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Abstract

This paper studies the welfare implications of sectoral labor adjustment cost in a two-sector small open economy model with sticky prices. We find that, when the economy faces external shocks, if monetary policy can stabilize the real economy, then sectoral labor market adjustment cost will lead to welfare loss. However, if monetary policy such as fixed exchange rates cannot stabilize real variables, then some degree of labor market friction will improve welfare instead and the gain will be significant. As a result, the welfare gap between flexible exchange rates and fixed exchange rates decreases with sectoral labor market friction. This is because the friction can offset some of the nominal rigidity and become a substitute for monetary policy to stabilize the real economy.

Keywords: Labor Adjustment Cost, Exchange Rate Policy, Two-Sector Model, Welfare
JEL Classification: F3, F4

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1. Introduction

Recently, the framework of a two-sector small open economy model has been extensively used to study monetary policy and welfare for small open economies. For example, Devereuex, Lane, and Xu (2006) compare alternative monetary policies for an emerging market economy that experiences external shocks in a two-sector small open economy. Ortega and Nooman (2006) investigate the welfare properties of different monetary rules in an estimated two-sector small open economy, and find that a substantial welfare gain is made from targeting sectoral rather than aggregate inflation.

However, the literature on the two-sector small open economy model usually assumes domestic resource allocation is costless. That is, labor or capital is perfectly mobile across sectors. This prevalent assumption overlooks some important consequences of the friction in sectoral resource reallocation. For instance, Morshed and Turnovsky (2003) develop a two-sector model with sectoral capital adjustment cost. They show that the cost has important consequences for the dynamics of capital accumulation, particularly for real exchange rate dynamics. Nevertheless, the impact of sectoral labor market friction,[1] especially its welfare implications, is not well studied in the literature. As pointed out by Garcia-Cebro and Varela-Santamaria (2009), there are many factors which may result in imperfect mobility between sectors. If the spatial distribution of sectors is considered, then the physical process of labor reallocation may absorb resources; also, human capital or skill of workers may be sector-specific. Thus, training (or learning) costs may occur when the workers switch to a new sector. For example, when a worker switches from an auto company in Detroit to an IT company in Los Angeles, he/she needs to pay the moving cost, learning cost, and other costs due to the changes in the nature of work. To explore this issue, we construct a two-sector model of a small open economy, which is closely related to Devereux, Lane, and Xu (2006). The main feature of our model is that we assume that sectoral labor reallocation involves adjustments cost, expressed as resources lost in the adjustment process.[2]

Our model shows that the presence of sectoral labor adjustment cost does not affect the welfare ranking of monetary policies. However, the welfare consequence of labor market friction depends critically on the nature of monetary policy rules. For example, if a monetary rule that can stabilize the real economy is chosen, such as a non-traded goods price targeting (NTP) rule, then there is a small welfare loss caused by the presence of sectoral adjustment cost. However, if a policy rule that cannot stabilize the real economy is given, such as a fixed exchange rate rule, then the presence of labor market friction will lead

[1] Ju and Wei (2007) argue that the domestic labor market friction is important for the current account adjustment in a multiple tradeable sectors model.

[2] The use of sectoral labor adjustment cost does not affect the steady state. It only affects the dynamics of the economy. However, if we model the intersectoral labor mobility as the imperfect substitution of sector labors as in Garcia-Cebro and Varela-Santamaria (2009), then the steady state is affected by the elasticity of substitution between labor, and so is the welfare. Therefore, it is more difficult to do a welfare comparison. Another advantage of using labor adjustment cost is that we can choose the parameters of labor adjustment cost to match the elasticity of substitution between sector labors.

to welfare gain instead and this gain will be significant, approximately 0.15 percent steady state consumption.

What causes the difference? Intuitively, this is due to the nature of monetary policy rules. In general, if there is no sectoral labor adjustment cost and no output-stabilizing policy, then sectoral output, employment, and capital could be very volatile. As a result, the aggregate output, consumption, and employment will be volatile. The over-fluctuation of real variables is inefficient. Therefore, the presence of labor adjustment cost will hinder this inefficient labor movement across sectors, which leads to welfare gain. In a sense, sectoral adjustment cost actually plays a substitute role in stabilizing the real economy when there is a lack of output-stabilizing monetary policies. This is because the labor market friction can offset the friction caused by nominal rigidities. However, if an output-stabilizing rule exists, such as the NTP rule, then the economy responds in a manner equivalent to that of a fully flexible price economy. The fluctuation of real variables is small, so is the labor movement across sectors. This means that the benefit of stabilizing the sectoral output will be small. Due to the resource loss, the welfare cost of introducing labor adjustment cost will still exist. In such a case, nominal rigidities are fully eliminated by monetary policy and the benefit of labor market friction disappears. This finding has very important policy implications for small open economies under fixed exchange rate regimes. Under a fixed exchange rate regime, the economy cannot be insulated from external shocks. With perfect labor mobility, all real variables will be volatile, which reduces welfare. However, if we introduce a friction, such as sectoral labor adjustment cost or polices that can restrict domestic labor mobility, then the response of real sectoral variables to external shocks will be limited. This may improve welfare. Therefore, a policy that can reduce domestic mobility might be desirable for the developing economies, especially when the economy is constrained by fixed exchange rates.

