37
	R^2	0.07		

Notes: This represents a panel regression of the real exchange rate on relative productivity in the traded goods sector to the non-traded goods sector over the 1995-2009 sample. The Eurozone countries are: Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, and Finland.
The floating rate countries are Denmark, Sweden, the UK, Norway, and Switzerland.

Figure 1: Real Exchange Rate: Eurozone and Floaters
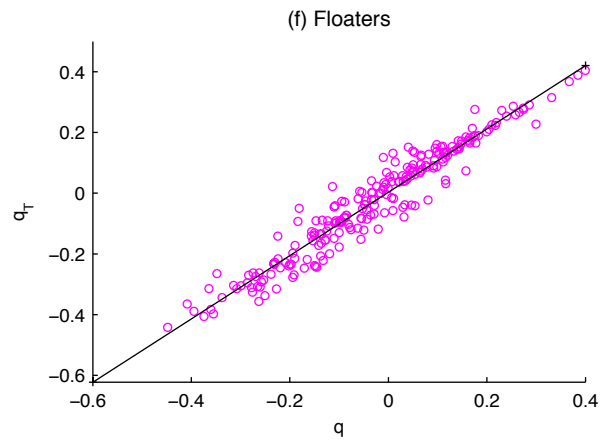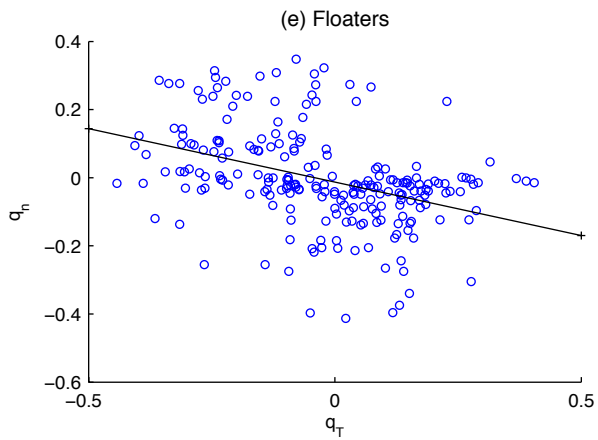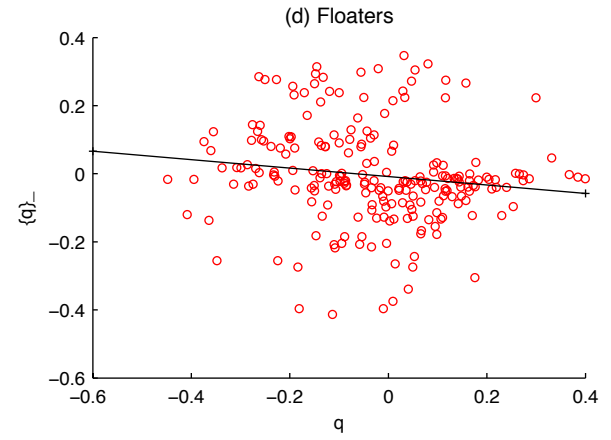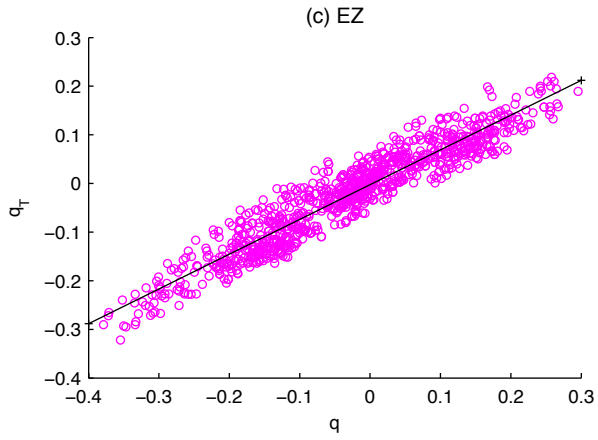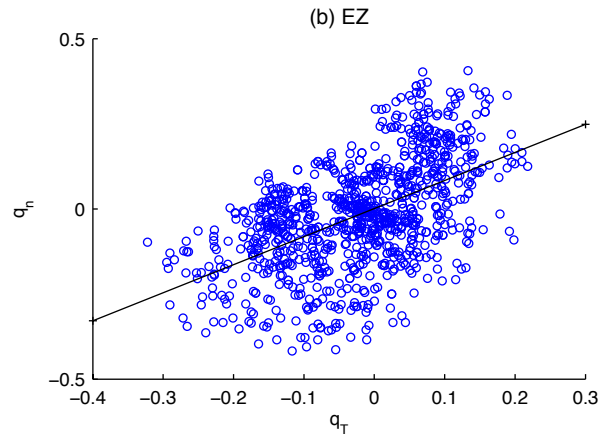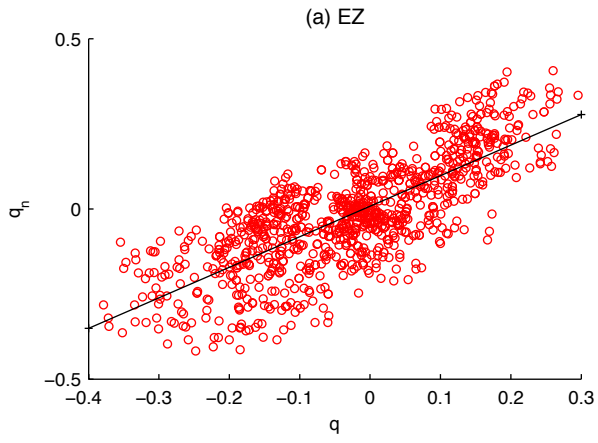
