This PDF is a selection from a published volume from the National Bureau of Economic Research

Volume Title: NBER International Seminar on Macroeconomics 2009

Volume Author/Editor: Lucrezia Reichlin and Kenneth West, organizers

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-70750-4 (paper)

Volume URL: http://www.nber.org/books/reic09-1

Conference Dates: June 12-13, 2009

Publication Date: June 2010

Chapter Title: Comment on "The Nontradable Goods' Real Exchange Rate Puzzle"

Chapter Author: Jonathan Eaton

Chapter URL: http://www.nber.org/chapters/c11919

Chapter pages in book: 250 - 260

Comment

Jonathan Eaton, *Pennsylvania State University and NBER*

I. Introduction

Exchange rates have exasperated economists for some time. Lucasz Drozd and Jaromir Nosal dissect movements in bilateral real consumption exchange rates into their traded and nontraded components for a broad set of country pairs. They first divide each country i's goods into those that are traded, T, and those that are nontraded, N, with respective price indices P_i^N and P_i^T, which combine into the overall price index, as given in their equation (3), with ζ the share of nontraded goods. The deflator-based real exchange rate between country i and j, rer_{ij}, their equation (4), relates the overall price indices of two different countries, P_i and P_j, translating country j's price index into country i's currency at the nominal exchange rate e_{ij}. They then decompose rer_{ij} into its traded goods component rer_{ij}^T, their equation (5), and the nontradable real exchange rate rer_{ij}^N, their equation (6). The first is simply the ratio of the two countries' traded price indices with country j's translated into i's currency at the nominal exchange rate e_{ij}. The second is the ratio of the ratios of the nontraded to traded price indices of the two countries. Thus, their equation (7):

$$rer = rer^T rer^N$$

or

$$\left(\frac{e_{ij}P_j}{P_i}\right) = \left(\frac{e_{ij}P_j^T}{P_i^T}\right)\left(\frac{P_j^N/P_j^T}{P_i^N/P_i^T}\right)^{\zeta}. \quad (1)$$

Note that the nominal exchange rate e_{ij} appears in both rer_{ij} and in rer_{ij}^T but not in rer_{ij}^N.

978-0-226-70749-5/2010/2009-0061$10.00

For most country pairs, they find that

1. rer^N is only mildly negatively correlated with rer^T.
2. rer^N is less volatile than rer^T.
3. Most of the volatility in *rer* arises from volatility in rer^T.

Nosal and Drozd then go on to see how far a "standard" model can explain these relationships. Their standard model has the following features:

1. There are two symmetric small countries, $i = H, F$, and a large country, $i = G$, each of which can produce a traded and a nontraded good, $j = T, N$, using only labor with output per worker z_i^j. The standard Ricardian assumptions apply: workers are mobile between the two activities within a country but not between countries, so that each country has a wage w_i.

2. The only source of shocks is volatility in the six z_i^j's, which follows a joint AR(1) process.

3. Distributors of traded goods in each country combine a constant elasticity of substitution combination of the three traded goods plus ξ units of the nontraded good to form a local traded good. The profit of a distributor in country *i* is given in their equation (13). The price of the composite traded good bought by consumers in country *i* is P_i^T, with the price of the good produced by each country *j* in country *i* denoted p_i^j, $j = H, F, G$. The weights on the composites in P_i^T are ω_i^j, with an elasticity of substitution γ. As there are apparently no trade costs, and competition is perfect, the law of one price should apply to p_i^j (rendering the *i* unnecessary). However, the P_i^T can differ across *i*'s because of the nontraded component and because the weights ω_i^j can differ according to both *i* and *j*. Indeed, this is how the calibrated model appears to introduce home bias in trade.[1]

4. The *numéraire* in each country is the composite consumption bundle.[2]

The analysis raises several issues.