Our paper is a variant of Devereux, Lane, and Xu (2006) with the introduction of sectoral labor adjustment cost. With respect to sectoral labor market friction, Ju, Shi, and Wei (2010) also use the same sectoral labor adjustment cost to model the labor market friction and study how it affects the current account adjustment in a multiple tradeable sectors model. In addition, Kang (2010) introduces the labor adjustment cost in a two-country model, and investigates the leading and lagging relationships in international business cycles. However, the labor adjustment cost occurs in the aggregate level, not in the adjustment process of the sectoral level. Garcia-Cebro and Varela-Santamaria (2009) study the role of imperfect intersectional labor mobility in the transmission mechanism of an unanticipated expansion to aggregate variables of a small open economy. In their model, the imperfect labor mobility is modelled as the imperfect substitution between sectoral labors, which leads to disutility when the households change the labor supply from one sector to another. Cook and Xu (2010) examine the regional labor mobility in a monetary union model. They also assume that labor is an imperfect substitute across regions and the household can develop a labor habit associated with working in a particular region.

This paper is organized as follows. Section 2 presents the basic model. Section 3 examines the dynamics of the economy. Section 4 analyzes the welfare implications of the presence of sectoral labor adjustment cost under different monetary rules. Section 5 concludes.

2. A Two-Sector Sticky Price Model

In this section, we develop a two-sector sticky price small open economy model that builds on Devereux, Lane, and Xu (2006). There are three agents in the model: consumers, firms, and a monetary authority. Firms in two sectors produce goods using labor and capital, and sell goods to domestic residents or foreign markets. The monetary authority sets nominal interest rates.

2.1 Household

The representative consumer has preferences given by

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \eta \frac{L_t^{1+\psi}}{1+\psi} \right), \tag{2.1}$$

where C_t is consumption, and L_t is labor supply. Consumption is a Cobb-Douglas function of consumption of non-traded goods and an import good, where $C_t = \frac{1}{a^a (1-a)^{1-a}} C_{Nt}^a C_{Ft}^{1-a}$. Hence, the consumer price index is $P_t = P_{Nt}^a P_{Ft}^{1-a}$, with P_{Nt} (P_{Ft}) defined as the time t price of the non-traded (import) good. For simplicity, we assume the change of exchange rate passes through into the import price completely. This implies $P_{Ft} = S_t P_{Ft}^*$, where P_F^* is the world price of import goods and S_t is the nominal exchange rate. To introduce nominal prices in the non-traded goods sector, we allow for imperfect competition in the sector. The non-traded goods are differentiated, with elasticity of substitution across varieties equal to λ, so that for non-traded goods, $C_{Nt} = [\int_0^1 C_{Nt}(i)^{\frac{\lambda-1}{\lambda}} di]^{\frac{\lambda}{\lambda-1}}$, with $\lambda > 1$.

Households have access to the domestic bond market and the international bond market. Trade in international bonds is subject to small portfolio adjustment costs. If the household borrows an amount D_t, then these portfolio adjustment costs are $\frac{\psi_D}{2}(D_{t+1} - \overline{D})^2$ (denominated in the composite good), where

$\overline{D}$ is an exogenous steady state level of net foreign debt.[3] The household can borrow directly in terms of foreign currency at a given interest rate i_t^*, or in domestic currency assets at an interest rate i_t. Households own all home production firms and therefore receive the profits on these firms. In the model, the labor cannot be costless and instantaneously reallocated between the traded good sector and the non-traded good sector. To model the labor market friction, following Ju, Shi and Wei (2010), we assume that if the household supply L_{it} to sector i in period t, then there will be an adjustment cost $\frac{\phi_i}{2}(L_{it}-\overline{L}_i)^2$, where ϕ_i is the parameter that measures the labor market friction and $\overline{L}_i$ is the labor supply to sector i in steady state.[4]

A household's revenue flow in any period then comes from wage income $W_{Xt}L_{Xt}+W_{Nt}L_{Nt}$, capital rental income from both the traded sector and non-traded sector R_tK_t, transfers T_t from government, profits from the non-traded sector Π_t, less debt repayment from the last period $(1+i_t^*)S_tD_t+(1+i_t)B_t$, as well as portfolio adjustment costs. B_t is the stock of domestic-currency debt. The household then obtains new loans from the domestic and/or international capital market, and uses these to consume and pay labor adjustment cost and portfolio adjustment cost.

Thus, the household' budget constraint is

$$\begin{aligned}&P_t(C_t+I_t+\frac{\phi_X}{2}(L_{Xt}-\overline{L}_X)^2+\frac{\phi_N}{2}(L_{Nt}-\overline{L}_N)^2+\frac{\psi_D}{2}(D_{t+1}-\overline{D})^2)\\&=W_{Xt}L_{Xt}+W_{Nt}L_{Nt}+R_tK_t+T_t+\Pi_t+S_tD_{t+1}+B_{t+1}-(1+i_t^*)S_tD_t-(1+i_t)B_t.\end{aligned} \tag{2.2}$$

The capital accumulation is described by

$$K_{t+1}=(1-\delta)K_t+I_t. \tag{2.3}$$

The household optimum can be characterized by the following conditions:

3 As in Schmitt-Grohé and Uribe (2003), these portfolio adjustment costs eliminate the unit root in the economy's net foreign assets.

