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Tariff-tax reform and exchange rate dynamics in a monetary economy

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ABSTRACT

Using a dynamic monetary model, this paper analyzes the short- and long-run impacts of a tariff-tax reform on the economy, with attention being paid to short-run fluctuations in exchange rates. When a policy reform is announced and if the public believe that it will decrease excess demand, the domestic currency depreciates now to reflect its future depreciation. On the contrary, the domestic currency immediately appreciates if the public believe that it will increase excess demand. However, if there is a relatively small increase in excess demand, the public may mis-react in the exchange rate market by observing currency depreciation first and then appreciation toward the steady-state rate.

1. Introduction

For the last three decades, trade liberalization via reductions in import tariffs and removals of trade barriers has become a global trend in world trade. As is well known, exchange rates have been left as one of the main factors affecting exports and imports of goods and services. Maintaining the stability

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of foreign exchange markets has thus been a target for many economies. However, the recent turmoil in global financial markets and accompanying declines in the U.S. dollar have raised new concerns about global financial order and the stability of the exchange-rate systems.

In the literature on international finance, Dornbusch (1976) was the first to analyze the dynamic behavior of exchange rates in a monetary economy. A permanent monetary expansion causes the fluctuation in the exchange rate to be greater in the short run than in the long run. The extent of this short-run overshooting depends on how slowly the goods market adjusts relative to asset markets. Later studies (e.g., Agénor, 1995; Ahtiala, 1998; Chang & Lai, 1997; Chao, Hu, Tai, & Wang, 2011; Devereux & Purvis, 1990; Frenkel & Rodriguez, 1982; Wilson, 1979) focused on how monetary and fiscal policies affect dynamic adjustments of the economy. A common feature in these studies is that the exchange rate may either overshoot or undershoot its long-run equilibrium level.[1] Nonetheless, related issues on commercial policy, such as import tariffs and exchange rates, remain unexplored.

Differing from monetary or fiscal policies, in reducing tariffs trade liberalization directly yields a loss of revenue to the government. Many countries have considered raising other taxes, such as consumption taxes, to maintain a balanced government budget.[2] The studies on this neutral tariff-tax reform can be found in Michael, Hatzipanayotou, and Miller (1993) and Hatzipanayotou, Michael, and Miller (1994). However, their studies are confined in the real side of the economy, in which monetary phenomena, such as movements in exchange rates, cannot be examined.

The purpose of this paper is to fill up this lacuna by investigating the dynamic impacts of a neutral tariff-tax reform on key monetary variables, such as prices and exchange rates, in a monetary economy. However, it should be mentioned that the tax reform is usually featured by an anticipated implementation in nature. For example, Taiwan joined the World Trade Organization (WTO) on January 1, 2002. At that time, the average tariff rate on agricultural products was negotiated to decrease from 20.02% in 2001 to 14.01% in 2002, and was finally reduced to 12.86% at the end of the year 2004 or in 2007. In addition, the average tariff rate on industrial products was negotiated to decrease from 6.03% in 2001 to 5.78% in 2002, and was finally reduced to 4.15% at the end of the year 2002 or in 2004. In view of this fact, it seems plausible that the tariff-tax reform is usually conducted with a pre-announcement, and hence the analysis dealing with an anticipated tariff-tax reform may be more realistic in the real world. In doing so, how the relevant macro variables will react to the new information contained in the announcement of the neutral tariff-tax reform can be fully understood.

The remainder of this paper is organized as follows. The analytical framework is outlined in Section 2, while Section 3 characterizes the dynamic behavior of the economy associated with the tariff-tax reform. Section 4 concludes.

2. The model

The theoretical framework we shall develop can be treated as an extension of the Dornbusch (1976) model. The open economy we consider is operating under flexible exchange rates and is assumed to be small in the sense that it cannot affect the foreign price level and interest rate. Moreover, we assume that market participants form their expectations with perfect foresight and capital is perfectly mobile internationally. In departing from the Dornbusch (1976) model, to reflect the neutral tariff-tax reform, the government is assumed to finance its fiscal spending by levying consumption tax and import tariffs.

The following equations describe the economy:

$$\dot{P} = \pi(Y^D - Y^S), \tag{1}$$

[1] The empirical studies on the exchange-rate overshooting hypothesis are inclusive. Frankel (1979), Driskill (1981) and Papell (1988) support an overshooting of the exchange rate, while Backus (1984) and Flood and Taylor (1996) do not support the overshooting hypothesis. While these studies pay attention to the volatility of the nominal exchange rate, some other studies, including Devereux (1997), Carr and Floyd (2002), and Yuan (2011), instead focus on the volatility of the real exchange rate, such as Arize (1995).