II. What Are Traded Goods in the Model and in the Data?

The price indices and real exchange rates in Drozd and Nosal's equations (3) and (5) are defined as P_i^T, while the data for P_i^T are the manufacturing value-added deflators. These measures would seem more like the p_i^H, p_i^F, and p_i^G in the model, that is, the prices of the tradable goods that are produced rather than consumed, that is, the manufacturing component of the consumer price index. Later on, in their equation (16), however, the rer^T expression is indeed in terms of the p's, yielding the unnumbered expression after equation (16) in which rer^N depends only on the technology terms z. Hence, I leave with the impression that Drozd and Nosal mean the relevant traded goods' prices to be the p's.[3]

III. How Are the Findings Connected to the "Exchange Rate Disconnect"?

In their classic "Six Puzzles" paper, Obstfeld and Rogoff (2000) listed the "exchange rate disconnect" as the sixth, and most puzzling, puzzle. In my words, this puzzle says "nominal exchange rates move around a lot, but their movements don't affect the relative prices we face very much except when we're tourists abroad."

It seems that the phenomenon that Drozd and Nosal are finding is another manifestation of this disconnect. The nominal exchange rate e_{ij} is highly volatile, while the local currency price indices, P_i^T, P_i^N, P_j^T, and P_j^N, are not. Hence, through the relationship in equation (1), movements in e_{ij} generate a lot of variation in both rer_{ij} and rer_{ij}^T but not in rer_{ij}^N, since e_{ij} appears only in the first two.

Figure 1 illustrates the point for the United States and Japan over the years 1971–2006. Over the period, the nominal value of the dollar depreciated against the yen (black line) with several wide swings.[4] The top line (dark gray) suggests that these swings were synchronized with swings in the relative gross domestic products (GDPs) of the two countries (translating the Japanese GDP into U.S. dollars at the contemporaneous nominal exchange rate; OECD 2008), except in the last decade, when the nominal exchange rate was stable while the GDP of the United States grew relative to Japan's. The light gray line reports the ratio of the consumer services price index to industrial product price index in the United States over the period (*Economic Report of the President*, U.S. Council of Economic Advisors [2009]). This ratio is much less volatile and does not appear to move very much with the nominal exchange rate or with relative GDPs.

Now, of course, why e_{ij} is so volatile in the first place remains a puzzle. Atkeson and Burstein (2008) present a closely related decomposition that presents even more of a puzzle for Drozd and Lukasz's standard model. Atkeson and Burstein decompose the producer price index (PPI) bilateral real exchange rates for manufactures, which should correspond quite closely to Drozd and Nosal's rer^T, as

$$rer_{ij}^T = \frac{e_{ij}p_j^j}{p_i^i} = \left(\frac{p_j^i}{p_i^j}\right)\left(\frac{p_i^j}{p_i^i}\right)\left(\frac{e_{ij}p_j^j}{p_j^i}\right), \tag{2}$$