4 As pointed out by the referee, labor adjustment cost is similar to adjustment costs to convert output into capital. This is because it also reduces the volatility of real variables. However, the standard capital adjustment cost occurs mostly in the process of new capital formation. If the responses of the economy to shocks do not require the creation of new capital or the responses to shocks can simply lead to the reallocation of resources across sectors, then the capital adjustment cost might be different from the intersectoral adjustment cost.

$$\frac{1}{1+i_{t+1}^{*}}\left[1-\frac{\psi_D P_t}{S_t}(D_{t+1}-\overline{D})\right]=\beta E_t\left[\frac{C_t^{\sigma}P_t}{C_{t+1}^{\sigma}P_{t+1}}\frac{S_{t+1}}{S_t}\right] \tag{2.4}$$

$$\frac{1}{1+i_{t+1}}=\beta E_t\left(\frac{C_t^{\sigma}P_t}{C_{t+1}^{\sigma}P_{t+1}}\right) \tag{2.5}$$

$$1=E_t\{\beta\frac{C_t^{\sigma}}{C_{t+1}^{\sigma}}[1-\delta+\frac{R_{t+1}}{P_{t+1}}]\}$$

$$\frac{W_{Xt}}{P_t}-\phi_X(L_{Xt}-\overline{L}_X)=\eta L_t^{\psi}C_t^{\sigma},\quad \frac{W_{Nt}}{P_t}-\phi_N(L_{Nt}-\overline{L}_N)=\eta L_t^{\psi}C_t^{\sigma}. \tag{2.6}$$

Equations (2.4) and (2.5) represent the Euler equations for the purchase of international and domestic bonds. The combination of these two equations gives the representation of interest rate parity for this model. Equation (2.6) describes the labor supply equations for the export sector and the non-traded good sector, respectively. Their combination gives

$$\frac{W_{Xt}}{P_t}-\frac{W_{Nt}}{P_t}=\phi_X(L_{Xt}-\overline{L}_X)-\phi_N(L_{Nt}-\overline{L}_N), \tag{2.7}$$

This implies that the parameters of labor adjustment cost determine the magnitude of the response of the wage differential to the relative sectoral labor supply.[5]

2.2 Firms

Both traded goods and non-traded goods are produced by combining labor and capital. The production technology for a firm in the non-traded goods sector is a CES production function given by

$$Y_{it}=A_i[\alpha_i^{\frac{1}{\gamma}}K_{it}^{\frac{\gamma-1}{\gamma}}+(1-\alpha_i)^{\frac{1}{\gamma}}L_{it}^{\frac{\gamma-1}{\gamma}}]^{\frac{\gamma}{\gamma-1}},\quad i=N,X \tag{2.8}$$

where A_i is a productivity parameter, and K_{it} and L_{it} are the capital and labor used by firms in sector i, respectively. α_i is the share of capital in production and γ is the elasticity of substitution between capital

5 This equation is observationally equivalent to the relative sectoral labor supply equation, $\frac{W_N}{W_X}=constant(\frac{L_N}{L_X})^{\frac{1}{\theta}}$, in Garcia-Cebro and Varela-Santamaria (2009) after log-linearization. In the calibration, we will choose ϕ_N and ϕ_X to match the elasticity of substitution between sector labors, θ.

and labor.[6] Cost minimizing then implies the following equations:

$$K_{it} = \alpha_{it}(\frac{R_t}{MC_{it}})^{-\gamma} Y_{it}, \quad i = N, X \tag{2.9}$$

$$L_{it} = (1-\alpha_{it})(\frac{W_{it}}{MC_{it}})^{-\gamma} Y_{it}, \quad i = N, X \tag{2.10}$$

where $MC_{it} = [\alpha_{it} R_t^{1-\gamma} + (1-\alpha_{it}) W_{it}^{1-\gamma}]^{\frac{1}{1-\gamma}}$ is the marginal cost for sector i. Equations (2.9)-(2.10) characterize cost minimization in the non-traded good sector and the export good sector. Note that we assume the law of one price holds in the traded good price so that $P_{Xt} = S_t P_{Xt}^*$, where P_{Xt}^* is the world price of the traded good. Since the export sector is competitive, $P_{Xt} = MC_{Xt}$. Movements in P_{Xt}^*, relative to the import price P_{Ft}^*, represent terms of trade shocks for the small open economy.

The non-traded goods sector is monopolistic competitive and contains a unit interval [0,1] of firms indexed by j. Each monopolistically competitive firm j produces a differentiated non-traded good, which is an imperfect substitute for others in the production of composite goods, $Y_N = (\int_0^1 Y_N(j)^{\frac{\lambda-1}{\lambda}} dj)^{\frac{\lambda}{\lambda-1}}$, where λ is the elasticity of the substitution between differentiated non-traded goods. Hence, the demand faced by each individual non-traded good, j, is

$$Y_N(j) = (\frac{P_N(j)}{P_N})^{-\lambda} Y_N, \tag{2.11}$$

where $\frac{P_N(j)}{P_N}$ is the relative price of each variety with respect to the aggregate price index, P_N, which is given by $P_N = (\int_0^1 P_N(j)^{1-\lambda})^{\frac{1}{1-\lambda}}$.

We assume a standard Calvo Pricing technology. A given firm may reset its price with probability $1-\omega$ each period. Therefore, when allowed to reset price, a firm j will choose $P_{Nt}^o(j)$ to maximize weighted expected profit:

6 Duffy and Papageorgiou (2000) show that the estimation of the elasticity of substitution between capital and labor are different for rich and poor countries. I use the CES production function instead of the Cobb-Douglas production function so I can vary the parameter of the elasticity of substitution between capital and labor to do sensitivity analysis.

