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Original Paper

Economic Development under Persistent Currency Intervention

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Abstract

During the recent two decades, the spectacular economic growth of China has been under increasing scrutiny in the literature. However, prevailing discourses have either evaluated the causes/effects of the RMB exchange rate misalignment or theorized the investment/speculation channels. The implication of this persistent currency intervention (CI) regime on economic development, in comparison, remains one of the most contentious subjects in international economics. To shed light on this issue, this research develops a new macroeconomic model to address the two core attributes of China's persistent CI: the stagnant adjustment of the capital markets and the fast liberalization of the commodity markets. It investigates the impacts of macroeconomic controls on output growth and price levels from multiple aspects. It also makes several interesting discoveries in opposition to key postulations of existing macroeconomic models.

Keywords

economic development, monetary policy, foreign exchange

1. Introduction

The previous three decades have witnessed dramatic changes in China's macroeconomic policies. Before 1994, the Chinese foreign exchange (FX) markets developed in a dual-track system where official and swap-market exchange rates coexisted to settle trade-related and black-market transactions. In 1994, however, the People's Bank of China (PBoC, the central bank) abolished the then prevailing swap markets and initiated a rigorous currency intervention (CI) policy. Under this new policy, non-state entities were merely permitted to hold stipulated quantities of foreign currencies in their accounts. Any extra amounts must be sold to the PBoC at the official exchange rates (Note 1). Meanwhile, the PBoC adopted a stringent monetary policy to sterilize the mounting foreign assets in its balance sheet. It also maintained draconian controls on external financial accounts and domestic interest rates to insulate speculative attacks against China's financial system (Neftci & Menager-Xu, 2006; Goldstein, 2009; Lombardi & Wang, 2016).

Alongside with CI, the Chinese authority rolled out a series of profound fiscal reforms in the early 1990s to liberalize domestic commodity markets and join the World Trade Organization. Since then, the Chinese commodity markets system has developed rapidly. Now China has grown into a vital hub of global manufacture and trading network. According to the International Monetary Fund, China's share of global GDP surged 9 fold, from 2.0% in 1994 to 17.7% in 2020. China also overtook the United States to become the world's largest goods trading nation since 2013.

In advanced economies, commodity prices rarely adjust as swiftly as financial instruments. This makes nominal rigidity of goods prices a standard setting in theorizing dynamic economies (Dornbusch, 1976; Calvo, 1983; Temple, 2002; Smets & Wouters, 2003; and Drazen, 2003). In China, however, the underdevelopment of the financial system and the liberalization of the commodity markets would call for substantial challenge to this supposition. For example, Eichengreen and Kawai (2014) points out that exporters and importers might use "leads and lags" strategies in trade invoicing and settlement to evade financial restrictions.

So far, numerous surveys have examined the financial frictions in China during CI (Note 2). The potential incompatibility of the nominal rigidity setting with persistent CI, in comparison, has not received intense scrutiny in the literature. This paper sheds light on this issue by developing a new macroeconomic model to theorize the sluggish adjustment of capital markets and the fast liberalization of commodity markets.

In particular, it assumes that the nominal interest rate is exogenous in the system.

The expected inflation rate is the fundamental impetus that drives the financial market equilibrium. The paper also employs a series of auto-regressive and cross-effect parameters of the model to proxy the commodity price rigidity/flexibility levels.

After establishing the conceptual model, the paper further explores the stability condition of the system and delve into its implications of structural changes and impulse variations for economic development. Results show that the system is stable if and only if the price sensitivity to the output change is higher in the output- adjustment equilibrium than that in the price-adjustment equilibrium. In the short- run, expansionary fiscal policies could raise outputs while deflate prices, while monetary controls involve tradeoffs between high productivity and low inflation. From the long-run perspective, however, specific monetary policies, such as interest rate reduction and monetary contraction, would elicit economic upturns.

The organization of the paper is as follows. First, it develops the CI model, analyzes the short-run effects of structural changes, and inspects the stability condition of the system in Section 2. After that, it further explores the long-run ramifications of structural changes and transitory shocks on the economy in Section 3. Section 4 presents the concluding remarks of the paper.

2. The Model

Consider a growing economy in which the interest rate changes sluggishly. In comparison, the expected inflation rate adjusts relatively swiftly and serves as the core endogenous financial instrument in affecting the capital and future production markets.

2.1 Model Specification

Suppose the production/supply y is driven by demand. At time t, the expected output at time $t + 1$, $E_t[y_t+1]$, is determined as follows:

$$E_t[y_t+1] = f\ (y_t,\ p_t,\ E_t[\pi_t+1],\ s_t) \tag{1}$$

where p_t is the relative domestic-to-foreign output price index (Note 3); $E_t[\pi_t+1] = E_t[p_t+1]-p_t$ is the expected inflation tomorrow; s_t represents the government spending (Note 4).

Here $\frac{\partial f}{\partial E_t[\pi_{t+1}]}$ is assumed positive: An expected inflation jump tomorrow would raise the expected output demand. In contrast, $\frac{\partial f}{\partial p_t}$ is projected negative to manifest the inverse relationship between the relative price and the competitiveness of the commodity. Furthermore, $\frac{\partial f}{\partial y_t}$ and $\frac{\partial f}{\partial s_t}$ are positive to reflect the positive effects of income growth and fiscal expansion on output demand. $\frac{\partial f}{\partial y_t}$ is assumed less than unity so that y cannot grow indefinitely, i.e., $\frac{\partial f}{\partial y_t} < 1$. In reality, one may vividly picture this condition as the decreasing return to scale (DRTS) technology in the economy.