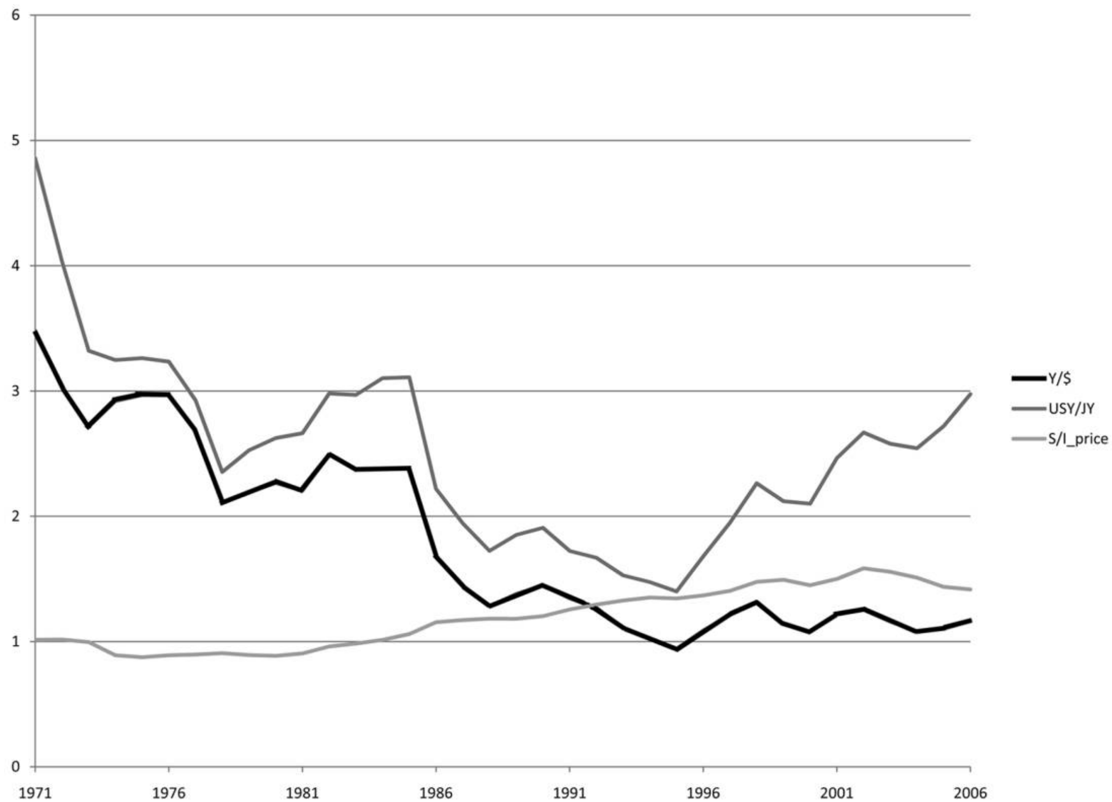

Fig. 1. Japanese yen per US$, U.S. GDP relative to Japanese GDP, and the relative price of U.S. services to industrial products, 1971–2006

where I use the country of origin as a subscript and the destination country as a superscript.[5] If in Drozd and Nosal's standard model the law of one price applies to each country's traded good, then the last two terms on the right-hand side do not move, so that variation in rer_{ij}^T would correspond to variation in the terms of trade (p_i^j/p_j^i). In fact, Atkeson and Burstein (2008) find that variation in the last two terms are major contributors to rer_{ij}^T among a set of industrialized countries. Hence, there is a further dimension in which the standard model fails.

As the title of their paper suggests, Atkeson and Burstein's finding is a manifestation of the well-known "pricing to market" phenomenon: Export prices tend to move with other prices in the destination market rather than with prices in the country of origin. Atkeson and Burstein (2008) explain this phenomenon with oligopolistic competition in which each seller sets a price in a market response to its competition there. Since most production is local, local producers dominate price setting by everyone, including foreign sellers. Note that the Atkeson and Burstein phenomenon is also consistent with the exchange rate disconnect. If nominal exchange rates move around much more than prices anywhere, most of the variation in rer_{ij}^T comes from the third term.

Another explanation for these pricing phenomena is that the set of goods a country exports is smaller than the set of goods it produces, and the range of goods that it exports can vary. This explanation goes back to Dornbusch, Fischer, and Samuelson's (1977) classic paper but requires trade costs.

Say that there are a continuum of goods indexed by $[0, 1]$ and C countries. Country i's efficiency-producing good j is $z_i(j)$. To deliver 1 unit of any good from country i to country n requires shipping $d_{ni} \geq 1$ units from i. With perfect competition and inputs costing c_i in country i, good j will have a price $p_{ni}(j) = c_i d_{ni}/z_i(j)$ in country n if bought from country i. People in country n will buy good j from the source with the lowest $p_{ni}(j)$. Say that the z are the realizations of random variables drawn from the distribution,

$$\Pr[Z \geq z] = \exp(-T_i z^{-\theta}),$$

where T_i reflects the overall level of technology and θ the variability of technologies across individual goods. As shown in Eaton and Kortum (2002), if preferences across the goods are constant elasticity of substitution, the price index in country n will be

$$P_n = \gamma \left[\sum_{i=1}^{C} T_i (c_i d_{ni})^{-\theta} \right]^{-1/\theta}, \tag{3}$$

where γ is a constant depending only on θ and the elasticity of substitution. Country i's share in market n is

$$\pi_{ni} = \frac{T_i(c_i d_{ni})^{-\theta}}{\sum_{k=1}^{N} T_k(c_k d_{nk})^{-\theta}},$$

which declines with d_{ni} (so that transport costs, rather than Armington shares, determine market share). Moreover, not only is P_n the overall price index in market n, it is also the price index of the goods from each country selling in n. A consequence is that exogenous shocks (say, to technologies or to preferences) generate shifts in market shares but not in the relative price indices of the goods from different sources sold in a particular destination. Hence, the export price index from each source moves with prices in the destination, not the source, creating the appearance of "pricing to market" in the aggregate of goods sold.