$$E_t \sum_{l=0}^{\infty} [(\beta\omega)^l \frac{\Lambda_{t+l}}{\Lambda_t} \frac{\Pi_{t+l}(j)}{P_{t+l}}], \tag{2.12}$$

where $\Pi_{t+l}(j) = (P_{Nt}^o(j) - MC_{Nt+l}(j))Y_{Nt+l}(j)$ is the non-traded firm j 's profit in period $t+l$, $\Lambda_t = C_t^{-\sigma}$ is the marginal utility of consumption for a representative household, and $MC_{Nt}(j)$ represents the marginal cost for non-traded firms. The optimal price for the non-traded good firm is given by

$$P_{Nt}^o(j) = \frac{\lambda}{\lambda - 1} \frac{E_t \sum_{l=0}^{\infty} (\beta\omega)^l \frac{\Lambda_{t+l}}{P_{t+l}} MC_{Nt+l} P_{Nt+l}^{\lambda} Y_{Nt+l}}{E_t \sum_{l=0}^{\infty} (\beta\omega)^l \frac{\Lambda_{t+l}}{P_{t+l}} P_{Nt+l}^{\lambda} Y_{Nt+l}} \tag{2.13}$$

We can rewrite the aggregate price for non-traded goods as $P_{Nt} = [\omega(P_{Nt-1})^{1-\lambda} + (1-\omega)(P_{Nt}^o)^{1-\lambda}]^{\frac{1}{1-\lambda}}$ because a fraction ω of prices remains unchanged from the previous period.

2.3 Monetary Policy Rules

The monetary authority uses a short-term domestic interest rate as a monetary instrument. The interest rate rule is given by

$$1 + i_{t+1} = \left(\frac{P_{Nt}}{P_{Nt-1}} \frac{1}{\bar{\pi}_n} \right)^{\mu_{\pi_n}} \left(\frac{S_t}{\bar{S}} \right)^{\mu_S} (1 + \bar{i}). \tag{2.14}$$

where μ_{π_n} allows the monetary authority to control the inflation rate in the non-traded goods sector around a target rate of $\bar{\pi}_n$ and μ_S controls the degree to which the monetary authority attempts to control variations in the exchange rate, around a target level of $\bar{S}$.

The general form of the interest rate rule (2.14) allows for two types of monetary policy stances. The first stance is one whereby the monetary authority targets the inflation rate of non-traded goods (NTP rules), so that $\mu_{\pi_N} \to \infty$. As shown by Devereux, Lane, and Xu (2006), this NTP rule can replicate a flexible price allocation. The exchange rate is flexible under such a rule, so this rule also represents a flexible exchange rate regime. The second stance we analyze is a simple fixed exchange rate rule (FER rule) by setting $\mu_s \to \infty$, whereby the monetary authority adjusts interest rates to keep the nominal exchange rate fixed at the target level, $\bar{S}$.

2.4 Equilibrium

In an equilibrium, the non-traded goods market clears. That is,

$$Y_{Nt} = a\frac{P_t Z_t}{P_{Nt}}, \tag{2.15}$$

where Z_t is the total demand for aggregate goods and is given by

$$Z_t = C_t + I_t + \frac{\psi_D}{2}(D_{t+1} - \bar{D})^2 + \frac{\phi_X}{2}(L_{Xt} - \bar{L}_X)^2 + \frac{\phi_N}{2}(L_{Nt} - \bar{L}_N)^2. \tag{2.16}$$

In the model, the demand for aggregate goods comes mainly from household consumption and investment. In addition, because portfolio adjustment costs and labor adjustment cost are represented in terms of the composite final good, part of these costs must be incurred in terms of non-traded goods and import goods. Meanwhile, the labor market condition must be satisfied:

$$L_{Xt} + L_{Nt} = L_t. \tag{2.17}$$

In equilibrium, $B_t = 0$. Therefore, the aggregate budget constraint for the economy can be rewritten as

$$P_t Z_t + S_t(1+i_t^*)D_t = P_t Y_t + S_t D_{t+1}. \tag{2.18}$$

where $Y_t = \frac{P_{Nt}Y_{Nt} + P_{Xt}Y_{Xt}}{P_t}$ is the total output of this small open economy. Equation (2.18) implies that total expenditures must equal total receipts, which are the output of each sector, plus new net foreign borrowing.

The equilibrium now is defined as follows: given the stochastic process of terms of trade shocks ($\frac{P_{Xt}^*}{P_{Ft}^*}$) and the monetary policy rule (μ_{π_n}, μ_{π_s}), an equilibrium is an allocation { C_t, L_t, L_{Nt}, L_{Xt}, Y_{Nt}, Y_{Xt},

K_{Nt} , K_{Xt} , I_t , Z_t , D_t , Y_t } and { P_t , P_{Nt} , P_{Ft} , P_{Xt} , MC_{Nt} , MC_{Xt} , S_t , R_t , i_t , W_{Nt} , W_{Xt} } that satisfies households' and firms' optimization conditions and the market clearing conditions.

3. Results

3.1 Calibration

The model is solved numerically using a second order approximation to the true dynamic stochastic system, where the approximation is done around the non-stochastic steady state. The structural parameter choices for the model are described in Table 1. We assume that the inter-temporal elasticity of substitution in consumption, $\frac{1}{\sigma}$, is 0.5 and the elasticity of labor supply, $\frac{1}{\psi}$, is unitary, which are both within the range of the literature. The elasticity of substitution between varieties of non-tradable goods determines the average price-cost mark-up in the non-tradable sector. We follow standard estimates from the literature in setting a 10 percent mark-up, so that $\lambda = 11$. The steady state world interest rate is set to 4 percent annually, so that at the quarterly level, this implies a value of 0.99 for the discount factor. We set the scale parameter of labor disutility η to 2.5 so that the steady state labor in benchmark case is 0.24, which implies 40 hours per week.

For the small open economy, $1-a$ represents the openness. Following Gali and Monacelli (2005), we choose $a = 0.6$ so that the ratio of imports to GDP is 0.4.[7] In the later section, we will vary the value of a to do a robustness check.

