Input Substitution, Export Pricing, and Exchange Rate Policy

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Abstract

This paper develops a small open economy model with sticky prices to show why a flexible exchange rate policy is not desirable in East Asian emerging market economies. We argue that weak input substitution between local labor and import intermediates in traded goods production and extensive use of foreign currency in export pricing in these economies can help to explain this puzzle. In the presence of these two trade features, the adjustment role of exchange rate is inhibited, so even a flexible exchange rate cannot stabilize the real economy in face of external shocks. Instead, due to the high exchange rate pass-through, exchange rate changes will lead to instability in both inflation and production cost. As a result, a fixed exchange rate may dominate a monetary policy rule with high exchange rate flexibility in terms of welfare. In a sense, our finding provides a rationale for "fear of floating" phenomenon in these economies. That is, "fear of floating" may be central banks' rational reaction when these economies are constrained by the trade features mentioned above.

JEL classification: F3, F4
Keywords: Input substitution, Export pricing, Exchange rate flexibility, Welfare

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1 Introduction

The purpose of this paper is to explain why exchange rates in East Asian economies are usually not as flexible as those in developed countries, i.e., why these economies usually adopt fixed or less flexible exchange rate policies. We argue that this phenomenon can be attributed to two features in the trade structure of these economies: weak input substitution between local labor and import intermediates in the traded good production and extensive use of foreign currency in export pricing.

The debate on fixed versus flexible exchange rates has been at the heart of international monetary economics for many years. Friedman (1953) and later Mundell (1961) made the case for flexible exchange rates as an efficient adjustment mechanism, cushioning the economy against external shocks when domestic price levels cannot change quickly enough. The implication is then for a small economy buffeted by external disturbances from the rest of the world, it is better to allow the exchange rate to adjust.

Recently, a large number of papers have examined the business cycle stabilization and welfare properties of simple monetary rules in dynamic, general equilibrium, sticky-price small open economy models. (See Devereux, Lane and Xu, 2006; and Gali and Monsacelli, 2005). An especially pertinent example is Schmitt-Grohe and Uribe (2001), who examine a small open economy model and compare the welfare properties of a number of interventionist monetary policy rules[1] with a fixed nominal exchange rate rule. The stabilization properties of each of monetary rules with exchange rate flexibility were superior to a fixed exchange rate rule.

However, in reality, many East Asian economies, such as Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, and Thailand, pegged their currencies to the dollar explicitly or implicitly. The exchange rate regimes ranged from a currency board hard peg in Hong Kong to a sliding or crawling peg in Indonesia.[2] So volatilities of East Asian

[1] All these rules allow for exchange rate movement.

[2] Although these pegs were often not openly admitted or were disguised as currency baskets, the common adherence to the dollar is easy to recognize. For example, Singapore follows an exchange-rate-centered monetary policy, targeting a trade-weighted exchange rate index. Thailand follows a managed °oating system since the ¯nancial crisis. Park et al. (2001) shows that Korea is still fearful of °oating although it claims a °exible exchange rate regime.

currencies were usually much lower than those of major currencies.

Thus, it remains a challenge for economists to explain the exchange rate regime choices or the inflexibility of exchange rates in these economies. Calvo and Reinhart (2002) argue that this is is because of the "fear of floating', which is due to the financial fragility or the presence of foreign currency debt or currency mismatch in these economies. Cespedes, Chang, and Velasco (2004) and Calvo (2000) also show that, with high foreign currency debt ratio in emerging market economies, a balance sheet effect may lead to a real contraction when exchange rate devaluates. This will force central banks to stabilize exchange rates. So in emerging market economies, the desirability of flexible exchange rate is subject to the financial conditions.

Nevertheless, recent literature find that for a small open economy, a fixed exchange rate is still dominated by a flexible exchange rate in terms of welfare, even when financial frictions or potentially large balance-sheet effects are taken into consideration. For example, Gertler, Gilchrist, and Natalucci (2007) show that fixed exchange rates exacerbate financial crises by tieing hands of the monetary authorities, so welfare loss following a financial crisis is significantly larger under fixed exchange rates relative to flexible exchange rates. Chang and Velasco (2006) study the simultaneous determination of exchange rate regimes and portfolio choice between domestic and foreign currency bond. They find that "fear of floating" may emerge endogenously when there is a currency mismatch in assets and liabilities, but the floating exchange rate regimes always Pareto dominates the fixed exchange rate regime. Devereux, Lane, and Xu (2006) show that financial frictions magnify the volatility of the economies but do not affect the ranking of alterative policy rules. Given the structure of their model, they find that the policy maker would always want to choose a flexible exchange rate.[3]

In this paper, we will re-examine the issue of exchange rate policy in emerging market economies. In particular, we will focus on how trade structure features in East Asian economies, instead of financial condition, affect choices of exchange rate policy. Our research

[3] Choi and Cook (2004) ¯nd that a ¯xed exchange rate stabilizes banks' balance sheets and leads to greater business cycle stability than does an in°ation-targeting interest rate rule. But this comparison is not based on welfare metric.

is motivated by two well-observed facts in trade sector in these economies. First, it is noted that more and more intermediate goods and raw materials are imported by East Asian economies for the re-exporting of finished products to other countries. For example, more than 50 percent of trade in East Asian economies is processing trade[4]. Secondly, most export goods in these economies are priced in foreign currency, especially in US dollar. Cook and Devereux (2006) document that about 90 percent of export goods in Thailand and Korea are preset in US dollar. They refer to this aspect as external currency pricing.

Why these two features are important for the choice of exchange rate policy? This is because they both limit the adjustment role of exchange rates, which in turn reduces the desirability of flexible exchange rates. Given high percentage of processing trade in the total trade, the elasticity of substitution between imported intermediates and local labor will be very small in the production of traded goods. In some cases, these two inputs are even complementary. In general, the expenditure-switching role of exchange rate adjustment depends critically on the substitutability of inputs of production. When the substitutability is low, then expenditure-switching effect is not important. Therefore, on the production side, if imported inputs and domestic inputs have low substitutability or are complementary, the benefit of flexible exchange rates under price rigidity is limited as the expenditure-switching effect in inputs substitution is small or dissappear. Meanwhile, when most export goods are priced in foreign currency, in short run, export prices are fixed in terms of foreign currency and the exchange rate movement cannot help export firms to stabilize the export demand or improve their export competitiveness. Therefore, this feature also reduces the incentive of these economies to increase the exchange rate flexibility.

Furthermore, as emphasized by Calvo and Reinhart (2002), exchange rate shocks in emerging market economies tend to feed into aggregate inflation at a much faster rate than in industries economies (also see Choudhri and Hakura 2003, and Devereux and Yetman 2005). In an economy with high exchange rate pass-through to consumption goods, there is a clear trade-off between output stability and inflationary stability. However, due to the

[4] Processing trade refers to the business activity of importing all or part of the raw and auxiliary materials, parts and components, accessories, and packaging materials from abroad in bond, and re-exporting the ¯nished products after processing or assembly by enterprizes within the domestic economy.

absence of expenditure-switching effect in both production side and market demand side, the function of exchange rate changes to stabilize real economy disappears. The only benefit of having exchange rate movement is to adjust the relative prices between home goods and foreign goods in the consumption basket. Nevertheless, as noted by Fraga, Goldfajn and Minella (2003), in emerging market economies, consumption goods represented only 21.3% of total imports, whereas capital goods and intermediate goods shares are 29.5% and 46.2%, respectively. This implies that in these economies, the expenditure-switching effect on the consumption side might be quite small and may be welfare-dominated by the inflation nonstability caused by flexible exchange rates, since now a flexible exchange rate does not help to stabilize output, but leads to inflation instability. Therefore, a fixed exchange rate regime may be the optimal monetary policy for a small open economy characterized by weak traded good input substitution and foreign currency export pricing.

Thus, besides financial fragility, the trade structure of emerging market economies may also cause the "fear of floating". Even without considering the balance sheet effect, in a small open economy with the two features mentioned above, a fixed exchange rate may be superior to a flexible exchange rate in terms of welfare.

To explore our explanation, we develop a small open economy stochastic general equilibrium model with sticky prices, where there is vertical trade. Export firms are monopolistic competitive, and they produce differentiated finished goods using import intermediate and local labor. Meanwhile, export goods prices are set in foreign currency and firms need to pay a menu cost to adjust their prices. In this economy, we assume central bank chooses a simple interest rate targeting rule, which can represent different exchange rate regimes. Therefore, we can investigate welfare properties of different monetary policy rules when the economy is in face of external shocks.