Figure 2: Real Exchange Rate: Eurozone−Floaters Interaction
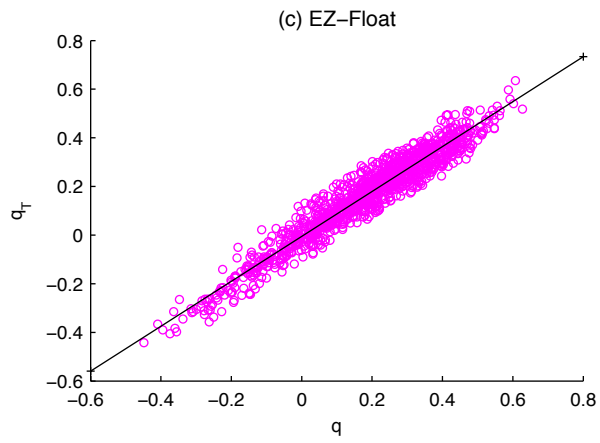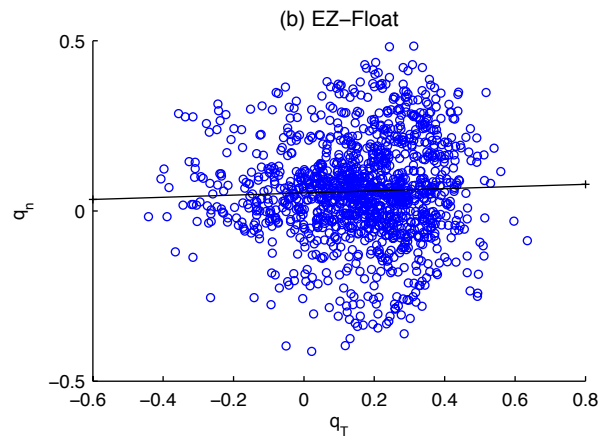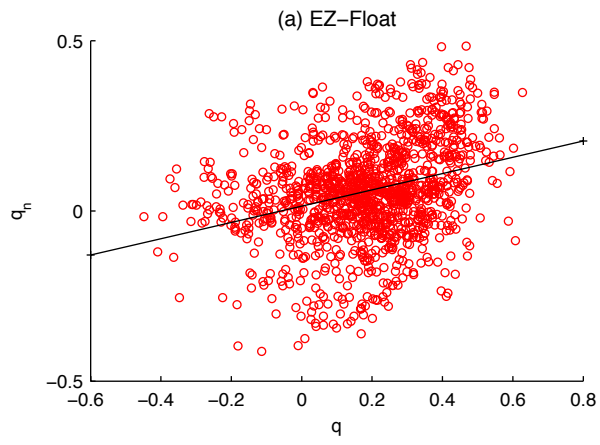
Figure 3: Real Exchange Rates and Relative Productivity
