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Reexamination of Dornbusch's Overshooting Model: Empirical Evidence on the Saddle Path

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Abstract

Recently, the phenomenon that the movement of exchange rates in response to monetary shocks does not reach a peak instantaneously, known as the delayed overshooting puzzle, has attracted the attention of many researchers. Although it is important to pay attention before the peak of the overshoot, it is also necessary to take account of the convergence process after the peak to assess Dornbusch's model appropriately. As is well known, the saddle path is the process by which the new steady state is reached. Our empirical results based on the structural vector autoregression (VAR) analysis using yen-dollar and mark-dollar rates show that the processes are unstable. Therefore, it is possible that the convergence processes deviate from the saddle paths or that the saddle paths shift on their way toward the steady state. However, the phenomenon cannot explain in a regular theoretical sense under the structural VAR analysis's supposition that an additional shock does not occur after the initial shock. Our results have implications for future research on exchange rate dynamics, although it is not possible for us to explain the mechanism of this phenomenon without further investigation.

Keywords: Dornbusch's overshooting model; saddle path; exchange rate dynamics

JEL classification: E30; E40; F31; F41

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I. INTRODUCTION

Thirty years have passed since Dornbusch published “Expectations and Exchange Rate Dynamics”. His proposition that a monetary shock induces a large swing in the exchange rate due to price stickiness changed the concept of exchange rate fluctuation dramatically, and many economists cite the paper even today.[1] In fact, Dornbusch (1976) set the stage for the debate on the source of real exchange rate fluctuation that Mussa (1986) and Stockman (1988) sparked. Mussa and Stockman insist the source of real exchange rate fluctuation is mainly monetary factor under sticky price and real factor, respectively. Recently, the variance decomposition approach by the structural vector autoregression (VAR) analysis plays a central role as a tool to resolve the controversy.

Dornbusch (1976) continues to affect the field of international monetary economics, but Dornbusch's overshooting model has faced many challenges from the both theoretical side and empirical findings. Recently, the delayed overshooting puzzle has been considerably debated. Delayed overshooting implies that the exchange rate does not reach the peak in response to monetary shock immediately. This debate was sparked by Eichenbaum and Evans (1995), whose finding by the structural VAR analysis points out a limitation of Dornbusch's model, which is that it fails to acknowledge that a monetary policy shock induces a systematic departure from uncovered interest rate parity in the background of the delayed overshooting.[2] The evidence of this causes considerable controversy from theoretical and empirical viewpoints. Especially, Gourinchas and Tornell (2004) and Faust and Rogers (2003)

[1] See Rogoff (2002).

[2] Eichenbaum and Evans (1995), p.984.

are worthy of attention. Gourinchas and Tornell (2004) present a theoretical model that rationalizes the forward discount puzzle and exhibits the delayed overshooting pattern. Correspondingly, Faust and Rogers (2003) claim that delayed overshooting is largely attributable to dubious identifying assumptions and show that the delayed overshooting does not occur by the modification of the methodology.

Our research parallels that of Eichenbaum and Evans (1995) in that we focus attention on the response of the exchange rate to monetary shocks. However, our research is unique in that we pay attention to the response of the exchange rate not before the peak, but after it. The convergence process to the new steady state after the peak is known as the saddle path. Discussing the saddle path is important for judging the validity of Dornbusch's model. Interestingly, our results show that the convergence processes after the peak derived by the structural VAR approach are unstable in the case of the yen-dollar and the mark-dollar rates. Therefore, it is possible that the convergence processes deviate from the saddle paths, or that the saddle paths shift on their way toward the steady state. We could say that the phenomenon is a puzzle due to the difficulty of explaining it either theoretically or empirically.

Section II briefly introduces an outline of the famous Dornbusch's overshooting model. Section III derives the convergence process to the new steady state caused by a monetary shock. Section IV presents our conclusions.

II. OUTLINE OF DORNBUSCH'S OVERSHOOTING MODEL

The process by which a monetary shock causes the nominal and real exchange rates to overshoot and subsequently leads the exchange rates to converge to a new

steady state is expressed in Figure 1.[3] The initial condition is (q_0, s_0). Suppose that an unanticipated permanent increase in the money supply of a country occurs under the condition that real income is not very responsive, and that the price of goods remains constant in the short run. Other things being equal, the interest rate of the country decreases and the nominal and real exchange rates would initially follow similar tracks in response to the monetary shock, so that they would proceed from (q_0, s_0) to (q^*, s^*) along the 45-degree line.[4] Then, the price of goods will rise until the increase in price becomes equal to the expansion of the money supply, and the interest rate will gradually return to the equilibrium value. Therefore, the nominal and real exchange rates converge to a new steady state in the long run, that is, (q_0, s^e).

