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Persistent real exchange rates ☆

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ABSTRACT

Three well known facts that characterize exchange rate data are: (a) the high correlation between bilateral nominal and real exchange rates; (b) the high degree of persistence in real exchange rate movements; and (c) the high volatility of real exchange rates. This paper attempts a joint, albeit partial, rationalization of these facts in an environment with no staggered contracts and where prices are preset for only one quarter. There are two key innovations in the paper. First, we augment a standard two-country open economy model with learning-by-doing in production at the firm level. This induces monopolistically competitive firms to endogeneize the productivity effect of their price setting behavior. Specifically, firms endogenously choose not to adjust prices by the full proportion of a positive monetary shock in order to take advantage of the productivity benefits of higher production. Second, we introduce habits in leisure. This makes the labor supply decision dynamic and adds an additional source of propagation. We show that the calibrated model can quantitatively reproduce significant fractions of the aforementioned facts. Moreover, as in the data, the model also produces a positive correlation between the terms of trade and the nominal exchange rate.

1. Introduction

Three well known facts that characterize exchange rate data are: (a) the high correlation between bilateral nominal and real exchange rates; (b) the high degree of persistence in real exchange rate movements; and (c) the high volatility of real exchange rates. These facts have proved to be non-trivial challenges for standard open economy dynamic general equilibrium models. The conventional approach to explaining these facts has been to assume sticky prices and/or staggered contracts. However, recent work by Chari, Kehoe and McGrattan (2002) has called this approach into question. They show that in order for sticky prices and staggered contracts to account for a significant fraction of the dynamics of exchange rates, prices must be fixed for at least one year. Recent evidence in Bils and Klenow (2004) seriously calls into question such long-lived price stickiness.[1]

In this paper we modify a standard two-country open economy model along two dimensions. First, we follow the work of Cooper and Johri (2002) and introduce a firm-level learning-by-doing effect into the production technology. In particular, higher production in any period by a firm leads to the accumulation of organizational capital by the firm. This causes increases not only in productivity in the next period but also in the stock of organizational capital in future periods. This feature makes the pricing decision of monopolistically competitive firms dynamic with firms endogeneizing the effect of their pricing decision today on productivity tomorrow. Hence, faced with a nominal shock firms voluntarily choose not to adjust their prices fully even when they

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[1] Bils and Klenow (2004) find that half of all posted prices last less than 4.3 months. Moreover, relative to the predictions of the standard sticky price models, they find that actual inflation displays far more volatility and less persistence even for goods which display high price stickiness.

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are free to do so. This generates endogenous price stickiness thereby lowering the degree of exogenous stickiness that is required to match the data. Second, we introduce habit persistence in leisure. By making the household's labor supply decision dynamic, this feature generates an additional mechanism for the endogenous propagation of shocks.

In an environment where prices are preset for just one quarter and there is no staggered price setting, we quantitatively evaluate the response of the model economy to estimated money shocks. We find that the net impact of our two key innovations on the dynamics of real exchange rates is substantial. In their absence, real exchange rates would display essentially no auto-correlation. For our baseline parameterization, the first-order autocorrelation coefficient of the simulated real exchange rate series is 0.80 while the standard deviation of the real exchange rate relative to output is 5.67. The data counterparts of these two numbers are 0.94 and 5.5. The model can also quantitatively reproduce the observed correlation between the nominal and real exchange rates.[2] Lastly, the model produces a positive, contemporaneous correlation of 0.24 between the nominal exchange rate and the terms of trade which is consistent with data. As pointed out by Obstfeld and Rogoff (2000), most of the standard sticky price models are unable to produce this positive correlation.

We find these results interesting on two counts. First, our results are supportive of the two key modifications that we introduced in this paper – learning-by-doing and habits – for understanding real exchange rate movements. Second, we believe that our results demonstrate that long-lived sticky prices are not necessary to explain persistent real exchange rate movements since all our results are derived in an environment with only one-period preset prices.