If we rearrange equation (2) as

$$rer_{ij}^{T} = \frac{e_{ij}p_j^j}{p_i^i} = \left(\frac{p_i^j}{p_i^i}\right)\left(\frac{e_{ij}p_j^j}{p_i^j}\right),$$

this alternative formulation has the implication that all of the action is in the first rather than the second term. This alternative is undoubtedly counterfactual as well, but Atkeson and Burstein's (2008) evidence suggests that it comes closer to the mark than the assumption that the export price index is the same as the price index of what the exporting country produces at home.

Surely Dornbusch et al.'s formulation overstates the extent to which export prices track the price levels in destinations rather than in sources. While there is much evidence that the extensive margin (more or fewer products) dominates long-run changes in trade, in the short run especially the intensive margin is important.[6] Since it explains differences between the export and domestic price index with the selection of products into the export market, it cannot explain why the price of exactly the same product would ever move differently in two markets. For this, an explanation based on imperfect competition, as pursued by Atkeson and Burstein (2008), is called for.

IV. Are Technology Shocks Enough?

Drozd and Nosal allow for two types of shocks in each country, shocks to the two efficiencies z_i^j. Stockman and Tesar (1995) find, using a model very similar to Drozd and Nosal's, that technology shocks alone have trouble delivering the positive consumption and price comovements observed in the data. They introduce shocks to preferences to account for this correlation. It would seem the model here would have the same trouble. Even though shocks to efficiency in nontraded goods could generate such comovement, they also generate large movements in the ratio of traded to nontraded goods as well, which are not apparent in Drozd and Nosal's decompositions.

V. How Far Can a Real Model with Expenditure Shocks Go?

Building on Dekle, Eaton, and Kortum (2007, 2008), Samuel Kortum and I undertook an exercise to ask how far a model built on that of Dornbusch et al. can go in explaining some of these phenomena. The model is not explicitly dynamic but simply feeds the history of deficits into a static Dornbusch et al. framework. Since technology and trade costs are held fixed, the shocks can be interpreted as the manifestation of expenditure shocks like those in Stockman and Tesar (1995).

Say that there is an integer C of countries. Each country has a labor force L_i that can be allocated between manufacturing and nonmanufacturing, T, or nonmanufacturing, N:

$$L_i^T + L_i^N = L_i.$$

Since there are no rents and only labor, all income is from labor, so that GDP is

$$Y_i = w_i L_i.$$

Country n's demand for manufacturing is

$$X_i^T = \alpha X_i + (1 - \beta) Y_i^T,$$

where X_i is total expenditure, X_i^T is manufacturing absorption, Y_i^T is manufacturing production, α is the share of manufactures in final absorption X_i, and β is the value-added share in manufacturing.

For simplicity, we treat all inputs into manufacturing as manufactures, so the same price index applies:

$$c_i = \kappa w_i^{\beta} \left(P_i^T \right)^{1-\beta},$$

where κ is a constant that depends on β.

An equilibrium is a set of wages w_i and price indices P_i^T solving equation (3) that equilibrate the market for each country's traded goods:

$$Y_i^T = \sum_{n=1}^{C} \pi_{ni} X_n^T$$

or

$$\alpha(w_i L_i + D_i) - D_i^M = \sum_{n=1}^{N} \pi_{ni} \Big[\alpha(w_n L_n + D_n) - (1-\beta) D_n^M\Big], \qquad (4)$$

where D_i is country i's total deficit and D_i^M its deficit in manufactures.