[2] According to the World Bank (2002), in low- and middle-income countries, the shares of taxes attributable to direct taxes (e.g., income, profits, and capital gains, and plus social security taxes), indirect taxes and international trade taxes in total government revenue changed from 22%, 26% and 17% in 1990 to 22%, 36% and 9% in 1999, respectively.

$$Y^D = C(Y^{DI}) + I(r) + G + X\left(\frac{EP^*}{P}\right) - \frac{EP^*(1+t_m+t_c)}{P(1+t_c)}M, \tag{2}$$

$$M = M\left[Y^S, \frac{EP^*(1+t_m+t_c)}{P(1+t_c)}\right], \tag{3}$$

$$Y^S = S\left[\frac{\alpha EP^*(1+t_m+t_c)+(1-\alpha)P(1+t_c)}{P}\right], \tag{4}$$

$$\frac{M^S}{P} = L(Y^S, r), \tag{5}$$

$$r = r^* + \frac{\dot{E}}{E}, \tag{6}$$

$$\Lambda = t_m\frac{EP^*}{P}M + t_cC = G, \tag{7}$$

$$Y^{DI} = Y^S - \Lambda, \tag{8}$$

where following conventional notation, the variables are defined as: P is the domestic price level; π is the speed of adjustment; Y^D is aggregate demand; Y^S is the aggregate supply; C is consumption expenditure; Y^{DI} is disposable personal income; I is investment expenditure; r is the domestic interest rate; G is government fiscal expenditure; X is exports; E is the exchange rate (defined as the domestic currency price of foreign currency); P^* is the foreign price level; t_c is the commodity tax rate; t_m is the tariff rate; M is imports; S is aggregate supply; M^S is nominal money supply; L is real money demand; r^* is the foreign interest rate; and Λ is total government tax revenues. In addition, a dot over a variable denotes the change in the variable with respect to time.

Eq. (1) indicates that the domestic price level adjusts sluggishly in response to excess demand in the goods market with π having a positive finite value. Eq. (2) refers to aggregate demand with consumption, investment, government expenditure, plus net exports. Following Chang and Lai (1997), consumption is positively related to disposable personal income, $1 > C_{Y^{DI}} > 0$, while investment negatively depends on the domestic nominal interest rate, $I_r < 0$. The export demand is specified as an increasing function of the relative price between foreign and domestic goods, $X_{q^*} > 0$, where $q^* = EP^*/P$. In line with the common specification in the literature, Eq. (3) states the import demand as being an increasing function of real output, $1 > M_Y = \partial M/\partial Y^S > 0$, and a decreasing function of the tax-inclusive relative price between foreign and domestic goods, $Mq < 0$, where $q = EP^*(1+t_m+t_c)/P(1+t_c)$.

Eq. (4) refers to the aggregate supply function. According to Salop (1974) and Purvis (1979), we assume that wages adjust flexibly and workers are concerned with the real wage, which is the nominal wage deflated by the tax-inclusive domestic general price level, $g = \alpha EP^*(1+t_m+t_c) + (1-\alpha)P(1+t_c)$, with α being the weight for the foreign price.[3] Therefore, output is specified as a decreasing function of the tax-inclusive domestic general price level relative to the producer price of the domestic good, $S_{q'} < 0$, where $q' = [\alpha EP^*(1+t_m+t_c) + (1-\alpha)P(1+t_c)]/P$. Eq. (5) describes the equilibrium condition for the money market, in which the demand for real money balances is a decreasing function of the interest rate, $L_r < 0$, and an increasing function of real output, $L_Y = \partial L/\partial Y^S > 0$.[4] Eq. (6) states the interest rate parity based on the assumption of perfect capital mobility. Eq. (7) represents the government budget constraint. Finally, Eq. (8) describes disposable personal income as being equal to real output minus taxes.

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[3] See Appendix A for a detailed derivation.

[4] In line with Marston (1982), the money-market equilibrium condition is expressed by $M^S/g = L[PY^S/g, r]$, which refers to money balances and nominal income being deflated by the general price level g. Assuming that the elasticity of money demand with respect to real income is equal to unity (i.e., the money demand function is homogeneous of degree one in real income), the money-market equilibrium condition can be alternatively written as the expression stated in (5).