We set $\alpha_X = 0.7$ and $\alpha_N = 0.3$, so that the labor share of traded output is 30 percent, and the labor share of non-traded output is 70 percent. Given the share of non-traded goods in final goods, the average capital share of GDP is about 40 percent. In our benchmark case, we set $\gamma = 0.9999$, which simply represents a Cobb-Douglas production. Duffy and Papageorgious (2000) argue that the elasticity of substitution between capital and labor varies with the development of economies. In the later analysis, we will also consider this issue and check if our results are more relevant for developing economies. The capital depreciation rate, δ, is set to 0.025. We set $\omega = 0.75$ so that all non-traded good prices adjust on average after four quarters, which follows the standard estimate used in the literature. We set $\overline{D} = 0$ so that the trade is balanced in the steady state. With respect to the costs of portfolio adjustment, we follow the estimate of Schmitt-Grohé and Uribe (2003) to set $\psi_D = 0.0007$.

7 We also calculate the average ratio of import to GDP of 11 countries, including Cambodia, Portugal, Vietnam, Korea, Sweden, Canada, the Philippines, Iceland, Poland, Mexico and Turkey. The ratio of imports to GDP in these countries ranges from 0.31 to 0.45. The average is 0.396.

For the sectoral labor market friction, we choose the parameters ϕ_N and ϕ_X to match the elasticity of substitution between sectoral labors. Log-linearizing Equation (2.7), we can have

$$\hat{W}_{Nt} - \hat{W}_{Xt} = \frac{1}{\theta}(\hat{L}_{Nt} - \hat{L}_{Xt}) \tag{3.1}$$

where $\theta = \frac{\overline{W}}{\overline{P}\overline{L}_N}\frac{1}{\phi_N} = \frac{\overline{W}}{\overline{P}\overline{L}_X}\frac{1}{\phi_X}$. Equation (3.1) is similar to the log-linearization of Equation (10) in Garcia-Cebro and Varela-Santamaria (2009). Note that θ is the elasticity of substitution between sector labors, which can measure the intersector labor mobility. Wages in two sectors diverge more for the low value of θ, so when θ tends to infinity, the household will set the same wage in both sectors, which implies perfect labor mobility. In calibration, we set $\phi_N = \frac{\overline{W}}{\overline{P}\overline{L}_N}\frac{1}{\theta}$ and $\phi_X = \frac{\overline{W}}{\overline{P}\overline{L}_X}\frac{1}{\theta}$ to match reasonable elasticity of substitution between sectoral labors, θ. In the following analysis, we will focus on the case $\frac{1}{\theta} = 0$ and $\frac{1}{\theta} = 1$, where the former represents perfect labor mobility and the latter represents imperfect labor mobility. In our benchmark case, these correspond to the case where $\phi_N = \phi_X = 0$ and $\phi_N = 85.4$ and $\phi_X = 271.6$.[8]

In the model, we consider the terms of trade shock, which is represented by a shock to $\frac{P_X^*}{P_F^*}$. Following Devereux, Lane, and Xu (2006), we assume that the shock is described as AR(1) processes with persistence 0.77 and variance $\sigma_e = 0.013^2$.

3.2 Impulse Responses to TOT Shock

Now we investigate how the presence of sectoral labor adjustment cost affects the transmission of shocks to the economy under two alternative monetary rules. Figures 1 and 2 report the response of both real variables (namely, consumption, employment, the trade balance, investment, sectoral outputs, and real exchange rate) and nominal variables (namely, overall inflation, the nominal exchange rate and the nominal interest rate) to terms of trade shocks.

[8] Note that steady state wage and labor change with structure parameters, hence, in the sensitive analysis, we also need to adjust ϕ_N and ϕ_X to get the same θ.

In the model, a positive terms of trade shock is equivalent to a positive income shock coming from the export sector. In Figure 1, given the NTP rule, the exchange rate is flexible. Therefore, this positive wealth effect leads to an increase in consumption and a decline in labor supply. Since a positive terms of trade shock is also equivalent to a positive productivity shock in the export sector, output and employment increases in the sector. The trade balance improves because the shock is transitory. To respond to the TOT shock, both nominal and real exchange rate appreciate. Due to the price stickiness in the non-traded goods sector, the exchange rate appreciation also leads to a decrease in domestic inflation and an increase in the nominal interest rate. However, in this case, when the sectoral labor adjustment cost is introduced, the responses of most variables do not change very much. For example, the impulse responses of consumption are almost coincident. This is because, when the exchange rate is flexible, it absorbs most of the external shocks, so the responses of real variables to shocks are very small. Therefore, even when there is friction in the process of labor reallocation, the dampening effect will be small as well.

We also notice that the exchange rate is less volatile under imperfect labor mobility than under perfect labor mobility. This is simply because the sectoral reallocation depends mainly on the change of the relative price of non-traded goods to imported foreign goods, which is determined by the change of the exchange rate. When there is imperfect labor mobility, the sectoral changes will be smaller. This implies less exchange rate variation is needed.

Figure 2 shows that when the exchange rate is fixed, both consumption and labor increase. Why does total labor increase now? This is because, in the beginning, the non-traded sector expands while the traded sector shrinks. Since the non-traded sector is labor intensive, aggregate labor increases as well. Due to the increase in domestic wage and inflation, the traded good sector does not benefit from the positive TOT shock. Instead, the non-traded goods sector gains from the increase in aggregate consumption. It can be observed that the responses of real variables under fixed exchange raters are much larger than those under flexible exchange rates. Therefore, although the introduction of sectoral labor adjustment cost does not affect the qualitative responses of these variables, the responses of most real variables are dampened significantly. For example, in the presence of sectoral labor adjustment cost, the initial response of labor is only half of that in the case without labor market friction. The responses of real variables under fixed exchange rates are much larger than those under flexible exchange rates, so the dampening effects should be quantitatively large as well, which may lead to significant welfare gain.