Following Schmitt-Grohe and Uribe (2004), we use a perturbation method to calculate welfare. We show that the presence of low input substitution (or input complementarities) and foreign currency pricing can affect the welfare ranking between flexible exchange rates and fixed exchange rates. That is, a fixed exchange rate can dominate a flexible exchange rate in terms of welfare. In particular, we find that both low input substitution and foreign currency pricing are essential in producing this result. To our knowledge, this paper is the first to show that a fixed exchange rate can be superior to a flexible exchange rate in terms of welfare. Therefore, a fixed exchange rate regime may be a rational policy choice for a small open economy characterized by weak input substitution in traded sector and foreign currency pricing of export goods. In a sense, our finding also provides a rationale for "fear of floating" phenomenon in East Asian economies. That is, controlling exchange rate fluctuation or "fear of floating" in these economies might be central banks' rational reaction when they are constrained by these trade structure features.

Our research is closely related to Devereux, Lane, and Xu (2006). Their emphasize the impact of financial friction on the choice of monetary policy rules for a small open economy. Our paper differs because we focus on how the trade structure of East Asian emerging market economies affects monetary transmission mechanism and the exchange rate policy. To our knowledge, this paper is the first to explore the implication of input substitution for exchange rate policy choice in the literature.

As to the discussion of the "fear of floating" phenomenon, our paper's major contribution is that we focus on how the trade structure features in East Asian economies, instead of the financial condition, affect the choices of exchange rate policy. Particularly, we show how the weak input substitution in the trade sector and the foreign currency pricing affect the exchange rate policy regimes in these economies. We argue that "fear of floating" in emerging market economies might be central banks' optimal reaction when they are constrained by these trade structure features.

This paper is organized as follows. Section 2 presents the basic setup of the model. Section 3 reports dynamics of our model when the economy is buffeted by different external shocks. Section 4 compares the welfare properties of different exchange rate regimes and discusses relevant implications. Section 5 concludes.

2 Basic Model

We construct a small open economy two-sector model. Two types of goods are produced: non-traded goods and traded goods. Domestic agents consume non-traded goods and imported foreign goods. The model exhibits the following three features: a) nominal rigidities, in the form of costs of price adjustment for non-traded goods and export goods firms; b) vertical trade, where export firms have to import intermediate goods to produce export goods;[5]and c) foreign currency pricing of export goods, i.e., export goods are priced in foreign currency (we will just call it dollar in later discussion).

There are three types of domestic agents in the model: consumers, firms, and the monetary authority. In addition, there is a 'rest of world' economy where foreign-currency prices of import goods are set, and where the foreign currency bond interest rates are determined. Domestic households decide consumption, labor supply and how much to borrow or lend on domestic and international financial markets. Production firms in two sectors hire labour from households, and sell goods to domestic residents and foreign markets. Monetary policy (or the exchange rate regime) is represented by a domestic interest rate targeting rule set by monetary authority.

The economy is subject to two types of external shocks: foreign demand shocks and world interest rate shocks. The detailed structure of the economy is described below. Where appropriate, foreign currency (dollar) prices are indicated with an asterisk.

2.1 Households

The preference of the representative household is given by:

$$EU = E_t \sum_{s=t}^{\infty} \beta^{s-t}\left[\frac{C_s^{1-\rho}}{1-\rho} - \eta \frac{L_s^{1+\psi}}{1+\psi}\right] \tag{2.1}$$

where C_t is an aggregate consumption index defined across domestic non-traded goods and foreign goods; E_t is the expectation operator conditional on information at time t; β is the discount factor; ρ is the inverse of the elasticity of intertemproal substitution; η is a scale parameter for the disutility of labor supply.

The consumption index C

households. The Cobb-Douglas form of equation (2.2) implies a unit elasticity of substitution between domestic goods and foreign goods in consumption. Given the consumption index, the consumer price index for domestic households can be derived as

$$P_t = P_{Nt}^{1-\alpha} P_{Ft}^{\alpha} \tag{2.3}$$

where P_N and P_F are the prices of domestic non-traded goods and imported foreign goods, respectively.

Households may borrow or lend in domestic or foreign non state-contingent bonds. Trade in foreign bonds is subject to small portfolio adjustment costs. If the household borrows an amount D_{t+1}, then the adjustment cost will be $\frac{\psi_D}{2}(D_{t+1} - \bar{D})^2$ (denominated in the composite good), where $\bar{D}$ is an exogenous steady state level of net foreign debt.[6] The household can borrow in foreign currency bonds at a given interest rate i_t^* , or in domestic currency bonds at an interest rate i_t.

Households own all home firms and therefore receive the profits on non-traded and traded firms. A consumer's revenue flow in any period then comes from the wage income $W_t L_t$, transfers T_t from government, profits from both the non traded sector and the traded sector Π_t, less debt repayment from last period $(1 + i_t^*)S_t D_t + (1 + i_t)B_t$, as well as portfolio adjustment costs. The household then obtains new loans from the domestic and/or international capital market, and uses all the revenue to finance consumption. The budget constraint is thus

$$P_t C_t = W_t L_t + T_t + \Pi_t + S_t D_{t+1} + B_{t+1} - P_t \frac{\psi_D}{2}(D_{t+1} - \bar{D})^2 - (1+i_t^*)S_t D_t - (1+i_t)B_t. \tag{2.4}$$

where S_t is the nominal exchange rate of dollar in terms of peso, D_t is the outstanding amount of foreign-currency debt, and B_t is the stock of domestic currency debt. Note that, i_t^* is the world interest rate and is exogenously given.

The household chooses how much non-traded and imported consumption goods to consume so as to minimize expenditure conditional on total composite demand. Demand for non-traded and imported goods is then

$$C_{Nt} = (1 - \alpha)\frac{P_t C_t}{P_{Nt}}, \qquad C_{Ft} = \alpha \frac{P_t C_t}{P_{Ft}} \tag{2.5}$$

[6] As pointed out by Schmitt-Grohe and Uribe (2003), these portfolio adjustment costs eliminate the unit root problem in the net foreign assets.

The household optimality conditions can be characterized by the following conditions:

$$\frac{1}{1+i^*_{t+1}}\left[1-\frac{\psi_D P_t}{S_t}(D_{t+1}-\bar{D})\right]=\beta E_t\left[\frac{C_t^{\rho}P_t}{C_{t+1}^{\rho}P_{t+1}}\frac{S_{t+1}}{S_t}\right] \tag{2.6}$$

$$\frac{1}{1+i_{t+1}}=\beta E_t\left(\frac{C_t^{\rho}P_t}{C_{t+1}^{\rho}P_{t+1}}\right) \tag{2.7}$$

$$W_t=\eta L_t^{\chi}P_tC_t^{\rho}. \tag{2.8}$$

Equations (2.6) and (2.7) represent the Euler equation for the foreign and domestic bond holdings. Equation (2.8) is the labour supply equation. Combining (2.6) and (2.7) can give interest rate parity condition for this economy.

We assume that the foreign good has a constant price of one in terms of dollar in the world market, [7] therefore, the price of imported foreign goods in terms of domestic currency is simply given by $P_{Ft}=S_t$. As a result, the domestic CPI price index is $P_t=P_{Nt}^{1-\alpha}S_t^{\alpha}$, which implies that exchange rate changes will fully pass through into import price and then the domestic CPI.

2.2 Firms

There are two sectors in this small open economy: non-traded good sector and traded good sector. Firms in these two sector produce differentiated goods and therefore have monopolistic power. Also, all firms face costs of price adjustment. The two sectors differ in their production technologies. Non-traded firms produce output using only labor, while export goods are produced by combining labor and import intermediate(or capital goods).