The linearized equation of (1), accordingly, can be written as:

$$E_t[g_{t+1}] = -\rho y_t - \phi p_t + \theta E_t[\pi_{t+1}] + \psi s_t + \alpha, \tag{2}$$

where $E_t[g_t+1] = y_t+1 - y_t$ is the expected output change at time $t + 1$. ρ, ϕ, θ and ψ are all positive parameters. In particular, $\rho \in (0, 1)$ can be treated as a measure on the level of DRTS technology which positively relates to the convergence speed of y_t. α is the parameter on the general technology condition.

Next, consider the funding market. In this market, the expected inflation rate serves as the core instrument that equalizes the demand and the supply. Assume that the funding demand is determined by the present output y_t and the future output growth $g_t+1 = y_t+1 - y_t$, while the funding supply is controlled by the nominal interest rate i_t and money supply m_t. Then the expected inflation rate tomorrow, $E_t[\pi_t+1]$, can be set as follows:

$$E_t[\pi_t+1] = h(p_t, y_t, E_t[y_t+1], i_t, m_t). \tag{3}$$

The impact of each factor on the expected inflation rate in (3) is projected as follows. (i) Because a positive price shock would cut down the future inflation, $\frac{\partial h}{\partial p_t}$ is negative. (ii) $\frac{\partial h}{\partial E_t[y_{t+1}]}$ is also negative to reflect the inverse relationship between the future output shock and the future price/inflation. (iii) On the contrary, $\frac{\partial h}{\partial y_t}$ is positive because a positive shock on present output would reduce the present price and hence raise the future inflation. (iv) Following the quantity theory of money $\frac{\partial h}{\partial m_t}$ is positive. (v) Similarly, $\frac{\partial h}{\partial i_t}$ is also positive: via encouraging the funding supply, an increment in the interest rate would raise the future inflation.

Linearalizing (3) yields:

$$E_t[\pi_{t+1}] = -\mu p_t + (\vartheta - \eta) y_t - \vartheta E_t[y_{t+1}] + \delta i_t + \gamma m_t + \beta, \tag{4}$$

where μ, η, ϑ, δ and γ are positive parameters, and the β symbolizes the general financial condition. In particular, $\frac{\partial E_t[p_{t+1}]}{\partial p_t} = 1 - \mu > 0$ reflects the rigidity level of price, while $\mu \in (0, 1)$ positively correlates with the price flexibility. Moreover, η is less than ϑ, which implies that the expected inflation is more sensitive to the expected future output than to the present output under the flexible price and rational expectation settings.

2.2 Short-Run Effects

Let $y_{t+1} = E_t[y_{t+1}] + \epsilon^y_{t+1}$ and $p_{t+1} = E_t[p_{t+1}] + \epsilon^p_{t+1}$, where ϵ^y_{t+1} and ϵ^p_{t+1} are two zero-mean disturbance terms. Then the system of (2) and (4) can be generalized as:

$$\mathbf{x_{t+1}} = (1 + \theta\vartheta)^{-1}(\mathbf{A x_t} + \mathbf{B z_t} + \mathbf{C w}) + \mathbf{u_{t+1}}, \tag{5}$$

where $\mathbf{x_t} = [y_t \;\; p_t]'$, $\mathbf{z_t} = [i_t \;\; s_t \;\; m_t]'$, $\mathbf{w} = [\alpha \;\; \beta]'$ and $\mathbf{u_t} = [\epsilon^y_t \;\; \epsilon^p_t]'$ denote the vectors of endogenous variables, exogenous variables, general productivity/financial conditions, and disturbance terms, respectively.

$$\mathbf{A} = \begin{bmatrix} 1 - \rho + \theta(\vartheta - \eta) & -(\phi + \theta\mu) \\ -(\eta - \rho\vartheta) & 1 - \mu + \vartheta\phi + \theta\vartheta \end{bmatrix}, \quad \mathbf{B} = \begin{bmatrix} \theta\delta & \psi & \theta\gamma \\ \delta & -\vartheta\psi & \gamma \end{bmatrix}, \quad \mathbf{C} = \begin{bmatrix} 1 & \theta \\ -\vartheta & 1 \end{bmatrix}.$$

are the corresponding matrices that characterize the short-run impacts of $\mathbf{x_t}$, $\mathbf{z_t}$ and $\mathbf{w}$.