Based on the above model, we consider the impacts of a tariff-tax reform on the economy. From (1) to (7), the dynamic system in terms of P and E for the economy can be expressed as follows:

$$\dot{P} = F(P, E, t_m, t_c), \tag{9}$$

$$\dot{E} = J(P, E, t_m, t_c). \tag{10}$$

Furthermore, a neutral tariff-tax reform is considered by replacing the tariff with a point-by-point increase in the consumption tax, i.e., $dt_m < 0$, $dt_c > 0$ and $dt_c = -dt_m$. At the stationary equilibrium, the economy is characterized by $\dot{P} = \dot{E} = 0$, and P and E are at their stationary levels, namely, $\hat{P}$ and $\hat{E}$. Assume that initially the economy is in its stationary equilibrium with $t_c = t_c^0$. Then, linearizing (9) and (10) around the steady-state equilibrium, the dynamic in Eqs. (9) and (10) can be represented in matrix form[5]:

$$\begin{bmatrix} \dot{P} \\ \dot{E} \end{bmatrix} = \begin{bmatrix} F_P & F_E \\ J_P & J_E \end{bmatrix} \begin{bmatrix} P - \hat{P} \\ E - \hat{E} \end{bmatrix} + \begin{bmatrix} F_{t_c} \\ J_{t_c} \end{bmatrix} (t_c - t_c^0), \tag{11}$$

where $F_P < 0$, $F_E > 0$, $F_{t_c} \gtrless 0$,[6] $J_P > 0$, $J_E < 0$ and $J_{t_c} < 0$, evaluated at $E = P = P^* = 1$ initially. Moreover, to simplify the analysis, in what follows we assume $t_c^0 = 0$. It is noted that F_{t_c} represents the effect of the change in the consumption tax on excess demand in the goods market; from this $F_{t_c} > 0$ denotes an increase in excess demand while $F_{t_c} < 0$ refers to a decrease in excess demand.

We now proceed to analyze the dynamic behavior of the economy. By letting λ be the eigenvalue of the dynamic system, the characteristic equation for (11) is

$$\lambda^2 - (F_P + J_E)\lambda + (F_P J_E - J_P F_E) = 0. \tag{12}$$

Let λ_1 and λ_2 be the two characteristic roots of the dynamic system that satisfies (12). We then have the following relationships:

$$\lambda_1 + \lambda_2 = F_P + J_E, \tag{12a}$$

$$\lambda_1 \lambda_2 = \Omega, \tag{12b}$$

where $\Omega = (\pi M^S / L_r)\{X_{q^*} - (1 + t_m C_{YDI})[M + M_q(1 + t_m)] - S_{q'}(1 + t_m)[1 + M_Y(1 + t_m C_{YDI}) - C_{YDI}]\}$. As addressed in the literature on dynamic rational expectation models, including Burmeister (1980) and Turnovsky (2000), the dynamic system has a unique perfect-foresight equilibrium if the number of unstable roots equals the number of jump variables. Since the model has one predetermined variable P and one jump variable E, the restriction $\Omega < 0$ should be imposed to ensure that $\lambda_1 \lambda_2 < 0$. This implies that the system displays saddle-point stability and, for expository convenience, it is assumed that $\lambda_1 < 0 < \lambda_2 < 0$.

The dynamic behavior of the system can be displayed by means of a phase diagram like Fig. 1. From (11), the slopes of the loci $\dot{P} = 0$ and $\dot{E} = 0$ are given by:

$$\left. \frac{\partial P}{\partial E} \right|_{\dot{P}=0} = -\frac{F_E}{F_P} > 0, \tag{13}$$

$$\left. \frac{\partial P}{\partial E} \right|_{\dot{E}=0} = -\frac{J_E}{J_P} > 0. \tag{14}$$

Thus, both the loci of $\dot{P} = 0$ and $\dot{E} = 0$ are upward sloping. As for the goods market indicated in (13), a depreciation of the domestic currency (a rise in E) tends to raise the domestic price because it increases aggregate demand via higher exports by (2), but leads to less aggregate supply by the

[5] See Appendix B for a detailed derivation.

[6] Total consumption demand equals the sum of domestic and foreign goods, where foreign goods are measured by domestic goods. Consequently, total consumption must be greater than imports, which means that the situation of $C < (1 - t_m)M$ does not exist.