2.2.1 Non-traded Sector

The non-traded sector is monopolistic competitive and contains a unit interval [0,1] of firms indexed by j. Each firm j produces a differentiated non-traded good, which is imperfect substitute for each other in the production of composite goods Y_N, produced by a representative competitive firm. Aggregate non-traded output is defined using the Dixit and Stiglitz

[7] For convenience, we assume that the price of imported consumption goods in terms of foreign currency is equal to the foreign price level P^*, which is generally normalized as 1.

function

$$Y_{Nt} = \left(\int_0^1 Y_{Nt}(j)^{\frac{\lambda-1}{\lambda}} dj \right)^{\frac{\lambda}{\lambda-1}} \tag{2.9}$$

where λ is the elasticity of substitution between differentiated non-traded goods. Given the above aggregation, the demand for each individual non-traded goods j can be derived as

$$Y_{Nt}(j) = \left(\frac{P_{Nt}(j)}{P_{Nt}}\right)^{-\lambda} Y_{Nt} \tag{2.10}$$

where the price index for the composite non-traded goods P_{Nt} is given by

$$P_{Nt} = \left(\int_0^1 P_{Nt}(j)^{1-\lambda} \right)^{\frac{1}{1-\lambda}} \tag{2.11}$$

Each monopolistically competitive firm has a linear production technology:

$$Y_{Nt}(j) = L_{Nt}(j) \tag{2.12}$$

We follow Rotemberg (1982) in assuming that each firm bears a small direct cost of price adjustment. As a result, firms will only adjust prices gradually in response to a shock to demand or marginal cost. Non-traded firms are owned by domestic households. Thus, a firm will maximize its expected profit stream, using the household's marginal utility as the discount factor. we may define the ob ob ob ob ob 0lJ/F117oo6.33-1.n derived as

When the parameter ψ_{P_N} is zero, firms simply set price as a markup over marginal cost. In general, however, the non-traded goods price follows a dynamic adjustment process.

2.2.2 Traded Sector

It is assumed that there is a unit interval [0,1] of firms indexed by i in the traded sector. They solve a similar maximization problem as firms in the non-traded sector. Each firm i in this sector sells a differentiated export good and aggregate traded good is given by

$$Y_{Tt} = \left(\int_0^1 Y_{Tt}(i)^{\frac{\lambda-1}{\lambda}} di\right)^{\frac{\lambda}{\lambda-1}} \tag{2.15}$$

Export firms, however, face the world market and use different production technology. Each monopolistically competitive firm i imports intermediate goods to produce differentiated good, and re-exports their output to the world market. So there exists the so-called "vertical trade" in this small open economy. The export firms i's production function is given as follows

$$Y_{Tt}(i) = [\alpha_T^{\frac{1}{\theta}} L_{Tt}(i)^{\frac{\theta-1}{\theta}} + (1-\alpha_T)^{\frac{1}{\theta}} IM_t(i)^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} \tag{2.16}$$

where α_T is the share of labor in the trade firms' production, $\theta \geq 0$ is the elasticity of substitution between local labor and import intermediate. When $\theta = 0$, the imported intermediate goods are complementary to the local labor in the production of traded goods. In this special case, the production function can be characterized by a fixed proportional technology or a Leontief technology:

$$Y_{Tt}(i) = \min[\frac{L_{Tt}(i)}{\phi}, IM_t(i)] \tag{2.17}$$

That is, producing one unit of traded good need ϕ units of local labor and one unit of import intermediate goods. In this paper, we will focus on the case where θ is very small or close to zero, so that we can examine how the weak input substitution or complementary input substitution implied by processing trade affects the desirability of exchange rate flexibility in the East Asian emerging economies.

In the general case where $\theta > 0$, the marginal cost MC_{Tt} is given by

$$MC_{Tt} = [\alpha_T W_t^{1-\mu} + (1-\alpha_T)(S_t P_m^*)^{1-\mu}]^{\frac{1}{1-\theta}} \tag{2.18}$$

If $\theta = 0$, then we have

$$MC_{Tt} = \phi W_t + S_t P^*_m \tag{2.19}$$

where P^*_m is the world price of intermediate goods and is assumed to be constant and equal to unity over time.

Since traded sector is monopolistically competitive, each traded firm i sets price in a way similar to the non-traded firms, but export prices can be either in terms of foreign currency or in domestic currency. We assume that of one unit of trade firms, $(1 - \kappa)$ are priced in domestic currency and κ in foreign currency.

Therefore, if firm i chooses its price in foreign currency, then its profit maximization problem is given by:

$$E_t \sum_{l=0}^{\infty} \beta^l \Gamma_{t+l} \left[S_t P^*_{TFt+l}(i) Y_{TFt+l}(i) - MC_{Tt+l} Y_{TFt+l}(i) - \frac{\psi_{P_T}}{2} P_{t+l} \left(\frac{P^*_{TFt+l}(i) - P^*_{TFt+l-1}(i)}{P^*_{TFt+l-1}(i)}\right)^2 \right], \tag{2.20}$$

subject to

$$Y_{TFt}(i) = \left(\frac{P^*_{TFt}(i)}{P^*_{Tt}}\right)^{-\lambda} Y_{Tt} = \left(\frac{P^*_{TFt}(i)}{P^*_{Tt}}\right)^{-\lambda} \left(\frac{P^*_{T_t}}{P^*}\right)^{-\mu} X_t \tag{2.21}$$

where $P^*_{TFt+l}(i)$ and $Y_{TFt+l}(i)$ represent the foreign currency price and output of traded good firm i which sets price in foreign currency. Y_{Tt} represents the aggregate output of domestically produced traded goods; P^*_{Tt} is the price index for all home produced export goods sold in the world market (will be defined later); P^* is the price level of final goods in the world market.[9] The demand structure implies that export firms' own elasticity of demand is also λ, where $\lambda > 1$. And the elasticity of substitution between aggregate home-produced traded goods and foreign goods is μ. Finally, X_t is the foreign demand shock.

If firm i sets its price in domestic currency, then its profit maximization problem is given by

$$E_t \sum_{l=0}^{\infty} \beta^l \Gamma_{t+l} \left[P_{TDt+l}(i) Y_{TDt+l}(i) - MC_{Tt+l} Y_{TDt+l}(i) - \frac{\psi_{P_T}}{2} P_{t+l} \left(\frac{P_{TDt+l}(i) - P_{TDt+l-1}(i)}{P_{TDt+l-1}(i)}\right)^2 \right], \tag{2.22}$$

subject to

$$Y_{TDt}(i) = \left(\frac{P_{TDt}(i)}{S_t P^*_{Tt}}\right)^{-\lambda} Y_{Tt} = \left(\frac{P_{TDt}}{S_t P^*_{Tt}}\right)^{-\lambda} \left(\frac{P^*_{T_t}}{P^*}\right)^{-\mu} X_t \tag{2.23}$$

[9] Without loss of generality, let P^*_{Tt} and P^* be denominated in dollars.

where $P_{TDt+l}(i)$ and $Y_{TDt+l}(i)$ represent the domestic currency price and output of traded good firm i which sets price in domestic currency.

Imposing symmetry, we may get the optimal price setting equation for P^*_{TFt} as:

$$\begin{aligned} P^*_{TFt} &= \frac{\lambda}{\lambda - 1}\frac{MC_{Tt}}{S_t} - \frac{\psi_{P_T}}{\lambda - 1}\frac{1}{S_t}\frac{P_t}{Y_{TFt}}\frac{P_{TFt}}{P_{TFt-1}}\left(\frac{P_{TFt}}{P_{TFt-1}} - 1\right) + \\ &\quad \frac{\psi_{P_T}}{\lambda - 1}E_t\left[\beta\frac{1}{S_t}\frac{C_t^{\rho}P_t}{C_{t+1}^{\rho}P_{t+1}}\frac{P_{t+1}}{Y_{TFt}}\frac{P_{TFt+1}}{P_{TFt}}\left(\frac{P_{TFt+1}}{P_{TFt}} - 1\right)\right]. \end{aligned} \tag{2.24}$$

Similarly, we may get the optimal price setting equation for P_{TDt} as:

$$\begin{aligned} P_{TDt} &= \frac{\lambda}{\lambda - 1}MC_{Tt} - \frac{\psi_{P_T}}{\lambda - 1}\frac{P_t}{Y_{TDt}}\frac{P_{TDt}}{P_{TDt-1}}\left(\frac{P_{TDt}}{P_{Tt-1}} - 1\right) \\ &\quad + \frac{\psi_{P_T}}{\lambda - 1}E_t\left[\beta\frac{C_t^{\rho}P_t}{C_{t+1}^{\rho}P_{t+1}}\frac{P_{t+1}}{Y_{TDt}}\frac{P_{TDt+1}}{P_{TDt}}\left(\frac{P_{TDt+1}}{P_{TDt}} - 1\right)\right] \end{aligned} \tag{2.25}$$

where Y_{TFt} and Y_{TDt} are given as below

$$Y_{TFt} = (\frac{P^*_{TFt}}{P^*_{Tt}})^{-\lambda}(\frac{P^*_{T_t}}{P^*})^{-\mu}X_t, \qquad Y_{TDt} = (\frac{P_{TDt}}{S_tP^*_{Tt}})^{-\lambda}(\frac{P^*_{T_t}}{P^*})^{-\mu}X_t, \tag{2.26}$$

and P^*_{Tt} represents the price index of these goods, which is given by

$$P^*_{T_t} = [\kappa {P^*_{TFt}}^{1-\lambda} + (1 - \kappa)(\frac{P_{TDt}}{S_t})^{1-\lambda}]^{\frac{1}{1-\lambda}} \tag{2.27}$$