4. Welfare Evaluation

We now investigate the impact of sectoral labor adjustment cost on welfare evaluation. The welfare measurement we use here is the conditional expected lifetime utility of the representative household at time zero. Following Schmitt-Grohe and Uribe (2004), the expected lifetime utility is computed conditional on the initial state being the deterministic steady state, which is the same for all monetary policy regimes.[9] To measure the magnitude of the welfare differential across regimes, we define ζ_k as the percentage change of deterministic steady state consumption that will give the same conditional expected utility EU under policy regime k. That is, ζ_k is given implicitly by

$$\frac{\frac{1}{1-\sigma}[(1+\zeta_k)\overline{C}]^{1-\sigma} - \frac{\eta}{1+\psi}\overline{L}^{1+\psi}}{1-\beta} = EU_k \tag{4.1}$$

where a bar over a variable denotes the deterministic steady state of that variable. If $\zeta_k > 0$ (< 0), the welfare under regime k is implied to be higher (lower) than that of the steady state case.

Table 2 reports welfare results under different monetary policy rules with and without sectoral labor adjustment cost. We find that the presence of sectoral labor adjustment cost does not affect the welfare ranking of monetary policy rules. However, the welfare consequences of introducing sectoral capital adjustment cost depends critically on the nature of monetary policy rules. If the economy follows an NTP rule, there will be a small welfare loss caused by the presence of sectoral labor adjustment cost. Nevertheless, if the economy is under a fixed exchange rate rule, then the presence of this adjustment cost will lead to a welfare gain instead. In particular, this gain under a fixed exchange rate rule is significant, approximately 0.15 percent steady state consumption if the labor adjustment cost is set to match $\frac{1}{\theta} = 1$. More robust results can be seen in Figure 3. Under a flexible exchange rate, as the non-traded goods are unchanged, the possibility of price adjustment $1-\omega$ does not affect the result at all. Since the nominal rigidities are fully eliminated, when the labor market friction increases, the economy suffers from more welfare loss. Under a fixed exchange rate, however, the smaller the ω, the smaller the nominal rigidity as well as the welfare loss caused by nominal rigidity. Given ω, the welfare loss decreases with the labor market friction.

What causes the different welfare consequences under different monetary policy rules when there exists sectoral labor adjustment cost? Table 3 shows that, under a flexible exchange rate, the welfare loss is due to the decrease in the consumption mean and the increase in the consumption variance. The presence of labor market friction does not affect inflation very much. Under a fixed exchange rate, when there is labor market friction, the consumption mean increases and the volatility of labor declines. Intuitively, this is due to the nature of monetary policy rules. As shown by Devereux, Lane, and Xu (2006), a fixed exchange rate tends to stabilize inflation and exchange rates at the expense of substantial

[9] The change of the structural parameter will affect the steady state; however, the change of the labor adjustment cost parameter does not affect the steady state.

instability in the real economy. In general, if there is no sectoral labor adjustment, then sectoral output cost, employment, and capital will be volatile. As a result, the aggregate output, consumption, and employment will be volatile. Obviously, excess fluctuation of the real variables is inefficient. Therefore, the presence of sectoral adjustment cost will hinder this inefficient labor reallocation across sectors, which leads to welfare improvement. In a sense, the sectoral adjustment cost actually plays a substitution role in stabilizing the real economy when there is a lack of output-stabilizing monetary policies. However, under an NTP rule, the economy responds in a manner equivalent to that of a fully flexible price economy. The fluctuation of real variables is small, so is the labor movement across sectors. Therefore, the benefit of sectoral adjustment in stabilizing the sectoral output will be small. Meanwhile, there is still resource loss in the process of labor allocation. Overall, there will be welfare loss after introducing sectoral adjustment cost.

Under a fixed exchange rate rule, the economy cannot be insulated from external shocks. With perfect labor mobility, all real variables such as aggregate output, consumption, sectoral output, capital, and employment will be volatile, which reduces welfare. However, if there exists the friction in the process of sectoral labor reallocation, then the responses of real sectoral variables to external shocks will be limited. This implies that the presence of labor adjustment cost acts as a substitution role in output-stabilizing policy. That is, when monetary policy rules can stabilize the real economy, then the effect of sectoral labor mobility on the economy will be small; in case there is no monetary policy of this type, then the sectoral labor adjustment cost can take the role of stabilizing the real economy. From the impulse functions, we do see this stabilizing feature when there is sectoral adjustment cost. In terms of welfare, the gain of stabilizing sectoral output is large and completely dominates the welfare cost of resource loss during the labor adjustment process.

Our robustness check will focus on two structure parameters. The first parameter is the a, which measures the degree of openness of the economy. For reasonable a, we find the change of the openness $1-a$ does not affect our results. In Table 4, I report welfare results for the cases where $a = 0.5$, $a = 0.55$, and $a = 0.65$.

The second parameter is γ, the elasticity of substitution between capital and labor. Table 5 reports the results for the cases where $\gamma = 0.8$, $\gamma = 0.95$, $\gamma = 1.05$, and $\gamma = 1.1$. For reasonable γ, we still find that the presence of sectoral labor market adjustment cost increases the welfare under fixed exchange rates while reducing the welfare under flexible exchange rates. Quantitatively, this finding seems to be more significant when the elasticity of substitution is less than 1. Duffy and Papageorgious (2000) show that capital and labor (adjusted by human capital) are more substitutable in rich countries and less substitutable in poor countries. In their estimation, the elasticity of substitution for developing countries is $\gamma = 0.8$ while the elasticity of substitution for industrial countries is $\gamma = 1.1$. This implies that our results are more relevant and important for developing countries. In other words, developing countries should take the labor market friction into consideration when faced with an exchange rate regime choice.