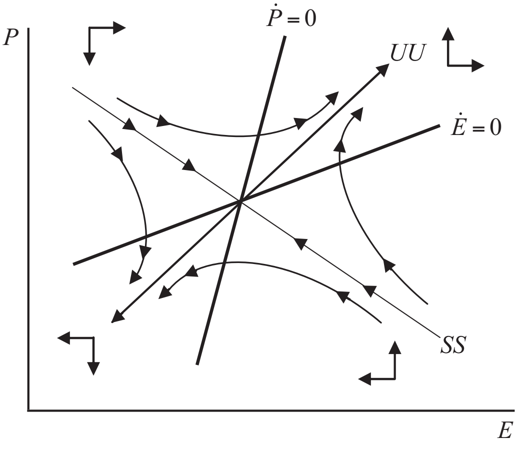

Fig. 1. Phase diagram.

relatively high foreign price in (4). This positive relationship between E and P also holds in the money market expressed in (14). From Eq. (6) with $\dot{E}=0$ we can infer that $r=r^*$. Thus, a rise in the exchange rate results in a lower aggregate supply and hence less real money demanded by (5). Consequently, according to (5), the excess supply of money pushes up the domestic price, as indicated in (14).

We turn next to consider the general solutions for P and E, which can be obtained by solving (11):

$$P=\hat{P}+A_1e^{\lambda_1 t}+A_2e^{\lambda_2 t}, \tag{15}$$

$$E=\hat{E}+\frac{\lambda_1-F_P}{F_E}A_1e^{\lambda_1 t}+\frac{\lambda_2-F_P}{F_E}A_2e^{\lambda_2 t}, \tag{16}$$

where A_1 and A_2 are undetermined coefficients.

Since $\lambda_1<0<\lambda_2$, the unstable and stable arms for the solutions, denoted by the UU and SS lines in Fig. 1, correspond respectively to the case of $A_1=0$ and $A_2=0$. From (15) and (16), the slopes of the UU line and the SS line are given by[7]

$$\left.\frac{\partial P}{\partial E}\right|_{UU}=\frac{F_E}{\lambda_2-F_P}=\frac{\lambda_2-J_E}{J_P}>0, \tag{17}$$

$$\left.\frac{\partial P}{\partial E}\right|_{SS}=\frac{F_E}{\lambda_1-F_P}=\frac{\lambda_1-J_E}{J_P}<0. \tag{18}$$

Hence, the UU line is upward sloping whereas the SS line is downward sloping. It is noted that by comparing (13), (14) and (17), we can infer that among the $\dot{P}=0$ line, the $\dot{E}=0$ line, and the UU line, the $\dot{P}=0$ line is the steepest while the $\dot{E}=0$ line is the flattest.[8] All other trajectories in Fig. 1 correspond to the values with $A_1\neq 0$ and $A_2\neq 0$ in (15) and (16). The common feature of these trajectories is that they start from the point with the slope of SS, and finally asymptotically approach the point with the slope of UU.

[7] The product of the SS line and the UU line is: $[(\partial P/\partial E)|_{SS}][(\partial P/\partial E)|_{UU}]=-(F_E/J_P)<0$. From the above equation and (16), the slopes of SS and UU are of opposite signs and the UU line is always upward sloping. This indicates that the SS line is downward sloping.

[8] We have: $\partial P/\partial E|_{\dot{P}=0}-(\partial P/\partial E)|_{UU}=-(F_E/F_P)-[F_E/(\lambda_2-F_P)]>0$; $(\partial P/\partial E)|_{UU}-(\partial P/\partial E)|_{\dot{E}=0}=[(\lambda_2-J_E)/J_P]-(-J_E/J_P)>0$. Thus, the $\dot{P}=0$ line is the steepest and the $\dot{E}=0$ line is the flattest.

3. Dynamic adjustments under neutral tariff-tax reform

We are now ready to address the dynamic adjustments of P and E in response to the pre-announcement of the neutral tariff-tax reform. The experiment we conduct is that, at time $t=0$, the authority announces the neutral tariff-tax reform by a cut in the tariff from t_m^0 to t_m^1 combined with a point-by-point increase in the commodity tax from t_c^0 to t_c^1 (i.e., $t_c^1 - t_c^0 = -(t_m^1 - t_m^0)$) at the specific date $t=T$ in the future. For expository convenience, in what follows 0^- and 0^+ represent the instants before and after the policy announcement, while T^- and T^+ represent the instants before and after the policy's implementation.