2.3 Monetary Policy Rules

The monetary authority uses a short-term domestic interest rate as monetary instrument. The general form of the interest rate rule may be written as

$$1 + i_{t+1} = \left(\frac{P_{Nt}}{P_{Nt-1}}\frac{1}{\bar{\pi}_n}\right)^{\mu_{\pi_n}}\left(\frac{S_t}{\bar{S}}\right)^{\mu_S}(1 + \bar{i}). \tag{2.28}$$

The parameter μ_{π_n} allows the monetary authority to control the inflation rate in the non-traded goods sector around a target rate of $\bar{\pi}_n$. μ_S controls the degree to which monetary authority attempts to control variations in the exchange rate, around a target level of $\bar{S}$. The general form of the interest rule (2.28) allows for two types of monetary policy stances. The first rule is one whereby the monetary authority targets the inflation rate of non-traded goods (NTP rules), so that $\mu_{\pi_N} \to \infty$. This is analogous to a domestic inflation targeting rule. The exchange rate is flexible under such a rule, so this rule also represents a flexible exchange rate regime. The second one we analyze is a simple fixed exchange rate rule (FER rules) by setting $\mu_s \rightarrow \infty$, whereby the monetary authority adjusts interest rates so as to keep the nominal exchange rate fixed at the target level $\bar{S}$.[10] Note that the form of our monetary rules is sightly different from that used by Devereux, Lane, and Xu (2006). We does not consider the consumer price inflation targeting (CPI) as a policy option in our model. This because, with high exchange rate pass-through and the price rigidity in the non-traded sector in this economy, a CPI inflation targeting rule is almost equivalent to a fixed exchange rate rule.

2.4 External Shocks

There are two shocks in this economy, the world interest rate shock i_t^* and the foreign demand shock X_t. We assume that the log of gross world interest rate $1 + i_t^*$ follows a AR(1) stochastic process given by

$$log(1 + i_{t+1}^*) = (1 - \rho_R) log(1 + \bar{r}) + \rho_R log(1 + i_t^*) + \epsilon_{i^*t} \tag{2.29}$$

with $0 < \rho_R < 1$ and the serially uncorrelated shock ϵ_{i^*t} is normally distributed with mean zero and variance $\sigma_{i^*}^2$. Meanwhile, the foreign demand X_t is assumed to follow a stochastic process

$$log(X_t) = (1 - \rho_X) log(\bar{X}) + \rho_X log(X_{t-1}) + \epsilon_{xt} \tag{2.30}$$

where $0 < \rho_X < 1$ and the serially uncorrelated shocks ϵ_{xt} is normally distributed with mean zero and variance σ_X^2.

2.5 Equilibrium

In equilibrium, besides the optimality conditions for firms and households, we have the following labor market, goods market, and bonds market clearing conditions.[11]

$$L_{Nt} + L_{Tt} = L_t \tag{2.31}$$

where $L_{Tt} = \alpha_T (\frac{W_t}{MC_{Tt}})^{-\mu} Y_{Tt}$.

[10] In numerical exercise, we set μ_{π_N} = 900 and μ_s = 900 for the NTP rule and the FER rule, respectively. In each case, we set policy so that the equilibrium is determinate.

[11] The details of the equilibrium conditions are given in the technical appendix.

The non-traded goods market clear condition is given by

$$Y_{Nt} = (1 - \alpha)\frac{P_t Z_t}{P_{Nt}} \tag{2.32}$$

where Z_t is the aggregate expenditure, which includes consumption, the foreign bond adjustment cost, and the price adjustment cost for traded and non-traded firms.

$$Z_t = C_t + \frac{1}{2}\psi_{p_N}(\frac{P_{Nt}}{P_{Nt-1}} - 1)^2 + \frac{\kappa}{2}\psi_{p_T}(\frac{P^*_{TFt}}{P^*_{TFt-1}} - 1)^2 + \frac{1-\kappa}{2}\psi_{p_T}(\frac{P_{TDt}}{P_{TDt-1}} - 1)^2 + \frac{1}{2}\psi_D(D_{t+1} - \bar{D})^2 \tag{2.33}$$

For the traded goods market, we have $Y_{Tt} = (\frac{P^*_{T_t}}{P^*})^{-\imath} X_t$, which implies that the aggregate output in the traded sector is determined by the foreign demand X_t and the relative prices of the domestic export goods.

In a symmetric equilibrium, the representative household's domestic bond holding $B_t = 0$. Therefore, using equation (2.33), we can rewrite the household's budget constraint as

$$S_t P^*_{Tt} Y_{T_t} - \alpha P_t Z_t - S_t P^*_m IM_t + S_t D_{t+1} - (1 + i^*_t) S_t D_t = 0. \tag{2.34}$$

This is a balance of payment condition, where trade surplus will be affected by the import for both the consumption goods $\alpha P_t Z_t$ and intermediate inputs $S_t P^*_m IM_t$.

3 The Dynamics of Model

This section discusses impulse responses of key aggregate variables to external shocks. This can help to highlight the transmission mechanisms of external shock in a small open economy characterized by the two features we emphasized - weak input substitution and extensive use offoreign currency pricing. We consider two types of external shocks: a) shocks to the world interest rate, which is represented by shocks to i^*_t; and b) foreign demand shock, which is represented by shocks to X_t.

3.1 Calibration

The parameters that need to be calibrated in our model are listed in Table 1. The coefficient of risk aversion ρ, is set to 2 as is commonly assumed in the literature. The discount factor β is calibrated at 0.99, so that the steady state annual real interest rate is 4%. The elasticity

Table 1: Calibration Parameters

Parameters	value	Parameters	value	Parameters	value
ρ	2	β	0.99	α	0.4
λ	11	α_T	0.3	κ	[0,1]
ψ	1	ϕ_D	0.0007	μ	1
σ_ϵ	1%	θ	[0,2]	η	1
ϕ_{P_N}	120	ϕ_{P_T}	105		

of labor supply $\frac{1}{A}$ is set to unity, following Christiano et. al (1997). The elasticity of substitution across individual export goods λ is chosen to be 11, which implies a steady state markup of 10%. This is equal to the common value found by Basu and Fernald (1997).[12] The elasticity of substitution between aggregate home-produced trade goods and foreign goods μ is set to unity. We set α_T=0.3, so that the share of labor in the production of trade goods is equal to that estimated in Cook and Devereux (2006) for Malaysia and Thailand. α is set to 0.4, which implies that the share of non-traded goods in the consumer price index equals 0.6. This is close to the evidence cited in Schmitt-Grohe and Uribe (2000) for Mexico, and by Cook and Devereux (2006) for Malaysia and Thailand. With $\alpha = 0.4$ and $\alpha_T = 0.3$, the total expenditure on imported goods (including the imported consumption goods and intermediate inputs) is about half of the GDP. [13]

Ortega and Rebei (2006) show that that price rigidity differs in different sector. Prices are more rigid in the non-traded sector than in the traded sector. Therefore, to determine the degree of nominal rigidity in the model, we set the parameters governing the cost of adjustment in the non-traded sector and traded sector as $\phi_{P_N} = 120$ and $\phi_{P_T} = 105$, respectively, which give us a implied Calvo price adjustment probability of approximately 0.80[14] and 0.70, respectively. This is consistent with the standard estimates used in the

[12] As pointed out by Cook and Devereux (2001), markups are usually higher in emerging markets, so they choose λ = 6. But for the processing trade ¯rms, the pro¯t margin is lower than others, so we still choose λ = 11 in this model.

[13] We set η = 1 as it is only a scale parameter in our model.

[14] That is, if the model is interpreted as being governed by the dynamics of the standard Calvo price adjustment process, ¯rms in the non-traded sector will adjust prices on average after 5 quarters.

literature that prices usually adjust on average after 4 quarters. As to the parameter related to the bond adjustment cost, we follow Schmitt-Grohe and Uribe (2003) and set $\phi_D = 0.0007$.