5. Conclusion

This paper develops a two-sector small open economy sticky prices model with labor market friction. We study the labor adjustment cost in the process of sectoral labor reallocation. Our results show that the increase in labor mobility is not necessarily welfare improving. Its welfare consequence depends critically on the monetary policy. In the face of an external shock, if the economy chooses a flexible exchange rate, then labor adjustment cost leads to welfare loss; whereas, if the economy chooses a fixed exchange rate, then the labor market friction helps increase welfare. This is because the labor market friction offsets some of the nominal rigidities when the monetary policy cannot eliminate it completely. These results imply that the welfare gap between flexible exchange rates and fixed exchange rates could be reduced by the presence of labor market friction. Our findings suggest that the status of the domestic labor market should be taken into consideration when the economy faces exchange rate regime choices.

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Table 1. Calibration Parameters

Parameter	value	Parameter	value	Parameter	value
σ	2	β	0.99	a	0.6
λ	11	γ	0.9999	α_N	0.3
α_X	0.7	ψ_D	0.0007	ω	0.75
ρ_{tot}	0.77	σ_e	0.013	η	2.5
ϕ_N	85.4	δ	0.025	θ	$1/\infty$
ϕ_X	271.6	ψ	1	$\overline{D}$	0

Table 2. Welfare Results under Different Monetary Policy Rules

ζ	$\frac{1}{\theta}=0$	$\frac{1}{\theta}=1$
NTP	0.020%	0.014%
FER	-0.224%	-0.071%

Table 3. Means and Standard Deviations of Major Variables

	Flex		Fixed	
	$\frac{1}{\theta}=0$	$\frac{1}{\theta}=1$	$\frac{1}{\theta}=0$	$\frac{1}{\theta}=1$
EC	5.1011	5.1010	5.0916	5.0968
σ_C	0.0158	0.0193	0.0295	0.0265
EL	0.24	0.24	0.2399	0.24
σ_L	0.0009	0.0004	0.0115	0.0042
$E\pi$	0	0	0	0
σ_π	0.0026	0.0021	0.0016	0.0018

Table 4. Welfare Change with the Degree of Openness (1- a)

	$a = 0.5$		$a = 0.55$		$a = 0.65$	
	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$
NTP	0.028%	0.022%	0.019%	0.014%	0.021%	0.014%
FER	-0.117%	-0.062%	-0.175%	-0.071%	-0.263%	-0.065%

Table 5. Welfare Change with the Elasticity of Substitution (γ)

	$\gamma = 0.8$		$\gamma = 0.95$		$\gamma = 1.05$		$\gamma = 1.1$	
	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$	$\frac{1}{\theta} = 0$	$\frac{1}{\theta} = 1$
NTP	0.017%	0.012%	0.020%	0.013%	0.020%	0.016%	0.020%	0.0%
FER	-0.202%	-0.030%	-0.286%	-0.058%	-0.167%	-0.084%	-0.137%	-0.109%