[Figure 1 about here]

When the nominal exchange rate depreciates to a greater extent in the short run than in the long run, as illustrated in Figure 1, the phenomenon is regarded as the exchange rate overshooting described by Dornbusch. These movements of exchange rates are also explicable by new open economy macroeconomics with the microfoundation, sticky price, and intertemporal model. Betts and Devereux (2000), who presented one version of the new open economy macroeconomics, show that the overshoot occurs with the model considering a price-setting mechanism referred to as

[3] See Dornbusch (1976), Chapter 9 of Obstfeld and Rogoff (1996), and Chapter 4 of Sarno and Taylor (2002) for the mathematical explanations.

[4] If the price of goods is not completely fixed in the short run, the nominal and real exchange rates pass above the 45-degree line.

pricing to the market, which means firms set different prices between domestic and foreign countries.[5] However, based on the structural VAR approach, many studies found that the nominal and real exchange rates do not instantaneously reach (q^*, s^*); this phenomenon is known as delayed overshooting. In recent research, Gourinchas and Tornell (2004) present a model of nominal exchange rate determination that includes a systematic distortion in investors' beliefs about the interest rate process; they explain that the delayed overshooting pattern may occur in theory.

The convergence process after the peak is the process of going from (q^*, s^*) to (q_0, s^e). Thus, the nominal and real exchange rates theoretically need to continue to appreciate from the peak to the new steady state, provided a new shock does not occur.

III. EMPIRICAL EVIDENCE

In this section, we examine how the nominal and real exchange rates respond to a monetary shock. We apply the simple structural VAR approach of Lastrapes (1992). This approach is not inconsistent with those of Dornbusch (1976), Betts and Devereux (2000), and Gourinchas and Tornell (2004), and is advantageous because it has a familiar identification.[6] This requires the first differences of the nominal and real

[5] See Chapter 10 of Obstfeld and Rogoff (1996) and Chapter 5 of Sarno and Taylor (2002) for details of the new open economy macroeconomics.

[6] There are many identification methods in the structural VAR approach in addition to that of Lastrapes (1992). For example, Clarida and Gali's (1994) approach is long-run restriction by three variables, and the approaches of Eichenbaum and Evans (1995) and Kalyvitis and Michaelides (2001) are short-run restriction by five or seven

exchange rates measured in natural logs, and the monetary and real shocks are identified by the long-run restriction that the nominal exchange rate responds while the real exchange rate is constant at the initial level, regardless of the monetary shock in the long run.[7]

We use the data on the yen-dollar and mark-dollar rates.[8] The nominal exchange rate of the period average and the seasonally adjusted gross domestic product deflators as the price levels that form the real exchange rate are applied. The data concerning the yen-dollar rate covers the period from the first quarter of 1981 to the fourth quarter of 2003, and the mark-dollar rate covers the period from the first quarter of 1975 to the fourth quarter of 1998 when capital controls were relatively small.[9] Both the nominal and real exchange rates are found to be I(1) processes, and

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variables. Faust and Rogers (2003) apply Faust's (1998) restriction by seven or fourteen variables. Although Clarida and Gali's (1994) approach assumes that the asymmetric monetary shock affects real output in the long run, it conflicts with the empirical results like those of Miyao (2002) as well as recent theories like the new open economy macroeconomics. Faust and Rogers (2003) discuss the drawback of Eichenbaum and Evans (1995). We discuss the approaches of Kalyvitis and Michaelides (2001) and Faust and Rogers (2003) later.

[7] See Lastrapes (1992) for details.

[8] The data source is the International Monetary Fund's International Financial Statistics.

[9] We only deal with the period when major part of the capital controls are relieved because the capital controls cause the failure of the uncovered interest rate parity and it influences the movement of exchange rate. See Frankel (1991), p.228 and p.252

cointegration is not found between these rates either for yen-dollar or dollar-mark, as for the augmented Dickey-Fuller test. The lag lengths in VAR including a constant term are selected up to lag 8 by the Akaike information criterion such that each selected lag length is 4. In addition, the null hypothesis of the Lagrange multiplier test statistic, which signifies that there is no autocorrelation up to lag 8, is not rejected at the 5 percent level, meaning the specifications in the selected lag lengths are empirically supported for both the exchange rates.[10]

We can acquire the dynamic responses of the nominal and real exchange rates to a standard deviation impulse in a monetary shock on the basis of the above identification and specification.[11] Our impulse-response functions are used to plot the convergence process in the real exchange rate–nominal exchange rate space for yen-dollar and mark-dollar, as shown in Figure 2.

[Figure 2 about here]

As is the case with Figure 1, Figure 2 shows that the real exchange rate depreciates in the short run while it does not respond to monetary shock in the long run, and the nominal exchange rate depreciates in the long run as well as in the short run related to the origin, (0, 0). However, points a and A, where the exchange rates

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about the capital controls of Japan and Germany.

[10] Since these tests are standard, the results are not reported due to space constraints.

[11] We do not report the results of real shocks because they are not central for this paper.

are located at the moment of the shock, are different from the maximum response point, because both the peak exchange rate responses are given by points b and B. Therefore, the findings are not consistent with Dornbusch's model, but they are consistent with Gourinchas and Tornell's model.