The elasticity of substitution between local labor and import intermediate in the traded sector (θ) and the degree of foreign currency pricing (κ) are important in determining the dynamics of the model. In our benchmark model, we will set $\theta = 0.01$ [15] and $\kappa = 1$. The values of these parameters can capture the facts in East Asian emerging market economies, that is, low elasticity of input substitution in traded sector and the wide use of foreign currency pricing in export pricing. Later, when we discuss the welfare analysis, we will consider a wide range of values of these two parameters and highlight their importance in determining the desirability of exchange rate flexibility.

For those parameters related to external shocks, we set $\rho_R = 0.54$, $\sigma_{i^*} = 0.007$, $\rho_X = 0.70$, and $\sigma_X = 0.0044$. The values of these parameters are close to empirical estimates from Devereux, Lane, and Xu (2006), Uribe and Yue (2006), and Ortega and Rebei (2006).

3.2 Impulse Response Function

Now we analyze the impact of shocks under a NTP rule and a FER rule (fixed exchange rate rule) in our benchmark model ($\theta = 0.01$ and $\kappa = 1$). The illustrations are divided into categories of real variables (namely, consumption C; employment L; non-traded employment L_N; and traded output Y_T) and those of nominal variables (namely, CPI price P; exchange rate S; marginal cost of traded goods MC_T; price for export goods in dollars P_T^*; non-traded price P_N).

3.2.1 Interest Rate Shocks

Figure 1 and 2 illustrate the effects of a world interest rate shock. The responses of variables are in terms of percentage deviation from their steady sate values to a one-period 100 basic points increase to the world interest rate.

[15] The case with $\theta = 0.01$ is close to the one with ¯xed proportional (Leontief) technology, where local labor is complementary with the imported intermediate goods. Later, when we set $\theta = 0.99$, this will be close to the case which represents a standard Cobb-Douglas technology with unitary input substitution elasticity.

The NTP rule allows for exchange rate movement. When the foreign interest rate increases, the nominal exchange rate depreciates. Due to the full exchange rate pass-though into the consumer price and traded firms' marginal cost, this depreciation generates a large initial burst of inflation and a sharp increase in traded firms' marginal cost. The aggregate inflation rises, as a result, the aggregate demand (consumption) decreases, which in turn decreases the demand for non-traded goods. Nevertheless, because of the expenditure-switching effect of exchange rate, the substitution between non-traded goods and imported consumption goods will lead to an increase of the demand for non-traded goods. In total, the substitution effect dominates the income effect, so the output of non-traded goods rises. In the traded sector, due to the presence of foreign currency pricing, the nominal exchange rate depreciation does not cause a large change in export volume and prices. Meanwhile, given the low input substitution in traded sector, the increase of traded labor is very small, though the total labor increase sharply.

The interest rate shock tends to be contractionary under the FER rule. As the FER rule prevents a nominal exchange rate depreciation, the domestic nominal and real interest rate will become the shock-absorber and increase, which leads to the contraction of the real variables. The consumption falls more than under the NTP rule, and now the non-traded sector output decreases as well because there is no expenditure-switching effect. Therefore, the non-traded good prices will decrease and so will the wage. For the traded sector, the response of output, prices, labor are similar to those under the NTP rule except the change of marginal cost of traded goods. Under the NTP rule MC_T increases since the nominal exchange rate depreciate. But under the FER rule, MC_T decreases because wage decreases.

From Figure 1 and 2, we can find that when the economy is constrained by the weak input substitution and foreign currency pricing of export goods, allowing for the exchange rate movement cannot stabilize real variables, such as consumption and employment. Instead, it causes large fluctuation in nominal variables, especially in inflation.

3.2.2 Foreign Demand Shocks

Figure 3 illustrates the effects of a persistent positive shock to the foreign demand. Under the NTP rule, the shock will lead to a nominal exchange rate appreciation. Since the export goods are priced in foreign currencies, the exchange rate adjustment cannot help to stabilize the demand. So the aggregate output in traded sector will bear the foreign demand shock fully. With low input substitution in the traded sector, the traded labor increases sharply as well. The expansion in trade sector generates a persistent increase in aggregate consumption followed by an initial fall, though these changes are very small. To respond to the expansion in traded sector, non-traded sector shrinks, output and employment decline. Nevertheless, the total labor still increases, as the impact of the shock on traded sector is much larger than that on non-traded sector. As to the nominal variables, the exchange rate appreciation leads to a decrease of inflation and the marginal cost of traded goods.

Figure 4 shows that, under the FER rule, the response of traded output and traded price are exactly the same as those under the NTP rule. Because there is no exchange rate movement, the responses of aggregate consumption and employment are different from those under the NTP rule. They both increase sharply, then return to the initial level quickly. In addition, we also can find that the fluctuation of CPI price and marginal cost are smaller than those under the NTP rule again. Note that MC_T increases under the FER rule because wage (non-traded price) increases.

In summary, the effects of the foreign demand shock are different from those of the interest rate shock. However, similar to the interest rate shock case, we find that given the weak input substitution and foreign currency pricing of export goods, the adjustment role of exchange rate movement is weakened. Allowing for exchange rate fluctuation cannot stabilize real variables, such as consumption and employment. Instead, it causes larger fluctuation in nominal variables, especially in inflation.

In the next section, we will investigate the implication of weak input substitution and foreign currency pricing on welfare ranking between the NPT rule and FER rule and check if a FER rule can dominate a NTP rule in terms of welfare.

4 Welfare Analysis

In this section, we discuss welfare properties of monetary rules in the economy. The welfare measurement we use here is the conditional expected lifetime utility of the representative

Table 2: Welfare Comparison (%)

	$\kappa = 1$	$\kappa = 0$
$\theta = 0.01$	$(\xi_{NTP} = 0.841, \xi_{FER} = 0.845)$	$(\xi_{NTP} = 1.020, \xi_{FER} = 0.845)$
$\theta = 0.99$	$(\xi_{NTP} = 0.316, \xi_{FER} = 0.304)$	$(\xi_{NTP} = 0.338, \xi_{FER} = 0.304)$

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 policy regimes.[16] To measure the magnitude of 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:

$$\frac{\frac{1}{1-½}[(1+\zeta_k)\bar{C}]^{1-½} \; i \; \frac{´}{1+\tilde{A}}\bar{L}^{1+\tilde{A}}}{1} \quad \text{con-}$$

To highlight the importance of both factors in determining the welfare ranking between the NTP rule and the FER rule, we do two welfare experiments. The results are given in Figure 5 and 6.

Figure 5 describes welfare changes under both the NTP rule and the FER rule when the degree of foreign currency pricing κ increases, given $\theta = 0.01$.[19] This figure shows that the welfare under the NTP rule decreases with κ, while the welfare under the FER rule does not vary with κ. The intuition is as follows, when κ increases, the degree of foreign currency pricing increases, which reduces the role of exchange rate adjustment in stabilizing export demand under the NPT rule. So the welfare under the NPT rule decreases with κ. Under the FER rule, pricing in terms of foreign or domestic currency does not matter any more, so the welfare under FER rule will not change when κ increases. That is, the impact of changes of κ on welfare under the NTP rule and the FER rule are different. Given low input substitution ($\theta = 0.01$), if κ is not too big, a NTP rule delivers higher welfare than a FER rule. However, when κ is big enough, the welfare ranking between them is reversed and the FER rule dominates.

Figure 6 reports changes of welfare differential between the NTP rule and the FER rule when θ increases, given $\kappa = 1$. As θ increases, the steady state also changes. Therefore, we can only compare the welfare differential between the two rules, but not the welfare for different values of θ. In Figure 6, there is no monotonic relation between welfare differential and θ. A low θ leads to a negative welfare differential, which implies the FER rule dominates the NPT rule in terms of welfare. Obviously, when inputs have low substitutability, the expenditure-switching role of exchange rate adjustment on input substitution is limited. So given extensive use of foreign currency pricing, the FER rule is better.

However, we can also see from Figure 6 that when θ increases, the welfare differential between the NPT rule and FER rule first increases, then declines. This is because when the elasticity of input substitution becomes too high, the exchange rate changes will lead to excess fluctuation of real variables, which also hurts the desirability of exchange rate flexibility. Nevertheless, for empirically relevant parameterizations ($\theta \in [0, 2]$), we can only

[19] Note that in this welfare experiment, the change of κ does not affect the steady state. So welfare results are comparable even when κ changes.

get a negative welfare differential when θ is quite small. For other reasonable values of θ, welfare ranking reversal.