Figure 1. Impluse Response to Terms of Trade Shock under Flexible Exchange Rates

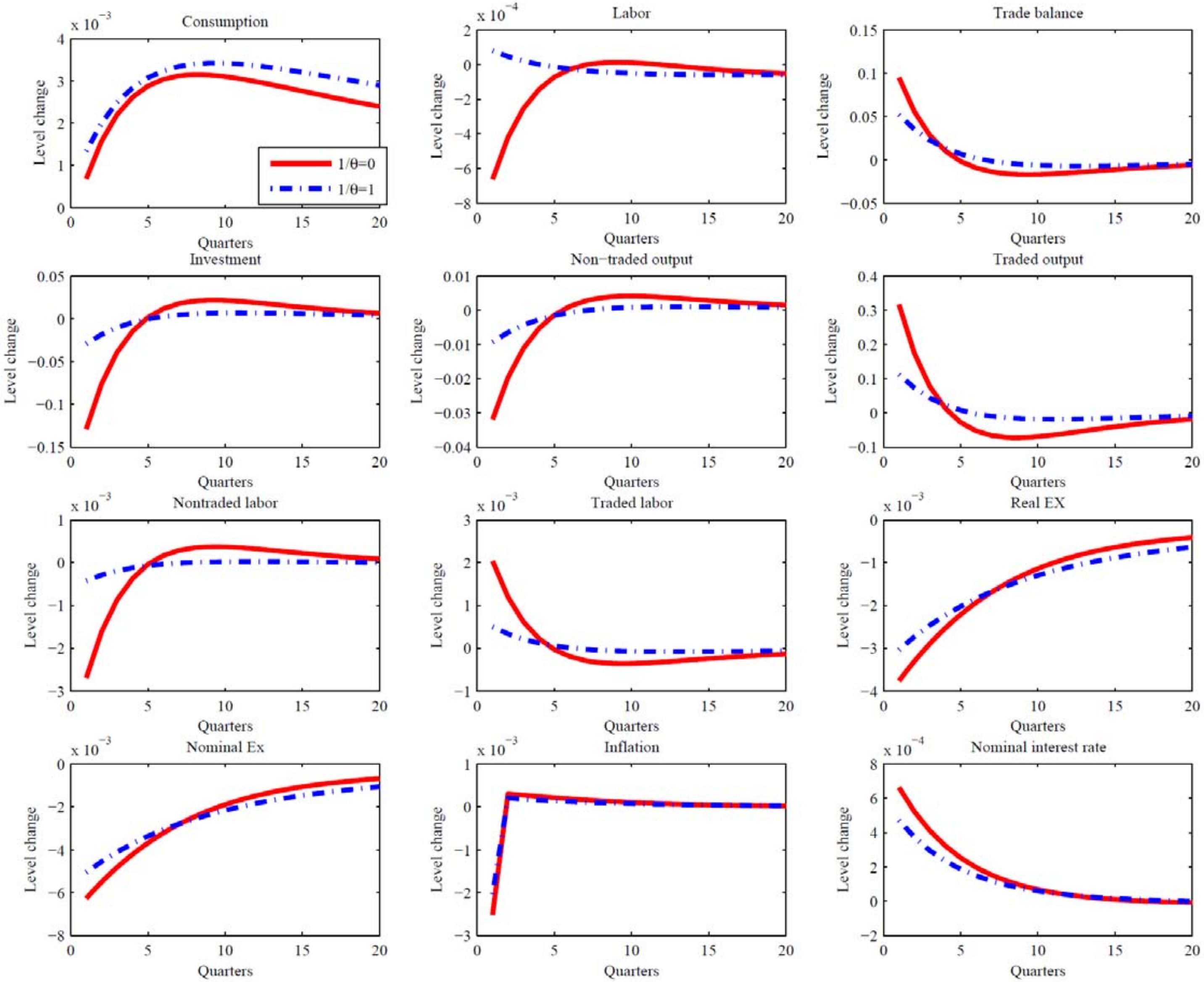

Figure 2. Impluse Response to Terms of Trade Shock under Fixed Exchange Rates

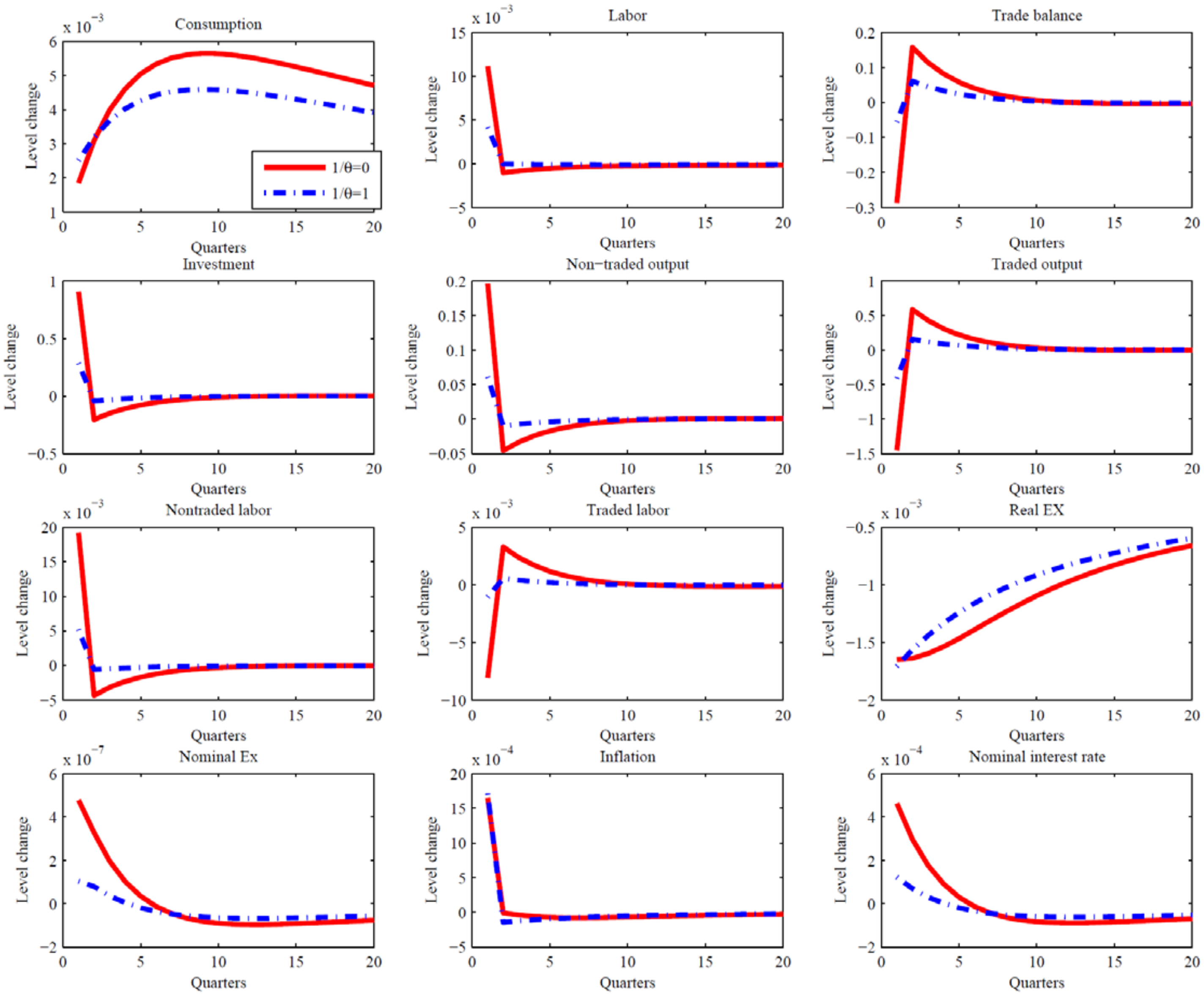

Figure 3. Welfare Change with Labor Market Friction