B suggests that in the short-run, a fiscal expansion would promote the output but reduce the relative price: $\frac{\partial y_{t+1}}{\partial s_t} = \frac{\psi}{1+\theta\vartheta} > 0$, $\frac{\partial p_{t+1}}{\partial s_t} = \frac{-\vartheta\psi}{1+\theta\vartheta} < 0$. In comparison, an increase in the interest rate or the money supply would raise both of the output and the relative price:

$\frac{\partial y_{t+1}}{\partial i_t} = \frac{\theta\delta}{1+\theta\vartheta} > 0$, $\frac{\partial p_{t+1}}{\partial i_t} = \frac{\delta}{1+\theta\vartheta} > 0$; $\frac{\partial y_{t+1}}{\partial m_t} = \frac{\theta\gamma}{1+\theta\vartheta} > 0$, $\frac{\partial p_{t+1}}{\partial m_t} = \frac{\gamma}{1+\theta\vartheta} > 0$ Likewise, **C** reveals a similar development pattern: a technology improvement would promote the output but reduce the relative price, while financial innovation would raise both output and inflation $\frac{\partial y_{t+1}}{\partial \alpha} = \frac{1}{1+\theta\vartheta} > 0$, $\frac{\partial p_{t+1}}{\partial \alpha} = \frac{-\vartheta}{1+\theta\vartheta} < 0$; $\frac{\partial y_{t+1}}{\partial \beta} = \frac{\theta}{1+\theta\vartheta} > 0$, $\frac{\partial p_{t+1}}{\partial \beta} = \frac{1}{1+\theta\vartheta} > 0$.

For convenience of interpretation, refer higher (lower) output and lower (higher) price as economic upturns (downturns). Then the foregoing results can be summarized as Proposition 1.

Proposition 1: In the short-run, fiscal expansions and technology improvements would create economic upturns, while monetary controls and financial innovations would incur tradeoffs between higher output and lower inflation.

2.3 Stability

For stable economic development, both roots of the characteristic function $\mathbf{I}-\frac{\mathbf{A}}{1+\theta\vartheta}\lambda = 0$ in (5) lie inside the unit circle. The following theorem holds from standard algebra (Note 5):

Theorem 1: The system is stable if and only if

$$\rho\mu > \phi\eta. \tag{6}$$

Therefore, to sustain stable development, the magnitudes of DRTS, ρ, and price flexiblity, μ, must be relatively high compared with the cross impacts of the present price (output) on the future output (price), φ (η).

To further elaborate this point, consider the two long-run relationships between y and p. Specifically, from setting π and g equal to zero respectively in (2) and (4), it follows that:

$$\begin{cases} \rho y + \phi p = \psi s + \alpha \\ \eta y + \mu p = \delta i + \gamma m + \beta \end{cases} . \tag{7}$$

From the forward-looking perspective, the left-hand side and the right-hand side of (1) would represent the expected future output and the present demand for future output, respectively. Thus the first equation of (7) could be pictured as the output- adjustment equilibrium. In comparison, the second equation of (7) can be regarded as the price-adjustment equilibrium, as it reveals the price level that equalizes the financial market.

From (6), it follows that

$$\frac{\rho}{\phi} > \frac{\eta}{\mu}. \tag{8}$$

Since $\frac{\rho}{\phi}$ and $\frac{\eta}{\mu}$ of (8) are the derivatives of the relative price p with respect to the output y in the first and second equations of (7) respectively, Theorem 1 can be restated as Proposition 2:

Proposition 2: The system is stable if and only if the price in the long-run output- adjustment equilibrium is more sensitive to the output change than that in the long- run price-adjustment equilibrium, and vice versa.

The intuition of Proposition 2 is as follows. In a demand-driven economy, output and price are negatively related from the long-run perspective. However, because the expected inflation rate in channeling funds is unrealized in each period, the price in the price-adjustment equilibrium in a stable economy would be less sensitive to an output change than that in the output-adjustment equilibrium, and vice versa (Figure 1).

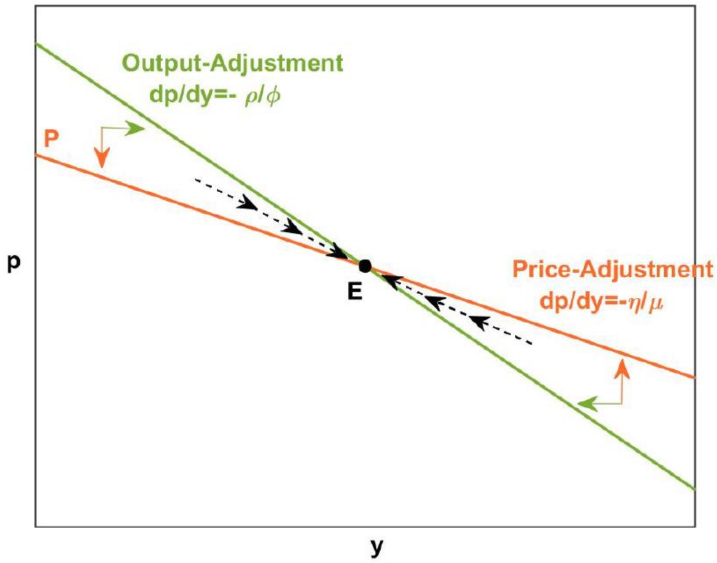

Figure 1. Illustration of the Stability Condition

3. Economic Development under CI

Albeit (6) may not hold well in countries with economies of scale, or rapid financial innovation, it might be compatible with economies under persistent CI. For one thing, as an important international production/assembly hub, China could share a similar DRTS technology of major economies. For another, the rapid integration of China's commodity markets into the international trading network has expedited the price adjustments. This section explores the ramifications of permanent structural changes and temporary endogenous shocks in a stable economy.