At the outset, the impacts of the neutral tariff-tax reform on steady-state values of P and E can be obtained from Eqs. (9) and (10) with $dt_c = -dt_m > 0$:

$$\frac{d\hat{P}}{dt_c} = -\frac{\pi L_Y S_{q'}}{\Omega L_r}\{(1-\alpha)X_{q^*} - (1+\alpha t_m)(1+t_m C_{YDI})[M + M_q(1+t_m)] - \alpha(1+t_m)(1-C_{YDI})[C-(1-t_m)M]\} \gtrless 0 \tag{19}$$

$$\frac{d\hat{E}}{dt_c} = \frac{\partial\hat{P}}{\partial t_c} - \frac{\pi M^S(1+t_m C_{YDI})M_q(1+t_m)}{\Omega L_r} + \frac{\pi M^S(1-\alpha)S_{q'}[1+M_Y(1+t_m C_{YDI}) - C_{YDI}]}{\Omega L_r} - \frac{\pi M^S[(1-C_{YDI})C + (t_m + C_{YDI})M]}{\Omega L_r} \gtrless 0 \tag{20}$$

As indicated in (19), the long-run impact of the tariff-tax reform via a change in the consumption tax on the steady-state price level is ambiguous. The intuition for this result can be explained by means of three channels. By referring to Eqs. (2) and (4), we then briefly state these three channels.

First, an increase in t_c (coupled with a point-by-point decrease in the tariff) will lower the relative price between the foreign and domestic goods $[EP^*(1+t_m+t_c)]/P(1+t_c)$, thereby resulting in an increase in domestic imports. This channel tends to lower the aggregate demand for output, leading to a tendency to lower the price level. Second, an increase in t_c will raise the tax-inclusive domestic general price level relative to the producer price of the domestic good $[\alpha EP^*(1+t_m+t_c)+(1-\alpha)P(1+t_c)]/P$, thereby reducing the aggregate supply of output and generating a tendency to raise the price level. Third, an increase in t_c will drive up government expenditure G and lead to a rise in the aggregate demand for output.[9] This in turn tends to boost the price level. As is evident, if the negative effect stemming from the first channel dominates the positive effect stemming from the second or the third channel, a rise in t_c tends to lower the price level. By contrast, if the negative effect arising from the first channel falls short of the positive effect arising from the second or the third channel, a rise in t_c tends to raise the price level.

Moreover, as expressed in (20), the long-run impact on the steady-state exchange rate is also ambiguous. On the one hand, a rise in t_c leads to a decline in the relative price between the foreign and domestic goods $[EP^*(1+t_m+t_c)]/P(1+t_c)$, and hence results in an increase in domestic imports. This tends to cause the domestic currency to depreciate (a rise in E). On the other hand, an increase in t_c will raise $[\alpha EP^*(1+t_m+t_c)+(1-\alpha)P(1+t_c)]/P$, and hence reduce the aggregate supply of output. This tends to reduce domestic imports and cause the domestic currency to appreciate (a fall in E). With these two conflicting effects, we thus have an ambiguous outcome arising from the impact of a change in t_c on the exchange rate.

[9] In an open economy, the domestic agents can consume both domestic and imported goods, and hence C reflects the total consumption of both domestic and imported goods. However, M only reflects the consumption of imported goods. Accordingly, we can infer the result $C > M$. It follows from Eq. (7) with $C > M$ and $dt_c = -dt_m$ that an increase in t_c is associated with a rise in G. For a detailed analysis regarding the relationship between C and M, see Turnovsky (1977, Ch. 9).

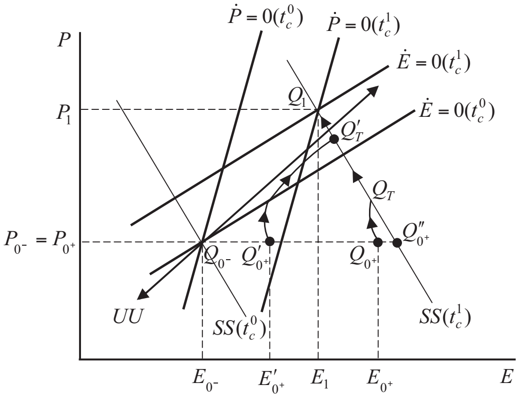

Fig. 2. Dynamic adjustments under $F_{t_c} < 0$.

After describing the long-run response of P and E, we then utilize phase diagrams to depict the dynamic paths toward them. From (11), in response to a rise in t_c coupled with a point-by-point reduction in t_m, the corresponding shifts in the loci of $\dot{P}=0$ and $\dot{E}=0$ are given by:

$$\left.\frac{\partial E}{\partial t_c}\right|_{\dot{P}=0} = -\frac{F_{t_c}}{F_E} \gtrless 0; \quad \text{if } F_{t_c} \lessgtr 0, \tag{21}$$

$$\left.\frac{\partial E}{\partial t_c}\right|_{\dot{E}=0} = -\frac{J_{t_c}}{J_E} < 0, \tag{22}$$

where F_{t_c} captures the direct impact of the tariff-tax reform on excess demand in the goods market as expressed in (1). Then, as depicted in the subsequent graphical diagrams, the $\dot{P}=0$ line shifts leftward when $F_{t_c} > 0$, while it shifts rightward if $F_{t_c} < 0$. Moreover, by (22), the tariff-tax reform always shifts the $\dot{E}=0$ line leftwards. We can also compare the magnitudes of the shifts between the $\dot{E}=0$ line and the $\dot{P}=0$ line under $F_{t_c} > 0$:

$$\left.\frac{\partial E}{\partial t_c}\right|_{\dot{P}=0} - \left.\frac{\partial E}{\partial t_c}\right|_{\dot{E}=0} = \frac{-F_{t_c}J_E + J_{t_c}F_E}{F_E J_E} \gtrless 0. \tag{23}$$