We can respecify the model in terms of changes to ask how changes in deficits, holding other parameters constant, affect relative w_i's, along with the P_i^T's and P_i^N's. Defining x' as the counterfactual value of x and $\widehat{x} = x'/x$, we can use data on each year's GDP and trade shares and rewrite equations (3) and (4) as

$$\widehat{w}_i Y_i + D_i' - \frac{1}{\alpha} D_i^{M'} = \sum_{n=1}^{N} \frac{\pi_{ni} \widehat{w}_i^{-\theta\beta} \widehat{P}_i^{T-\theta(1-\beta)}}{\sum_{k=1}^{N} \pi_{nk} \widehat{w}_k^{-\theta\beta} \widehat{P}_k^{T-\theta(1-\beta)}} \times \left(\widehat{w}_n Y_n + D_n' - \frac{1-\beta}{\alpha} D_n^{M'}\right)$$

and

$$\widehat{P}_n^T = \left\{ \sum_{i=1}^{N} \pi_{ni} \Big[(\widehat{w}_i)^{\beta} (\widehat{P}_i^T)^{(1-\beta)} \Big]^{-\theta} \right\}^{-1/\theta}.$$

By specifying the model in terms of changes, the current values of Y_i (GDP) and π_{ni} (trade shares) have all the information we need to know about the parameters T_i and d_{ni}. We then solve for the $\widehat{w}_i$ and $\widehat{P}_n^T$ that go with the counterfactual deficits D_i' and $D_i^{M'}$. We set $\alpha = .25$, (as in Alvarez and Lucas [2007]) and $\beta = .312$, the average across our sample.

To get much action requires a low value of θ, which may be justified in the short run for reasons discussed by Ruhl (2008).[7] Figure 2 reports the results of carrying out this exercise year by year for the United States for the period 1975–2006, setting $\theta = 1$. The x axis is the year, and the y axis is normalized at the mean share of U.S. GDP in the world total. We depict the actual relative U.S. GDP over the period in gray and what a 1-year-ahead forecast using next year's deficits would predict in black. Note that this exercise picks up most of the two big upward swings in U.S. GDP, in