In summary, our paper provides a rationale for the so-called "fear of floating" phenomenon. Different from other works in the "fear of floating" literature, we focus on how the trade structure features in East Asian economies, instead of financial conditions, affect the choices of exchange rate policy.

5 Conclusion

Most East Asian economies choose pegged exchange rate regimes or control exchange rate movements. The literature usually attributes this " fear of floating" to the balance-sheet effect or financial fragility in these economies. In this paper, we provide a new explanation for this phenomenon. We argue that two trade structure features in these economies can help to explain the lack of exchange rate flexibility in these economy. Specifically, weak input substitution in traded goods production and extensive use of foreign currency in export pricing inhibit the adjustment role of exchange rate in face of external shocks. A flexible exchange rate regime does not help to stabilize the real variables, but leads to more fluctuations in nominal variables, especially the inflation. Hence, allowing the exchange rates to float is not desirable in these economies. To explore our explanation, we develop a small open economy stochastic general equilibrium model with sticky prices. We compare welfare of alternative monetary policy rules and show that a fixed exchange rate rule can welfare-dominate a flexible exchange rate rule. Therefore, we argue that "fear of floating"

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Technical Appendix

Not to be Published

A Equilibrium Condition

Household

$$P_t = P_{Nt}^{1-\alpha} S_t^{\alpha} \tag{A.1}$$

$$C_{Nt} = (1 - \alpha)\frac{P_t C_t}{P_{Nt}} \tag{A.2}$$

$$C_{Ft} = \alpha \frac{P_t C_t}{S_t} \tag{A.3}$$

$$\frac{1}{1+i^*_{t+1}}\left[1 - \frac{\psi_D P_t}{S_t}(D_{t+1} - \bar{D})\right] = \beta E_t \left[\frac{C_t^{\rho} P_t}{C_{t+1}^{\rho} P_{t+1}} \frac{S_{t+1}}{S_t}\right] \tag{A.4}$$

$$\frac{1}{1+i_{t+1}} = \beta E_t \left(\frac{C_t^{\rho} P_t}{C_{t+1}^{\rho} P_{t+1}}\right) \tag{A.5}$$

$$W_t = \eta L_t^{\psi} P_t C_t^{\rho}. \tag{A.6}$$

Non-traded Sector

$$Y_{Nt} = L_{Nt} \tag{A.7}$$

$$\begin{aligned} P_{Nt} \;=\; & \frac{\lambda}{\lambda - 1} W_t - \frac{\psi_{P_N}}{\lambda - 1} \frac{P_t}{Y_{Nt}} \frac{P_{Nt}}{P_{Nt-1}} \left(\frac{P_{Nt}}{P_{Nt-1}} - 1\right) + \\ & \frac{\psi_{P_N}}{\lambda - 1} E_t \left[\beta \frac{C_t^{\rho} P_t}{C_{t+1}^{\rho} P_{t+1}} \frac{P_{t+1}}{Y_{Nt}} \frac{P_{Nt+1}}{P_{Nt}} \left(\frac{P_{Nt+1}}{P_{Nt}} - 1\right)\right]. \end{aligned} \tag{A.8}$$

Traded Sector

$$MC_{Tt} = [\alpha_T W_t^{1-\mu} + (1 - \alpha_T)(S_t P_m^*)^{1-\mu}]^{\frac{1}{1-\theta}} \tag{A.9}$$

$$P_{T_t}^* = [\kappa P_{TFt}^{*\,1-\lambda} + (1 - \kappa)(\frac{P_{TDt}}{S_t})^{1-\lambda}]^{\frac{1}{1-\lambda}} \tag{A.10}$$

$$L_{Tt} = \alpha_T (\frac{W_t}{MC_{Tt}})^{-\mu} Y_{Tt} \tag{A.11}$$

$$IM_t = (1 - \alpha_T)(\frac{S_t P_m^*}{MC_{Tt}})^{-\mu} Y_{Tt} \tag{A.12}$$

$$Y_{TFt} = (\frac{P_{TFt}}{P^*_{Tt}})^{-\lambda} Y_{Tt} \tag{A.13}$$

$$Y_{TDt} = (\frac{P_{TDt}}{S_t P^*_{Tt}})^{-\lambda} Y_{Tt} \tag{A.14}$$

$$\begin{aligned} P^*_{TFt} \quad = \quad & \frac{\lambda}{\lambda - 1}\frac{MC_{Tt}}{S_t} - \frac{\psi_{P_T}}{\lambda - 1}\frac{1}{S_t}\frac{P_t}{Y_{TFt}}\frac{P_{TFt}}{P_{TFt-1}}\left(\frac{P_{TFt}}{P_{TFt-1}} - 1\right) + \\ & \frac{\psi_{P_T}}{\lambda - 1}E_t\left[\beta\frac{1}{S_t}\frac{C_t^{\rho}P_t}{C_{t+1}^{\rho}P_{t+1}}\frac{P_{t+1}}{Y_{TFt}}\frac{P_{TFt+1}}{P_{TFt}}\left(\frac{P_{TFt+1}}{P_{TFt}} - 1\right)\right]. \end{aligned} \tag{A.15}$$

$$\begin{aligned} P_{TDt} \quad = \quad & \frac{\lambda}{\lambda - 1}MC_{Tt} - \frac{\psi_{P_T}}{\lambda - 1}\frac{P_t}{Y_{TDt}}\frac{P_{TDt}}{P_{TDt-1}}\left(\frac{P_{TDt}}{P_{Tt-1}} - 1\right) \\ & + \frac{\psi_{P_T}}{\lambda - 1}E_t\left[\beta\frac{C_t^{\rho}P_t}{C_{t+1}^{\rho}P_{t+1}}\frac{P_{t+1}}{Y_{TDt}}\frac{P_{TDt+1}}{P_{TDt}}\left(\frac{P_{TDt+1}}{P_{TDt}} - 1\right)\right] \end{aligned} \tag{A.16}$$

Market Clearing Condition

$$L = L_{Nt} + L_{Tt} \tag{A.17}$$

$$Z_t = C_t + \frac{1}{2}\psi_{p_N}(\frac{P_{Nt}}{P_{Nt-1}} - 1)^2 + \frac{\kappa}{2}\psi_{p_T}(\frac{P^*_{TFt}}{P^*_{TFt-1}} - 1)^2 + \frac{1-\kappa}{2}\psi_{p_T}(\frac{P_{TDt}}{P_{TDt-1}} - 1)^2 + \frac{1}{2}\psi_D(D_{t+1} - \bar{D})^2 \tag{A.18}$$

$$Y_{Nt} = (1 - \alpha)\frac{P_t Z_t}{P_{Nt}} \tag{A.19}$$

$$Y_{Tt} = (\frac{P^*_{T_t}}{P^*})^{-\mu} X_t \tag{A.20}$$

,

$$S_t P^*_T Y_{Tt} - \alpha P_t Z_t - S_t P^*_m IM_t + S_t D_{t+1} - (1 + i^*_t) S_t D_t = 0. \tag{A.21}$$

$$1 + i_{t+1} = \left(\frac{P_{Nt}}{P_{Nt-1}}\frac{1}{\bar{\pi}_n}\right)^{\mu_{\pi_n}}\left(\frac{S_t}{\bar{S}}\right)^{\mu_S}(1 + \bar{i}). \tag{A.22}$$

Stochastic Process

$$log(X_t) = (1 - \rho_x) log(\bar{X}) + \rho_x log(X_{t-1}) + \epsilon_{xt} \tag{A.23}$$

$$log(1 + i^*_{t+1}) = (1 - \rho_R) log(1 + \bar{r}) + \rho_R log(1 + i^*_t) + \epsilon_{i^*t} \tag{A.24}$$