3.1 Potential Output and Price Levels

Suppose the economy is stable. From (5) the long-run (potential) output and relative price, $\mathbf{x}_\mathbf{t}^* = [y_t^*, p_t^*]'$,

can be derived as:

$$\mathbf{x}_\mathbf{t}^* = \frac{\mathbf{\Phi z_t} + \mathbf{\Gamma w}}{\rho\mu - \eta\phi}. \tag{9}$$

where

$$\mathbf{\Phi} = \begin{bmatrix} -\delta\phi & \psi\mu & -\gamma\phi \\ \delta\rho & -\eta\psi & \gamma\rho \end{bmatrix}, \quad \mathbf{\Gamma} = \begin{bmatrix} \mu & -\phi \\ -\eta & \rho \end{bmatrix}.$$

are the coefficient matrices on the exogenous variables $\mathbf{z_t}$ and the structural factors $\mathbf{w}$, respectively.

$\rho\mu - \eta\phi > 0$ under (6). $\mathbf{x}_\mathbf{t}^* = [y_t^*, p_t^*]'$ denote the potential output and the relative price.

Under (6), $\rho\mu - \eta\varphi > 0$. Accordingly, (9) implies that all considered macroeconomic factors, if controlled properly, may promote economic upturns in the long-run.

Specifically, the economy would raise the long-run output but reduce the long-run price via: (1) cutting the nominal interest rate $(\frac{\partial y_t^*}{\partial i_t} = -\delta\phi < 0,\ \frac{\partial p_t^*}{\partial i_t} = \delta\rho > 0)$; (2) expanding the fiscal expenditure $(\frac{\partial y_t^*}{\partial s_t} = \psi\mu > 0,\ \frac{\partial p_t^*}{\partial i_t} = -\eta\psi < 0)$; (3) curbing the monetary supply $(\frac{\partial y_t^*}{\partial m_t} = -\gamma\phi < 0,\ \frac{\partial p_t^*}{\partial m_t} = \gamma\rho > 0)$;

(4) improving technology $(\frac{\partial y_t^*}{\partial \alpha} = \mu > 0,\ \frac{\partial p_t^*}{\partial \alpha} = -\eta < 0)$; and (5) financial regulations $(\frac{\partial y_t^*}{\partial \beta} = -\phi < 0,\ \frac{\partial p_t^*}{\partial \beta} = \rho > 0)$.

Proposition 3: Fiscal expansion, interest rate cut, monetary contraction, technology improvement and/or financial regulations would create economic upturns in the long-run.

De facto, Proposition 3 corresponds well to China's miraculous economic development during CI. In addition to fiscal expansion, currency sterilization, and financial regulations discussed in Sections 1 and 2, various surveys have also discovered that, China has also experienced persistently low interest rates and fast technology improvement since 1994 (Mehrotra, 2007; Corden, 2009; Bai, Hsieh, & Song, 2016). As suggested by Proposition 3, all these changes would promote economic upturns in China (Note 6).

3.2 Impulse Response Functions

Let $\xi_{\mathbf{t}} = [\xi_t^y, \xi_t^p]' = \mathbf{x_t} - \mathbf{x_t^*}$ denote the vector of the output gap and the inflation gap against their potential values. Combining (5) and (9) yields the following vector auto-regressive model:

$$\xi_{\mathbf{t+1}} = \mathbf{F}\xi_{\mathbf{t}} + \mathbf{u_{t+1}}, \tag{10}$$

where $\mathbf{F} = \frac{\mathbf{A}}{1+\theta\vartheta}$ is the transition matrix.

The recursive version of future output and price gaps, $\xi_{\mathbf{t+i}}, \mathbf{i} = \mathbf{1}, \mathbf{2}, \cdots$, accordingly, proceeds as follows:

$$\xi_{\mathbf{t+i}} = \mathbf{F^i}\xi_{\mathbf{t}} + \sum_{\mathbf{j=1}}^{\mathbf{i}} \mathbf{F^{j-1}u_{t+j}}. \tag{11}$$

Then the impulse response functions (IRFs) of $\xi_{\mathbf{t+i}}$ to $\mathbf{u_t}$ can be defined as:

$$\frac{\partial \xi_{\mathbf{t+i}}}{\partial \mathbf{u_t}} = \mathbf{F^i}. \tag{12}$$

In particular, from the short-run perspective, it follows directly that

$$\frac{\boldsymbol{\xi}_{\mathbf{t+1}}}{\mathbf{u_t}} = \mathbf{F} = \begin{bmatrix} \frac{1-\rho+\theta(\vartheta-\eta)}{1+\theta\vartheta} & -\frac{\phi+\theta\mu}{1+\theta\vartheta} \\ \frac{\vartheta(\rho-\frac{\eta}{\vartheta})}{1+\theta\vartheta} & \frac{1-\mu+\vartheta\phi+\theta\vartheta}{1+\theta\vartheta} \end{bmatrix}. \tag{13}$$

In (13), three relations can be easily identified: $\frac{\partial\xi_{t+1}^{y}}{\partial\epsilon_t^{y}} = \mathbf{F_{11}} > 0$, $\frac{\partial\xi_{t+1}^{y}}{\partial\epsilon_t^{p}} = \mathbf{F_{12}} < 0$, and $\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{p}} = \mathbf{F_{22}} > 0$.