That is, the leftward shift of the $\dot{P}=0$ line can be either smaller or larger than that of the $\dot{E}=0$ line. Accordingly, in what follows we discuss the dynamic adjustment of the exchange rates following a pre-announcement of the tariff-tax reform in two cases:

(A) A decrease in excess demand ($F_{t_c} < 0$)

Consider first the case where the introduction of a consumption tax leads to a decrease in excess demand for the domestic good ($F_{t_c} < 0$). As depicted in Fig. 2, let the initial equilibrium be at point Q_{0^-}, where the two lines of $\dot{P}(t_c^0)=0$ and $\dot{E}(t_c^0)=0$ intersect, and the domestic price and the exchange rate are respectively denoted by P_{0^-} and E_{0^-}. If the tariff-tax reform (i.e., $dt_c = -dt_m > 0$) decreases excess demand initially, then $\dot{P}(t_c^0)=0$ shifts rightwards to $\dot{P}(t_c^1)=0$ while $\dot{E}(t_c^0)=0$ shifts leftwards to $\dot{E}(t_c^1)=0$. This gives a new stationary equilibrium at point Q_1, with P and E being P_1 and E_1

Upon a permanent shock in the tariff-tax reform at the instant 0^+, the exchange rate rises while the domestic price remains unchanged. It is noted that the economy will instantaneously jump horizontally to different points in response to the time lag for implementing the policy T. If the time lag is relatively small (large), the economy jumps from Q_{0^-} to Q_{0^+} (Q_{0^+}'), and the exchange rate exhibits an over- (under-) shooting at the time of the policy announcement. In the limiting case for immediate implementation, the economy jumps from Q_{0^-} directly to Q_{0^+}'', leading to an

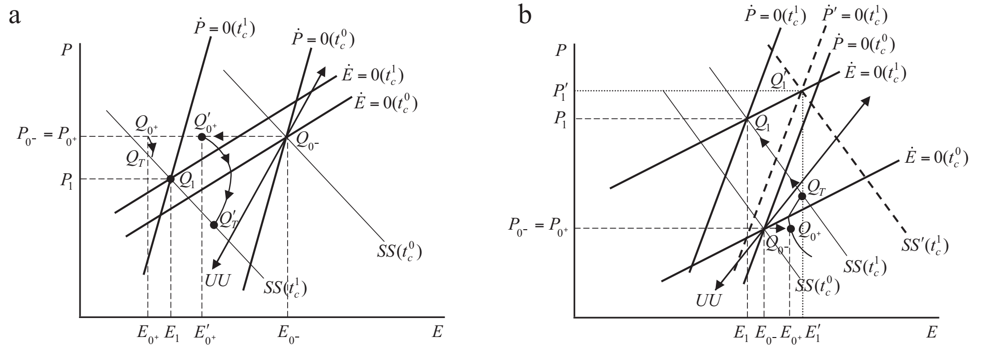

Fig. 3. (a). Dynamic adjustments under $F_{t_c} > 0$ (the loci of $\dot{P} = 0$ has a big shift leftwards). (b). Dynamic adjustments under $F_{t_c} > 0$ (the loci of $\dot{P} = 0$ shifts leftwards but not by so much).

over-shooting in the exchange rate. From 0^+ to T^-, if the time lag is relatively small, as the arrows indicate, P continues to increase and E continues to decrease, while the economy moves from Q_{0+} to Q_T. However, if the time lag is relatively large, as the arrows indicate, P continues to increase and E first falls and then rises, while the economy moves from Q'_{0+} to Q'_T. At the instant T^+, when the tariff-tax reform is actually implemented, the economy will reach a point on the convergent stable arm $SS(t_c^1)$. Thereafter, from T^+ onward, the economy will move along $SS(t_c^1)$ toward its new stationary equilibrium Q_1. As is evident, during the period between the announcement (0^+) and the implementation (T^-), even though the tariff-tax reform has not yet been implemented, the exchange rate will respond in advance.[10]