It is noteworthy that Figure 2 shows findings that are unexplainable even by Gourinchas and Tornell's theoretical model. We focus on the shape of the convergence process after the peak of the overshoot, a topic neglected by previous empirical studies. In a theoretical sense, it is necessary that the nominal and real exchange rates continue to appreciate to a new steady state after reaching the peak in response to a monetary shock. Nevertheless, Figure 2 shows the shift from point c to point d on the yen-dollar rate and from point C to point D on the mark-dollar rate on the way from the peak to the new steady state. In other words, this implies that the nominal and real exchange rates temporarily depreciate after the peak. It would also be difficult for us to explain such movements empirically, because the structural VAR approach supposes that an additional shock does not occur after the initial shock.

Finally, let us touch on the structural VAR analyses of Kalyvitis and Michaelides (2001) and Faust and Rogers (2003). Because these papers use identified restrictions that are considerably different from ours, they provide a valid criterion in deciding whether the unexplained movements of the saddle path occur nothing but the approach of Lastrapes (1992).[12] Although Kalyvitis and Michaelides (2001) essentially adopt the identified restriction of Eichenbaum and Evans (1995), they do not apply Eichenbaum-Evans indicators but rather the Bernanke-Mihov indicator as

[12] We can check whether the phenomenon occurs in previous studies by examining the results of the impulse response.

the monetary policy indicator. Faust and Rogers (2003) apply the identified restriction from the approach of Faust (1998), which allows one to suspend any dubious assumptions while maintaining any highly credible assumptions.[13] Based on the results, the authors of both papers insist that delayed overshooting does not occur. However, we found that the convergence process after the peak is unstable according to the results of each approach. Therefore, it would appear that the phenomenon does not depend on a particular identification of the structural VAR approach.

IV. CONCLUSION

Recently, there has been interest in the delayed overshooting puzzle as part of the debates on the exchange rate overshooting originally pointed out by Dornbusch, and considerable efforts have been devoted to finding the solution from theoretical and empirical viewpoints. However, previous researchers paid attention to the issue only before the peak of the overshoot, not after the peak. Examining the convergence process after the peak is also important in accurately assessing Dornbusch's overshooting model.

We acquire the convergence process on the yen-dollar rate and the mark-dollar rate based on the structural VAR approach. Our results show that the convergence processes after the peak are unstable; therefore, it is possible that the convergence processes deviate from the saddle paths or that the saddle paths shift on their way toward the steady state. Because the saddle path illustrates process to a steady state, the phenomenon cannot be explained theoretically. However, it would also be difficult to attribute the reason for the unstable convergence process to the specification errors

[13] Faust and Rogers (2003), p.1406.

of the empirical models in considering that the phenomenon occurs under the structural VAR analyses with a variety of identified restrictions. Our results would have implications for future research on exchange rate dynamics, although it is not possible for us to explain the mechanism of this phenomenon without further investigation. We might need to establish a new theoretical model with the behavioral economics and/or a new VAR model with more realistic identification method.

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Figure 1: Exchange rate overshooting and saddle path

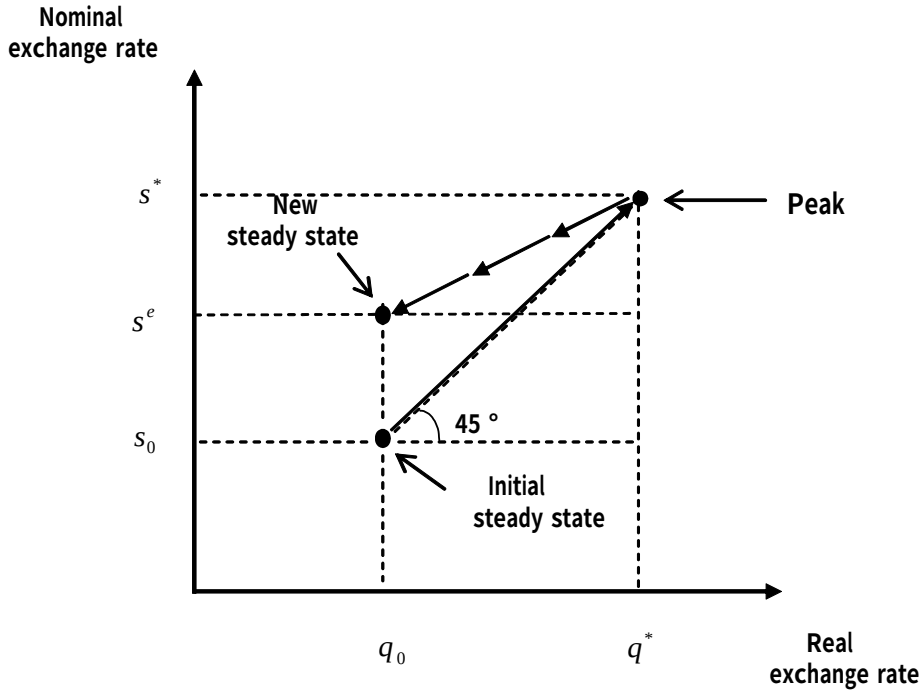

Figure 2: Empirical results of convergence process