Figure 1: Impulse Response to $+i^*$ shock under NTP Rule

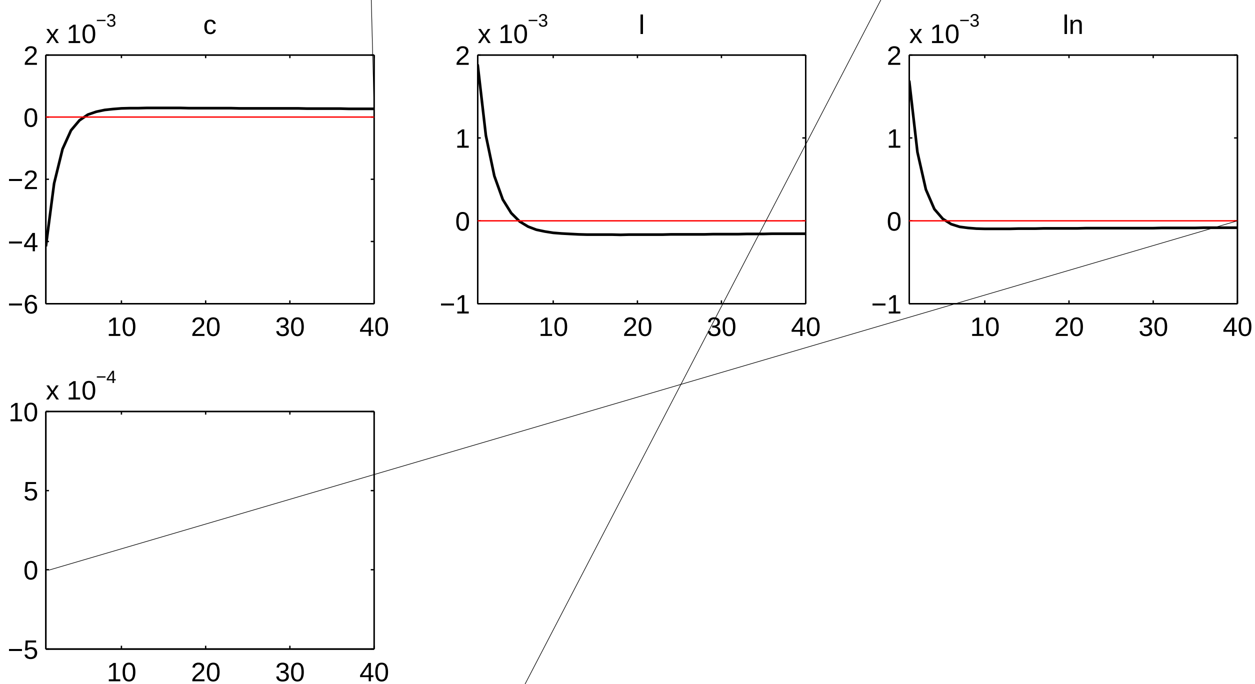

Figure 2: Impulse Response to $+i^*$ shock under FER rule

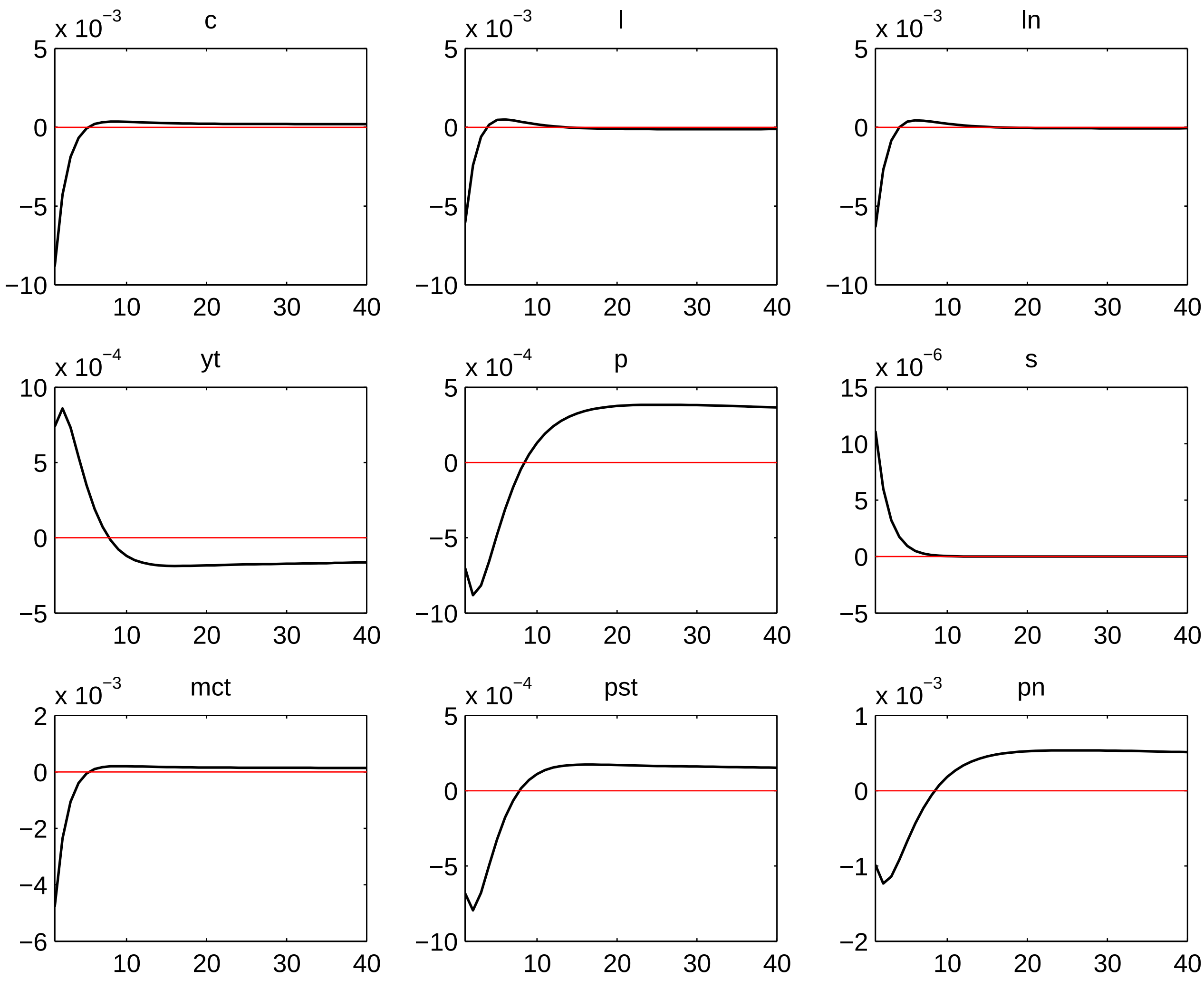

Figure 3: Impulse Response to $+X$ shock under NTP rule

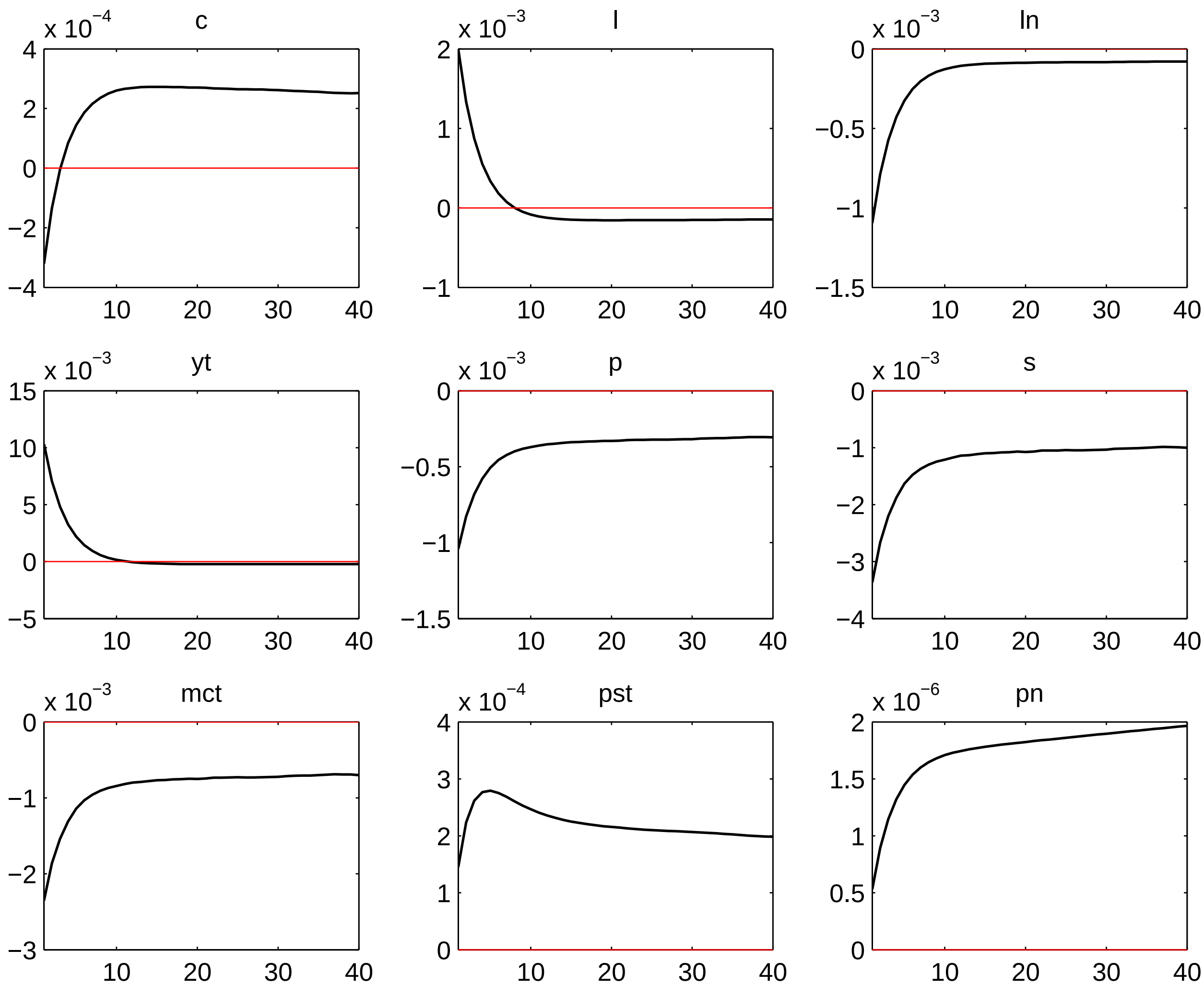