While most of the elements in the model are standard, the idea behind the introduction of the two main additional features – learning-by-doing (LBD) and habit persistence in leisure – require a little elaboration. Consider a one-time permanent increase in money supply in the standard model without LBD and habit persistence. The standard model has the property that a nominal shock raises nominal demand for goods. If price-setting monopolistically competitive firms were free to reset their prices then they would raise their price to the point that real demand for their goods remains at the profit maximizing level of output. Hence, persistence of a nominal shock on real variables is linked to the length for which firms are unable to adjust prices.

How does the introduction of LBD alter the logic above? LBD makes the pricing decision of the firm dynamic. At each point in time, a firm that is choosing prices trades off the positive revenue effect of a higher price with the negative future productivity effect of lower learning today due to lower production. Hence, the optimal price, ceteris paribus, is lower than in the standard model. Moreover, this effect introduces an endogenous source of propagation of shocks. A higher output today implies a greater stock of organizational knowledge tomorrow (due to learning). This directly reduces the marginal cost of production tomorrow and hence, induces the firm to raise prices by less than they would otherwise. Crucially, this effect always operates independent of whether the learning effect is internal or external to the firm.

If the LBD effect is endogeneized by the firm then there is a second reason for sluggish price adjustment. In particular, a higher output today raises the stock of organizational capital tomorrow. Current output and current organizational capital stock are complementary inputs in producing future organizational capital. Hence, in the period after the shock when the firm is free to reset prices, it realizes that the higher current stock of organizational capital implies the marginal learning from an extra unit of output today is higher than in steady state. Put differently, learning is cheaper. At the margin, this induces the firm to raise prices less than it would otherwise in order to take advantage of the cheaper learning environment. Thus, a one-time permanent increase in money supply in a model with LBD would raise prices but only gradually toward its long run steady state level. The process eventually dies out due to decreasing returns to scale in the learning function. In the new steady state prices would have adjusted by the full proportion of the shock.

What role do habits play in propagating nominal shocks? A typical feature of models with sticky prices is that output is demand determined. Hence, when firms are unable to adjust their price they increase their production by primarily increasing labor employed. Once firms are free to adjust prices output declines back to its steady state level with the adjustment coming through a fall in employment. Habits in leisure make the labor supply decision of households dynamic. At an optimum the household balances the marginal utility gain of an extra unit of leisure today with not just the foregone wage but also the reduced marginal utility from an additional unit of leisure tomorrow due to the higher stock of habits. Hence, households adjust their labor supply slowly over time which makes the output dynamics gradual in response to a shock. The flip side of this is that real wages adjust slowly which implies that prices which clear the goods market also adjust sluggishly relative to the standard model. This causes the real effects of nominal shocks to persist longer.

The intuition above suggests that the introduction of either learning or habits, by themselves, should increase the degree of persistence in the standard model. Indeed it does. Our quantitative results show that individually both LBD and habits raise the degree of persistence of real exchange rates relative to the standard model. However, neither effect is individually large enough to raise the persistence of real exchange rates close to the observed level in the data. When we introduce both effects simultaneously however, the persistence generated by the model rises significantly with the first-order autoregression coefficient of the real exchange rate in the model being 0.80 which is quite close to the 0.94 coefficient in the data. LBD and habits contribute roughly equal amounts to the overall degree of persistence generated by the model. Thus, to generate the correct quantitative magnitudes for the real exchange rate dynamics we need both learning and habits to operate simultaneously.

Our work is related to a large body of existing work on explaining real exchange rate fluctuations using models with sticky prices and monetary shocks. This literature goes back to Dornbusch (1976) but its modern general equilibrium version starts with Obstfeld and Rogoff (1995). Our work is probably closest in spirit to the papers by Betts and Devereaux (2000) and Chari, Kehoe and

[2] We follow Chari, Kehoe and McGrattan (2002) and use their data on the USA and a European aggregate entity as the two countries for constructing the relevant moments in the data for our two country model.