The sign of $\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{y}} = \mathbf{F_{21}}$ however, is controlled by $\rho - \frac{\eta}{\vartheta}$. Specifically, $\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{y}} > 0$ if $\rho > \frac{\eta}{\vartheta}$ but $\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{y}} < 0$ if $\rho < \frac{\eta}{\vartheta}$. These results are summarized as the following proposition:

Proposition 4: From the short-run perspective, an impulse increase in the relative price would incur an economic downturn. An impulse increase in the output would elicit an economic upturn if the DRTS technology is relatively insignificant, but would raise both output and price if the DRTS technology is relatively remarkable.

The intuition of Proposition 4 is as follows. Suppose the economy is at its steady state, i.e., $\boldsymbol{\xi}_{\mathbf{t}} = \mathbf{0}$. First, consider the IRFs of ϵ_t^{p}. A sudden increase in the present relative price would directly curtail the expected inflation and push up the expected real interest rate in the near future. As a result, the expected output in the next period declines, i.e., $\frac{\partial\xi_{t+1}^{y}}{\partial\epsilon_t^{p}} > 0$. However, because there is still a certain level of price rigidity, the relative price would not immediately adjust back to its potential level in the next period: $\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{p}} > 0$. Next, consider the IRFs of ϵ_t^{y}. Through raising both the present income and the expected inflation rate in the next period, a positive shock on the present output would cause the growth rate above its equilibrium level in the next period: $\frac{\partial\xi_{t+1}^{y}}{\partial\epsilon_t^{y}} > 0$. In comparison, its overall influence on the expected inflation rate is dependent on the relative stance of its direct effect ($\vartheta - \eta$) and its indirect effects mediated by the expected future output effect ($\vartheta - \rho\vartheta$). Specifically, the overall influence would be positive $(\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{y}} > 0)$ if the direct effect is bigger than the indirect effect, while it's negative $(\frac{\partial\xi_{t+1}^{p}}{\partial\epsilon_t^{y}} > 0)$ is the direct effect is smaller.

3.3 Classification

From standard algebra, it can be shown that:

Theorem 2: For sufficiently large i, (i) $\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} > 0$ if $\rho < \frac{\eta}{\vartheta}$ or $\rho > \frac{\eta}{\vartheta}$ & $\mu > \rho + \eta\theta + \phi\vartheta$, $\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} < 0$ if $\rho > \frac{\eta}{\vartheta}$ & $\mu < \rho + \eta\theta + \phi\vartheta$; (ii) $\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} < 0$; (iii) $\frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} < 0$ if $\rho < \frac{\eta}{\vartheta}$; $\frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} > 0$ if $\rho > \frac{\eta}{\vartheta}$; (iv) $\frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} > 0$ if $\rho < \frac{\eta}{\vartheta}$ or $\rho > \frac{\eta}{\vartheta}$ & $\mu < \rho + \eta\theta + \phi\vartheta$, $\frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} < 0$ if $\rho > \frac{\eta}{\vartheta}$ & $\mu > \rho + \eta\theta + \phi\vartheta$.

Based on Proposition 4 and Theorem 2, the CI economies can be classified into three types, as exhibited in Figure 2: $\text{(I) } \rho < \frac{\eta}{\vartheta}$; $\text{(II) } \rho > \frac{\eta}{\vartheta}$ & $\mu > \rho + \eta\theta + \phi\vartheta$; and $\text{(III) } \rho > \frac{\eta}{\vartheta}$ & $\mu > \rho + \eta\theta + \phi\vartheta$.