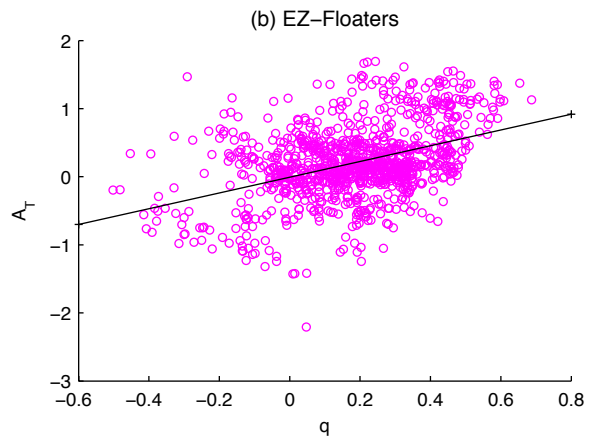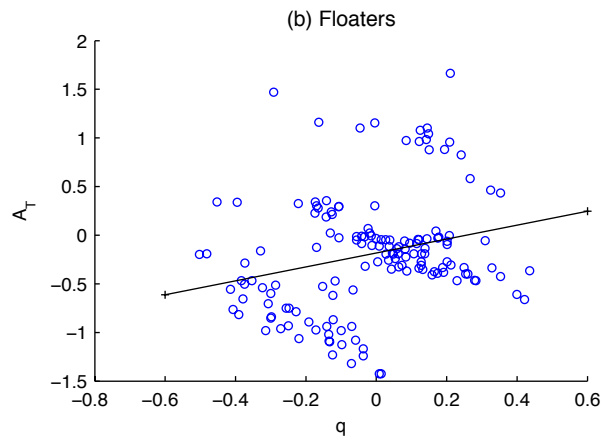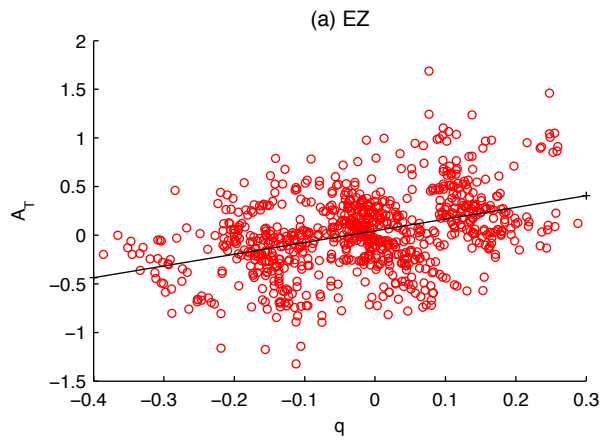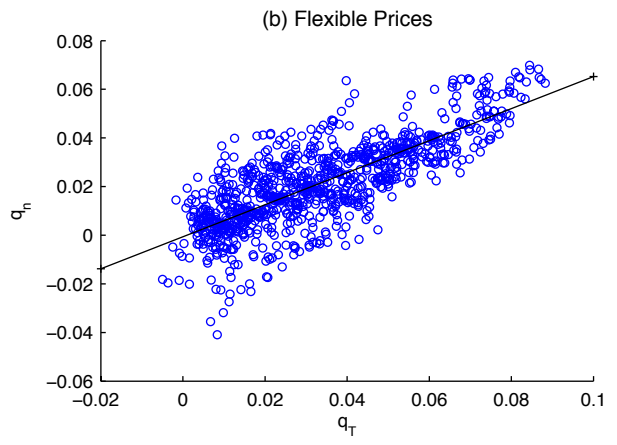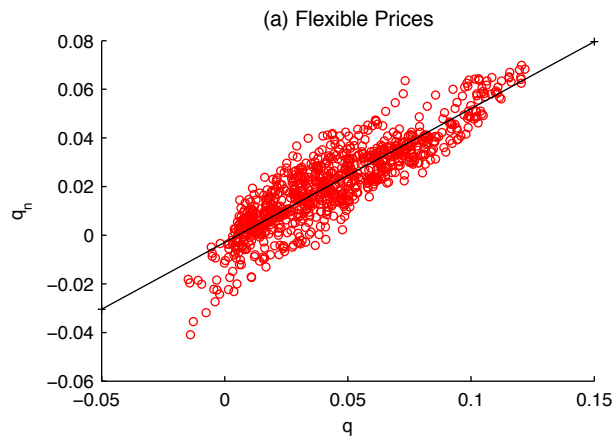
Figure 4: Real Exchange Rates with Flexible Prices
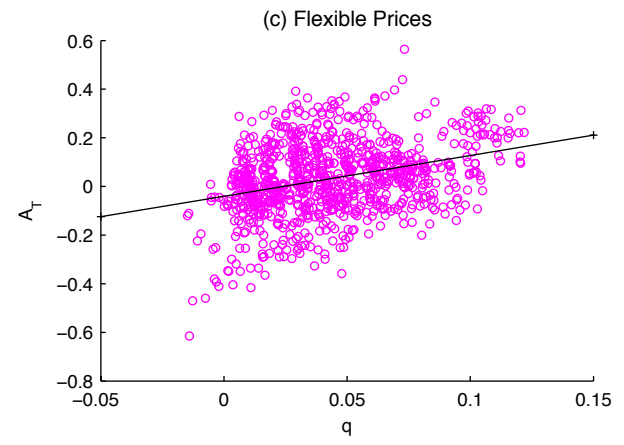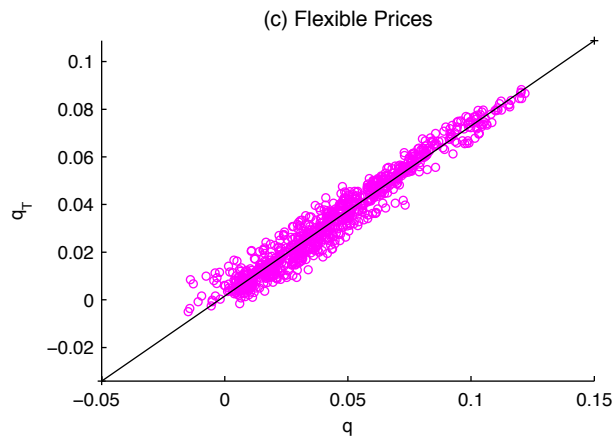
Figure 5: Fixed versus Floating Exchange Rates