Figure 4: Impulse Response to $+X$ shock under FER rule

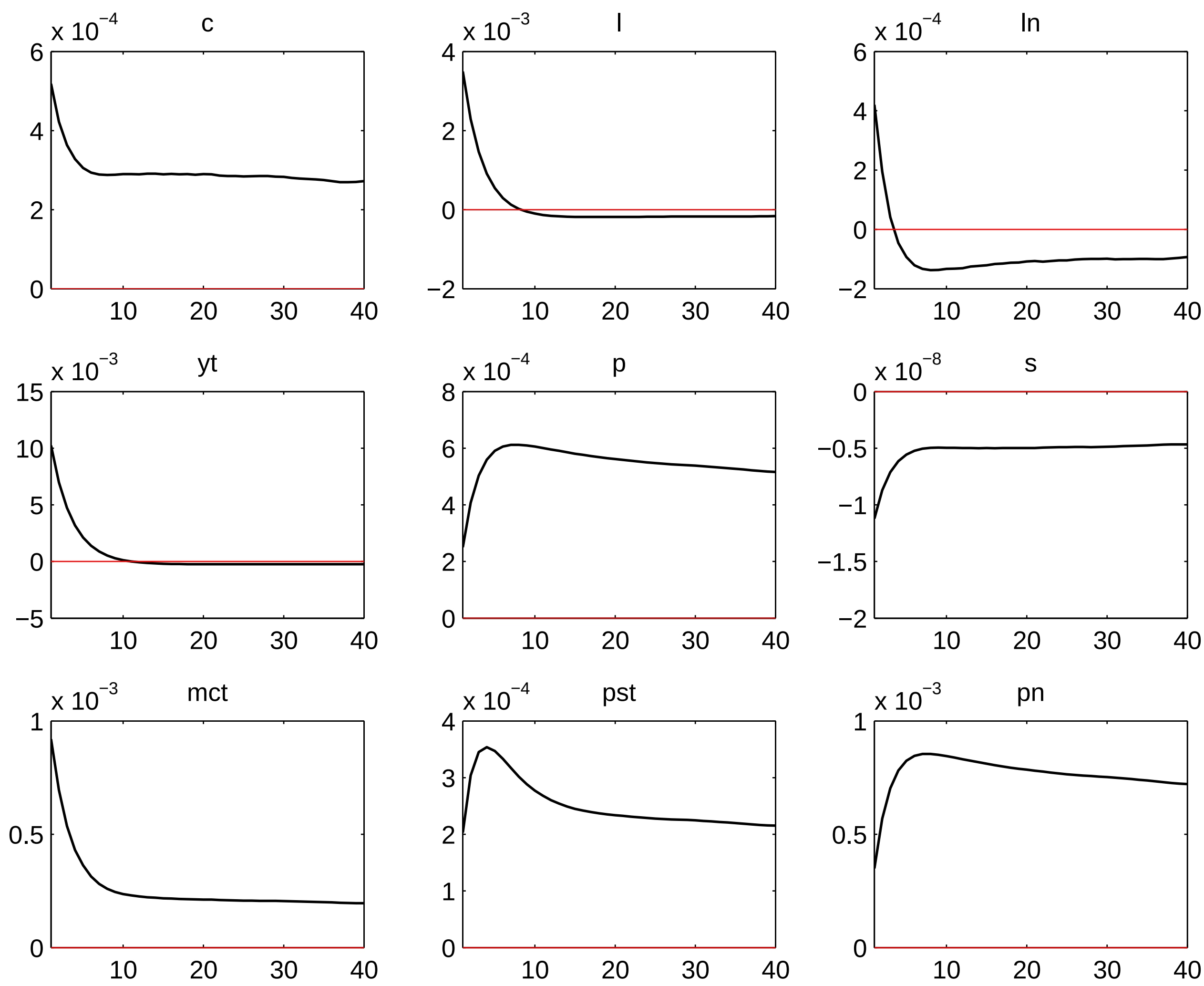

Figure 5: Welfare under NTP and FER rules when κ changes ($\theta = 0.01$)

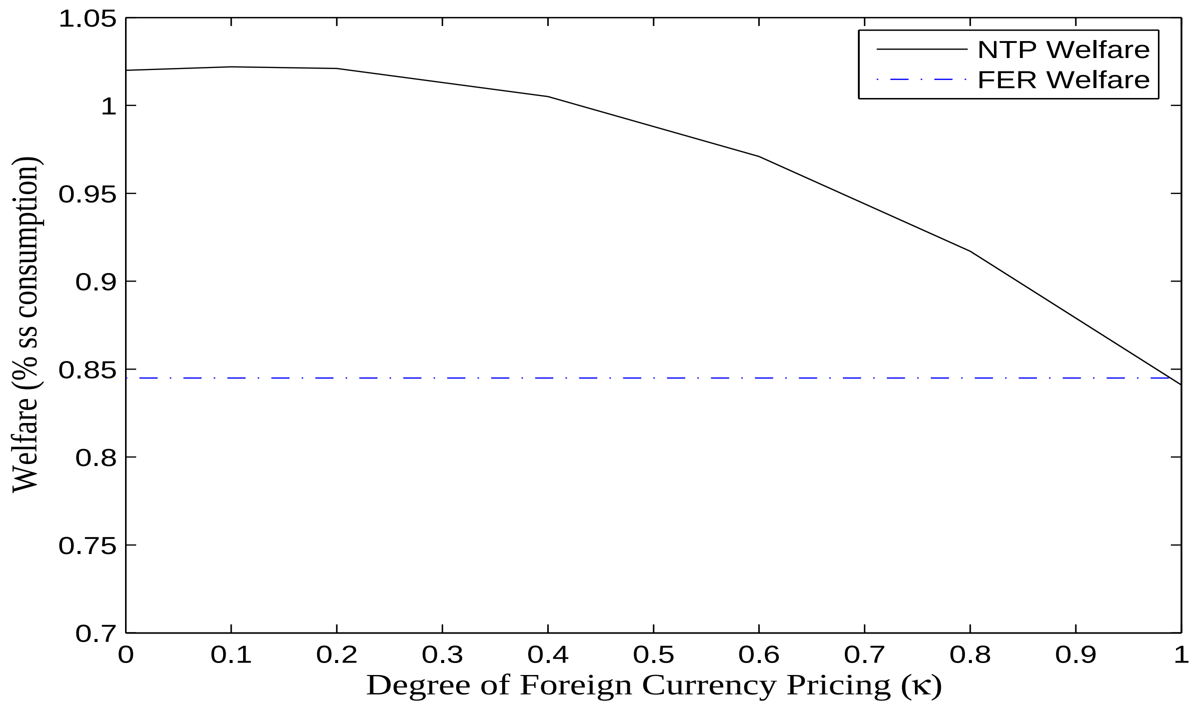

Figure 6: Welfare Di®erential between NTP and FER rules when θ changes($\kappa = 1$)