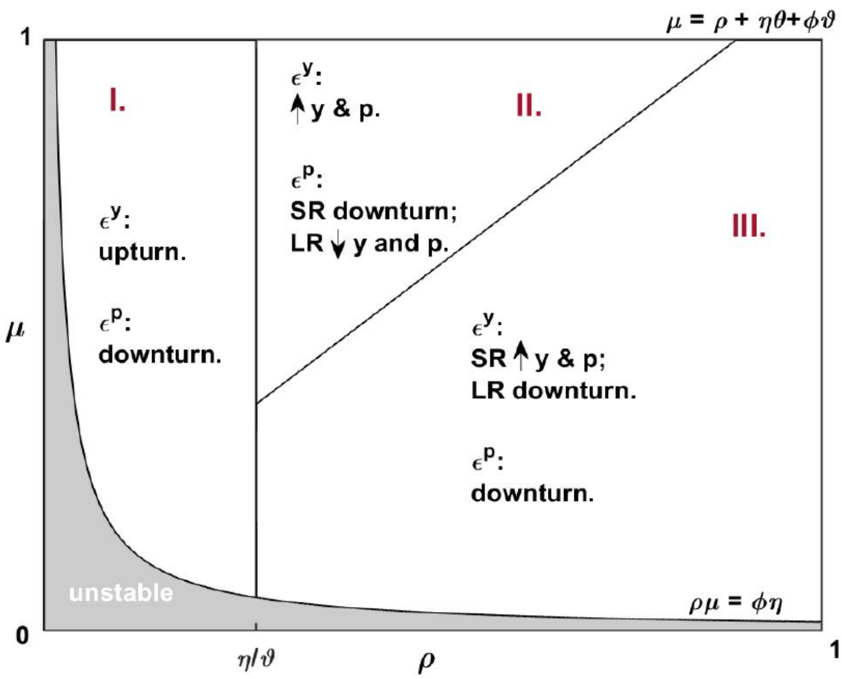

Figure 2. Positive ϵ^{y} and ϵ^{p} Shocks on Economic Development

In the Type I economy, an impulse increase in output would elicit persistent economic upturns $\left(\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} > 0, \frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} < 0\right)$ while an impulse surge in price would incur persistent economic downturns $\left(\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} < 0, \frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} > 0\right)$ In the real world, policymakers are usually resolute in intervening economic downturns but inactive during economic upturns. For the Type I economy, in particular, these unbalanced controls would entice persistent fiscal expansions and technology improvements to stimulate outputs, or persistent interest cuts, monetary contractions, and financial regulations to deflate prices. In this perspective, the structural variations suggested in Section 4.1 could even be promoted without strategic design. These results are summarized in Proposition 5.

Proposition 5: In so far as the DRTS technology is sufficiently low, structural development favorable to long-run economic upturns could proceed steadily via market- orientation (Note 7).

In the Type II economy, an impulse increase in the output would raise both long- run outputs and prices $\left(\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{11} > 0,\ \frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{21} > 0\right)$ while a positive price shock would first incur temporary economic bust $\left(\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+1}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} = \mathbf{F}_{12} < 0,\ \frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+1}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} = \mathbf{F}_{22} > 0\right)$ but then reduce both outputs and prices $\left(\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{12} < 0,\ \frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{22} < 0\right)$ Therefore, for the Type II economy, macroeconomic policies may not be sustainable in the long-run: both output and price interventions would encounter trade-offs between higher output and lower price. However, from the short-run perspective, policymakers would prefer to deflate prices or set price targets to create transitory economic upturns or control economic growth. These results are summarized in Proposition 6.

Proposition 6: In so far as the DRTS technology and the price flexibility are sufficiently high, a transitory output increase would raise both output and prices in the future, while a positive price shock would first incur economic downturn but would eventually reduce both output and prices in the long-run (Note 8).

In the Type III economy, a positive price shock would elicit economic downturns in future periods: $\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{12} < 0$ and $\frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{P}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{22} > 0.$ Thus policymakers would prone to deflate prices to propel economic upturns. However, a positive output shock would temporarily boost output and price but would entail economic downturns in the long-run: $\frac{\partial \xi^{\mathbf{y}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{11} < 0$ and $\frac{\partial \xi^{\mathbf{P}}_{\mathbf{t+i}}}{\partial \epsilon^{\mathbf{y}}_{\mathbf{t}}} = \mathbf{F}^{\mathbf{i}}_{21} > 0.$

Therefore, short-run output interventions could be ruinous because they could "trap" the economy in long-run downturns.

To further illustrate this point, consider the multiplier effect of the output shock ϵ^{y} on output: $\omega = \sum_{j=0}^{\infty} \frac{\xi^{y}_{t+j}}{\partial \epsilon^{y}_{t}}$ or $\sum_{j=0}^{\infty} \mathbf{F}^{\mathbf{i}}_{11}$ (Note 9). From standard algebra, it follows that:

$$\omega = \omega_0 \left(1 + \frac{\eta - \rho\vartheta}{\rho\mu - \phi\eta}\right), \tag{14}$$

where $\omega_0 = \frac{1}{\rho}$ is the benchmark multiplier based on (2). Obviously, $\omega < \omega0$ because $\eta - \rho\vartheta < 0$ in the Type III economy. Moreover, ω could even be negative if $\rho\mu - \varphi\eta < \rho\vartheta - \eta$ (lower-right of the Type III economy). These results are summarized in Proposition 7.

Proposition 7: In so far as the DRTS technology is relatively high but the price flexibility is relatively low, a transitory price increase would prompt economic upturns. In contrast, a positive output shock would first raise both output and price in the near future output, but would eventually incur economic downturns in the long-run (Note 10).

4. Concluding Remarks

This paper has developed a demand-driven production and flexible price model to characterize the economy with persistent CI. In this economy, the nominal interest rate is exogenously determined, while the expected inflation rate is the endogenous financial instrument intermediates the funding market. In the short-run, fiscal policies could be more effective than monetary policies in stimulating or cooling down the economy. From the strategic planning perspective, however, the policymakers could prompt long-run economic upturns through fiscal expansions, interest rate cut, or monetary contractions.

In general, the model differs from the stereotype financial distortion models which usually circle around economic troughs in short-run business cycles. It's also distinct from the standard macroeconomic frameworks with such a well-functioning financial systems that fiscal expansion would be detrimental to economic growth and monetary policies are ineffective in the long-run.

Albeit the present model is inspired from contemplating on China's economic development, it can be applied to examine economic issues of other countries in so far as the attribute of the sluggish interest rate/exchange rate adjustment is satisfied. For example, Section 4.3 classifies a CI economy into three types. While the "China miracle" after 1994 well exemplifies the Type I economy, the Types II and III economies would respectively resemble to the "groundhog day" economy and the "middle income trap" economy.

Moreover, from the theoretical perspective, the model may serve as a useful reference to more delicate analyses with detailed information on microeconomic components and transitional dynamics. For example, it could elicit a dynamic general equilibrium to examine the welfare of the representative agent subject to technological and institutional variations. It also provides insights on developing an international linkage model between CI and other economies.