(B) An increase in excess demand ($F_{t_c} > 0$)

We now turn to consider the second case in which the introduction of a consumption tax can actually cause an increase in excess demand ($F_{t_c} > 0$). This can happen when more tax revenue raises government spending and hence the aggregate demand reported in Eq. (2). As depicted in Fig. 3a, this shifts both loci of $\dot{P}(t_c^0) = 0$ and $\dot{E}(t_c^0) = 0$ leftwards to $\dot{P}(t_c^1) = 0$ and $\dot{E}(t_c^1) = 0$. Following the same illustration as that in Fig. 2, we can infer that the economy will jump horizontally to different points in association with the different values of T. If T is relatively small, the economy will jump to a point like Q_{0+}, and the exchange rate will exhibit an over-shooting at the instant of the policy announcement. However, if T is relatively large, the economy will jump to a point like Q'_{0+}, and the exchange rate will exhibit an under-shooting at the time of the policy announcement.

During the period between the policy announcement 0^+ and its implementation T^-, if the time lag is relatively small, P continues to fall and E continues to rise, while the economy moves from Q_{0+} to Q_T. However, if the time lag is relatively large, P continues to decrease and E first rises then falls, while the economy moves from Q'_{0+} to Q'_T. After the tariff-tax reform is actually implemented (from T^+ onward), the economy will move along $SS(t_c^1)$ toward its new stationary equilibrium Q_1.

Nevertheless, as illustrated in Fig. 3b, if the increase in government spending is not too large, the implementation of the tariff-tax reform still causes the loci of $\dot{P}(t_c^0) = 0$ to shift leftwards but not by so much. In this situation, at the new stationary equilibrium, the domestic price will rise while the exchange rate will either decrease or increase. In the short-run, the exchange rate will exhibit distinct dynamic patterns, including undershooting and mis-jumps at the moment of the policy announcement. To explain it in more detail, in Fig. 3b, the initial equilibrium of the economy is established at point Q_{0-}. In response to the tariff-tax reform, both $\dot{P} = 0(t_c^0)$ and $\dot{E} = 0(t_c^0)$ will shift leftwards to $\dot{P} = 0(t_c^1)$ and $\dot{E} = 0(t_c^1)$, respectively. If the leftward shift of the $\dot{P} = 0$ line is relatively large, the new

[10] Sargent and Wallace (1973) were the first to analyze the effect of an announcement. In addition, see the studies by Wilson (1979) and Dornbusch and Fischer (1980).

equilibrium point is established at a point such as point Q_1, where P and E are at P_1 and E_1, respectively. At the instant of the policy announcement, the economy will jump from point Q_{0^-} to a point like Q_{0^+}, and the exchange rate will instantaneously rise from E_0 to E_{0^+}. Obviously, the impact adjustment and the long-run adjustment of the exchange rate move in opposite directions. This implies that the exchange rate exhibits a mis-jump at the moment of the announced tariff-tax reform. Our result indicates that the exchange rate may exhibit a mis-jump even if the dynamic system embodies the saddle-point stability. This conclusion stands in sharp contrast to the Aoki (1985) viewpoint, which proposes that a mis-jump can occur only when the economy is characterized by global instability.

If the leftward shift of the $\dot{P} = 0$ line is relatively small (as indicated by the dotted line $\dot{P}' = 0(t_c^1)$), the new equilibrium point, say, point Q_1', will appear in the upper right of the initial equilibrium Q_{0^-}. Under such a situation, the dynamic response of the economy to the anticipated tariff-tax reform is the same as that exhibited in Fig. 2. To avoid the problem of clustered dynamic paths, in Fig. 3b we do not sketch the possible dynamic behaviors of the economy for this case. However, when confronted with such a situation, by referring to Fig. 2, we can conclude that the exchange rate may either overshoot or undershoot its long-run level at the instant of the tariff-tax reform policy announcement. It is worth mentioning that an increase in excess demand ($F_{t_c} > 0$) will generally cause the domestic currency to appreciate in value (a fall in the exchange rate) by casual observations. However, in this case, an increase in excess demand can lead the domestic currency to depreciate in value (a rise in the exchange rate) in the long run.

4. Concluding remarks

Using a dynamic monetary model, in this paper we have analyzed the short- and long-run impacts of a tariff-tax reform on the economy. The tariff-tax reform considered is a design that replaces tariffs with a point-by-point increase in consumption taxes. By paying much attention to short-run fluctuations of exchange rates in terms of overshooting, undershooting or mis-jumps, we have investigated their dynamic paths following the announcement of the tariff-tax reform. When the tariff reform is announced and if the public believe it will decrease excess demand, the domestic currency will depreciate now to reflect future depreciation. On the contrary, the domestic currency will appreciate immediately if the public believe it will raise excess demand. However, if there is a relatively small increase in excess demand, the public may mis-react in the exchange rate market by observing currency depreciation first and only then the currency's appreciation toward the steady-state rate.