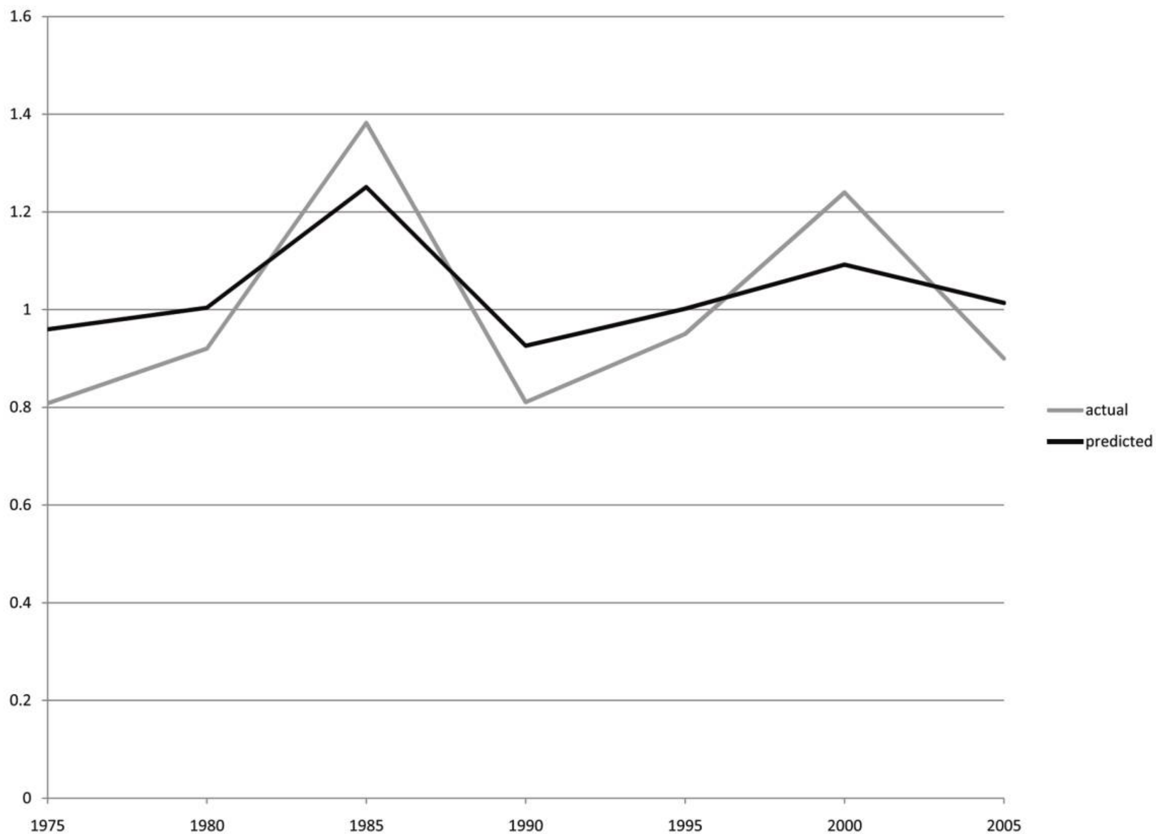

Fig. 2. United States GDP as a share of world total: actual and 5-year-ahead forecast (average share normalized at one)

the mid 1980s and at the end of the 1990s. We could think of large, positive U.S. expenditure shocks as leading to large deficits, raising demand for U.S. labor relative to the rest of the world's. Since most purchases, even in manufactures, are from the home country, the effect on U.S. prices is attenuated.[8]

Note that this exercise treats technology as fixed from one year to the next. All of the action is coming from somewhere else through the deficit.

In summary, a perfectly competitive real model will probably never account for all of the exchange rates puzzles we observe. But to have some chance it needs to incorporate two features lacking in Drozd and Nosal's standard model. First, it needs to recognize that the goods that a country exports are only a small and variable subset of what it produces for itself. Second, it needs to incorporate sources of variation other than shocks to technology.

Endnotes

1. Hence, Drozd and Nosal adopt the Armington assumption that goods differ intrinsically according to their source, with the weights that different destinations place on the goods from different sources varying across destinations.
2. Making for three *numéraires*, which seems a couple too many.
3. Adding to my uncertainty is that in Drozd and Nosal's eqq. (9) and (10), v's have as superscripts T and N along with subscripts $i = H, F, G$, while in the zero profit equation just above eq. (13) the v's and the corresponding prices, p, have superscripts N, H, F, G, as well as subscript i, which might mean that the traded good each country produces can, for some reason, have a different price in each market.
4. The yearly observation is the simple average of the monthly figure reported in the *Economic Report of the President* (U.S. Council of Economic Advisors 2009).
5. Atkeson and Burstein (2008) use country i's export price index, import price index, and manufacturing PPI to measure, respectively, p_i^j, p_j^i, and p_i^i, and they use country j's manufacturing PPI to measure p_j^j.
6. See Ruhl (2008).
7. See the discussion in Dekle et al. (2008).
8. Again, see the discussion in Dekle et al. (2008).

References

Alvarez, Fernando, and Robert E. Lucas. 2007. "A General Equilibrium Analysis of the Eaton-Kortum Model of International Trade." *Journal of Monetary Economics* 54:1726–68.

Atkeson, Andrew, and Ariel Burstein. 2008. "Pricing-to-Market, Trade Costs, and International Relative Prices." *American Economic Review* 98:1998–2031.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum. 2007. "Unbalanced Trade." *American Economic Review Papers and Proceedings* 97:351–55.

———. 2008. "Global Rebalancing with Gravity." *IMF Staff Papers* 55:511–40.

Dornbusch, Rudiger, Stanley Fischer, and Paul A. Samuelson. 1977. "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods." *American Economic Review* 67:823–39.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." *Econometrica* 70:1741–80.

Obstfeld, Maurice, and Kenneth Rogoff. 2000. "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" *NBER Macroeconomics Annual* 15:339–90.
OECD (Organization for Economic Cooperation and Development). 2008. *SourceOECD*. http://www.sourceoecd.org.
Stockman, Alan C., and Linda L. Tesar. 1995. "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements." *American Economic Review* 85:168–85.
Ruhl, Kim. 2008. "The International Elasticity Puzzle." Unpublished report, Stern School of Business, New York University.
U.S. Council of Economic Advisors. 2009. *Economic Report of the President*. Washington, DC: Government Printing Office.