References

Bai, C.-E., Hsieh, C.-T., & Song, Z. M. (2016). The Long Shadow of A Fiscal Expansion. *NBER Working Paper No. 22801*. https://doi.org/10.3386/w22801

Calvo, G. A. (1983). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics*, *12*(3), 383-398. https://doi.org/10.1016/0304-3932(83)90060-0

Corden, W. M. (2007). Those Current Account Imbalances: A Sceptical View. *World Economy*, *30*(3), 363-382. https://doi.org/10.1111/j.1467-9701.2007.01000.x

Corden, W. M. (2009). China's Exchange Rate Policy, Its Current Account Surplus, and the Global Imbalances. *Economic Journal*, *119*, F430-F441. https://doi.org/10.22459/CNPWC.07.2009.06

Dornbusch, R. (1976). Expectations and Exchange Rate Dynamics. *Journal of Political Economy*, *84*(6), 1161-1176. https://doi.org/10.1086/260506

Drazen, A. (2003). Interest Rate Defense against Speculative Attack as a Signal. A Primer. In *Managing Currency Crises in Emerging Markets* (pp. 37-60). University of Chicago Press.

https://doi.org/10.7208/chicago/9780226155425.003.0004

Eichengreen, B., & Kawai, M. (2014). Issues for Renminbi Internationalization: An Overview. *ADBI Working Paper Series No. 454*. https://doi.org/10.2139/ssrn.2382420

Goldstein, M. (2009). *The Future of China's Exchange Rate Policy*. Peterson Institute.

Jin, H., & Choi, E. K. (2013). Profits and Losses from Currency Intervention. *International Review of Economics & Finance*, *27*, 14-20. https://doi.org/10.1016/j.iref.2012.08.013

Jin, H., Lombardi, D., & Hu, C. (2015). Constraints of Currency Intervention on China's Monetary Policy. In *Enter the dragon: China's rise in the international financial system* (pp. 161-190). McGill-Queen's Press-MQUP.

Jin, H., Qian, Y., & Weingast, B. R. (2005). Regional Decentralization and Fiscal Incentives: Federalism, Chinese Style. *Journal of Public Economics*, *89*(9-10), 1719-1742. https://doi.org/10.1016/j.jpubeco.2004.11.008

Lombardi, D., & Wang, H. (2016). *Enter the Dragon: China in the International Financial System*. McGill-Queen's Press-MQUP.

Mehrotra, A. N. (2007). Exchange and Interest Rate Channels During a Deflationary Era: Evidence from Japan, Hong Kong and China. *Journal of Comparative Economics*, *35*(1), 188-210. https://doi.org/10.1016/j.jce.2006.10.004

Neftci, S. N., & Menager-Xu, M. Y. (2006). *China's Financial Markets: An Insider's Guide to How the Markets Work*. Elsevier.

Roodman, D. (2011). Fitting Fully Observed Recursive Mixed-Process Models with CMP. *The Stata Journal*, *11*(2), 159-206. https://doi.org/10.1177/1536867X1101100202

Shen, C., Jin, J., & Zou, H.-f. (2012). Fiscal Decentralization in China: History, Impact, Challenges and Next Steps. *Annals of Economics & Finance*, *13*(1).

Smets, F., & Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model of the euro area. *Journal of the European economic association*, *1*(5), 1123-1175. https://doi.org/10.1162/154247603770383415

Song, Z., Storesletten, K., & Zilibotti, F. (2011). Growing Like China. *American Economic Review*, *101*(1), 196-233. https://doi.org/10.1257/aer.101.1.196

Temple, J. (2002). Openness, Inflation, and the Phillips Curve: A Puzzle. *Journal of Money, Credit and Banking*, 450-468. https://doi.org/10.1353/mcb.2002.0049

Yu, Y. (2013). China's Groundhog Day Growth Pattern'. In *East asia forum* (Vol. 10).

Zhigang, Y. (2001). Further Reform of China's Fiscal System. *China & World Economy*, (1).

Notes

Note 1. Each year the PBoC issued an enormous amount of funds, denoted "funds outstanding for FX" (FX funds), to restrain renminbi (RMB, the Chinese currency) from appreciating.

Note 2. Exemplars include Corden (2007)'s "parking" theory and Jin and Choi (2013)'s profit analysis.

Note 3. For instance, $p = \ln\frac{P}{\varepsilon P^*}$, where P and P^* is are domestic output price and foreign output price respectively; ε is the direct exchange rate.

Note 4. Here the interest rate is omitted in the output equation because non-state high-productivity entities would mainly finance investments through interval savings during CI.

Note 5. Proofs of all theorems in the paper are displayed in Appendix A.

Note 6. In comparison, stylized macroeconomic models with a well-functioning financial system would encounter huge challenge in explaining the "China miracle". For example, expansionary fiscal policies in these models generally entail the "crowd out" effects, while monetary policies are often posited ineffective in the long-run.

Note 7. Section 5 shows that the "China miracle" can be classified into the Type I economy.

Note 8. In the real world, the Type II economy may corresponds to the "groundhog day" economy illustrated in Section 2: Stimulating the output would boost the inflation, while controlling inflation would contract the output.