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Appendix A.

Define labor employed as N. The production function can then be expressed as:

$$Y = Y(N); \quad Y_N > 0 \text{ and } Y_{NN} < 0 \tag{A1}$$

Let N^d denote the demand for labor. Firms hire workers to maximize profits according to the factor-hiring rule (i.e., the marginal revenue product of labor is equal to the nominal wage), that is

$$W = PY_N(N^d). \tag{A2}$$

On the other hand, in line with Salop (1974) and Purvis (1979), the supply of labor, N^s, is specified as an increasing function of the real wage for which the relevant price index is the tax-inclusive domestic general price $g = \alpha EP^*(1 + t_m + t_c) + (1 - \alpha)P(1 + t_c)$:

$$\frac{W}{g} = h(N^s); h' = \frac{d(W/g)}{dN^s} > 0. \tag{A3}$$

The equilibrium condition of the labor market is given by:

$$N^d = N^s = N. \tag{A4}$$

From (A2) to (A4), we have

$$PY_N(N) = gh(N). \tag{A5}$$

Eq. (A5) can alternatively be written as:

$$\frac{Y_N(N)}{h(N)} = \frac{g}{P}. \tag{A6}$$

Differentiating Eqs. (A1) and (A6), we can infer the following expressions:

$$dY = Y_N dN \tag{A7}$$

$$\frac{h(N)Y_{NN} - Y_N(N)h_N}{[h(N)]^2} dN = d\left(\frac{g}{P}\right). \tag{A8}$$

Substituting Eq. (A8) into (A7) yields:

$$dY = Y_N \frac{[h(N)]^2}{h(N)Y_{NN} - Y_N(N)h_N} d\left(\frac{g}{P}\right) \tag{A9}$$

Eq. (A9) can be expressed as the following functional form:

$$Y^S = S\left(\frac{g}{P}\right); \quad S' = \frac{Y_N[h(N)]^2}{h(N)Y_{NN} - Y_N(N)h_N} < 0. \tag{A10}$$

In Eq. (A10) the superscript “s” is added to highlight the output supply.

Appendix B.

This appendix provides the exact derivatives of the dynamic system in the main text. Recall the following dynamic system in terms of P and E in Eqs. (9) and (10):

$$\dot{P} = F(P, E, t_m, t_c),$$

$$\dot{E} = J(P, E, t_m, t_c).$$

where

$$F_P = \frac{\partial \dot{P}}{\partial P} = -\pi \left\{ X_{q^*} + \frac{I_r M^S}{L_r} - (1 + t_m C_{YDI})[M + M_q(1 + t_m)] \right.$$
$$\left. - S_{q'}\alpha(1 + t_m)[1 + M_Y(1 + t_m C_{YDI}) - C_{YDI} + \frac{I_r L_Y}{L_r}] \right\} < 0,$$

$$F_E = \frac{\partial \dot{P}}{\partial E} = \pi \left\{ X_{q^*} - (1 + t_m C_{YDI})[M + M_q(1 + t_m)] \right.$$
$$\left. - S_{q'}\alpha(1 + t_m)\left[1 + M_Y(1 + t_m C_{YDI}) - C_{YDI} + \frac{I_r L_Y}{L_r}\right] \right\} > 0,$$

$$F_{t_c} = \frac{\partial \dot{P}}{\partial t_c} = \pi \left\{ (1 + t_m C_{YDI})[M + M_q(1 + t_m)] - (1 - C_{YDI})[C - (1 - t_m)M] \right.$$
$$\left. - S_{q'}(1 - \alpha)\left[1 + M_Y(1 + t_m C_{YDI}) - C_{YDI} + \frac{I_r L_Y}{L_r}\right] \right\} \gtrless 0,$$

$$J_P = \frac{\partial \dot{E}}{\partial P} = \frac{[L_Y S_{q'} \alpha(1+t_m) - M^S]}{L_r} > 0,$$

$$J_E = \frac{\partial \dot{E}}{\partial E} = -\frac{L_Y S_{q'} \alpha(1+t_m)}{L_r} < 0,$$

$$J_{t_c} = \frac{\partial \dot{E}}{\partial t_c} = -\frac{L_Y S_{q'}(1-\alpha)}{L_r} < 0.$$

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