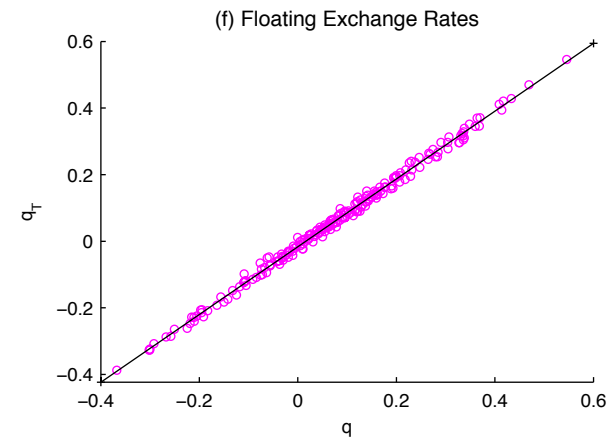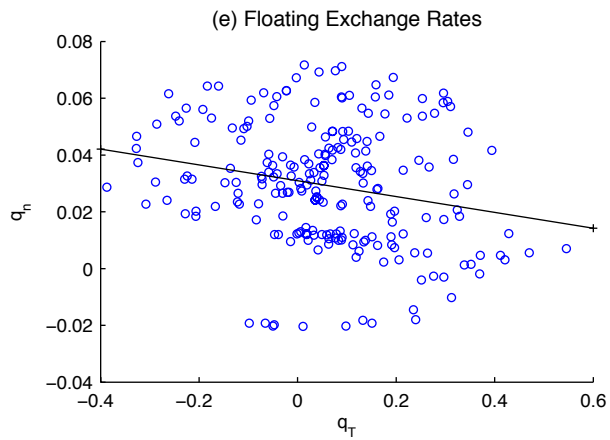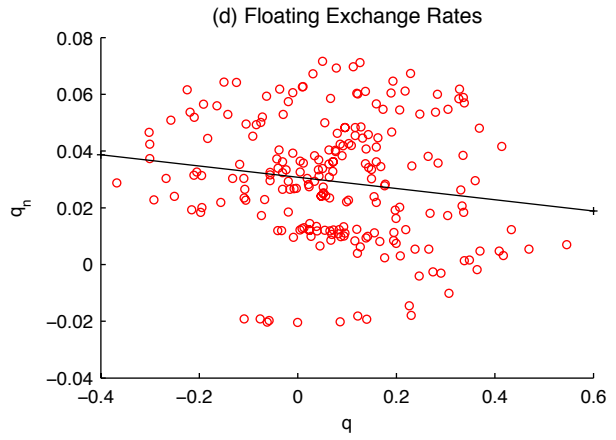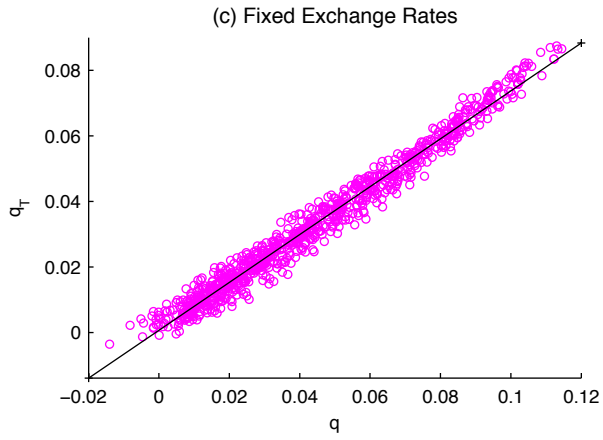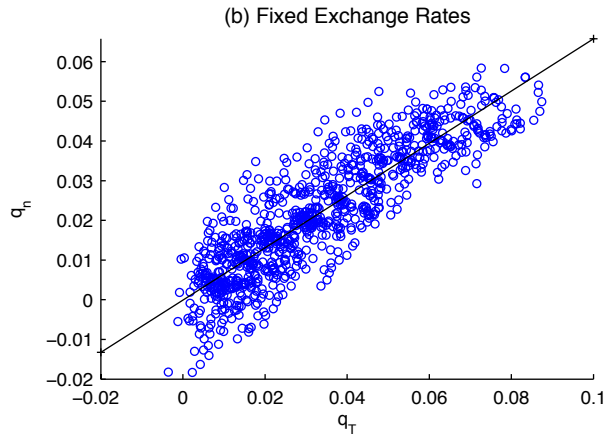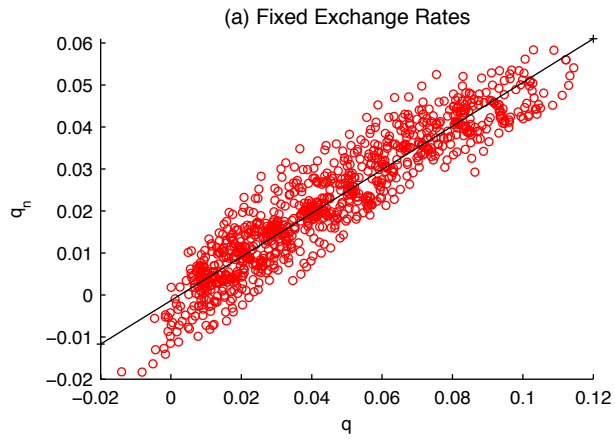Figure 6: Real Exchange Rates and Relative Productivity