Note 9. The general expression of $\mathbf{F}^{\mathrm{i}}_{11}$ is provided in (A.3).

Note 10. In reality, the Type III economy may be comparable to the "middle income trap" countries whose economic developments get stuck at certain middle income levels.

Appendix. Proofs of Sections 2 and 3

Theorem 1

Proof. From (5), it follows that the first minor and determinant of $\frac{\mathbf{A}}{1+\theta\vartheta}$ in (5) are both positive:

$\frac{A_{11}}{1+\theta\vartheta} = \frac{1-\rho+\theta(\vartheta-\eta)}{1+\theta\vartheta} > 0$ and $\left|\frac{A}{1+\theta\vartheta}\right| = \frac{(1-\rho)(1-\mu)+(\theta+\phi)(\vartheta-\eta)}{1+\theta\vartheta} > 0.$ Thus $\frac{\mathbf{A}}{1+\theta\vartheta}$ is a positively definite matrix, i.e., $\lambda 1$, $\lambda 2 > 0$.

To achieve stable economic development, both $\lambda 1$ and $\lambda 2$ must be smaller than unity, i.e., $\frac{\mathbf{A}}{1+\theta\vartheta} - \mathbf{I}$ is a negatively definite matrix. This is equivalent to $\left|\frac{\mathbf{A}}{1+\theta\vartheta} - \mathbf{I}\right| = \frac{\rho\mu-\eta\phi}{1+\theta\vartheta} > 0$ or $\rho\mu > \eta\phi$, since the first minor of $\frac{\mathbf{A}}{1+\theta\vartheta} - \mathbf{I}$ is negative: $\frac{1-\rho+\theta(\vartheta-\eta)}{1+\theta\vartheta} - 1 = -\frac{\rho+\theta\eta}{1+\theta\vartheta} < 0.$

Theorem 2

Proof. Based on the singular value decomposition method, **F** can be written as:

$$\mathbf{F} = \mathbf{V}\mathbf{\Lambda}\mathbf{V}^{-1}, \tag{A.1}$$

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where $\mathbf{\Lambda} = \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix}$ is the diagonal eigenvalue matrix with $\lambda 1 > \lambda 2$; **V** is a corresponding eigenvector matrix and $\mathbf{V}^{-1}$ is its inverse matrix. For example,

$$\mathbf{V} = \begin{bmatrix} \frac{\rho+(\phi+\eta)\vartheta-\mu-\Delta}{2(\eta-\rho\vartheta)} & \frac{\rho+(\phi+\eta)\vartheta-\mu+\Delta}{2(\eta-\rho\vartheta)} \\ 1 & 1 \end{bmatrix}, \ \mathbf{V}^{-1} \begin{bmatrix} \frac{\eta-\rho\vartheta}{\Delta} & -\frac{\rho+(\phi+\eta)\vartheta-\mu+\Delta}{2\Delta} \\ -\frac{\eta-\rho\vartheta}{\Delta} & \frac{\rho+(\phi+\eta)\vartheta-\mu-\Delta}{2\Delta} \end{bmatrix}, \quad \text{(A.2)}$$

where $\Delta = (1+\theta\vartheta)(\lambda_1 - \lambda_2)$.

From (A.1) and using the properties of $\lambda 1 + \lambda 2 = \mathbf{F11} = \frac{\mu+\rho-\eta\theta+\phi\vartheta+2\theta\vartheta}{1+\theta\vartheta}$ and $\lambda_1\lambda_2 = |\mathbf{F}| = \frac{-\eta\phi-\eta\theta+\mu\rho+\phi\vartheta+\theta\vartheta}{1+\theta\vartheta}$, we have

$$\mathbf{F}^{\mathrm{i}} = \mathbf{V}\mathbf{\Lambda}^{\mathrm{i}}\mathbf{V}^{-1} = \begin{bmatrix} \frac{\lambda_1^i+\lambda_2^i}{2} - \frac{(\rho+\eta\theta+\phi\vartheta-\mu)(\lambda_1^i-\lambda_2^i)}{2(1+\theta\vartheta)(\lambda_1-\lambda_2)} & -\frac{(\phi+\theta\mu)(\lambda_1^i-\lambda_2^i)}{(1+\theta\vartheta)(\lambda_1-\lambda_2)} \\ -\frac{(\eta-\rho\vartheta)(\lambda_1^i-\lambda_2^i)}{(1+\theta\vartheta)(\lambda_1-\lambda_2)} & \frac{\lambda_1^i+\lambda_2^i}{2} + \frac{(\rho+\eta\theta+\phi\vartheta-\mu)(\lambda_1^i-\lambda_2^i)}{2(1+\theta\vartheta)(\lambda_1-\lambda_2)} \end{bmatrix}. \quad \text{(A.3)}$$

It follows immediately that $\mathbf{F}^{\mathrm{i}}_{12} < 0$. $\mathbf{F}^{\mathrm{i}}_{21} < \mathbf{0}$ if $\rho < \frac{\eta}{\vartheta}$ while $\mathbf{F}^{\mathrm{i}}_{21} > \mathbf{0}$ if $\rho > \frac{\eta}{\vartheta}$.

Moreover, from $[(1+\theta\vartheta)(\lambda_1-\lambda_2)]^2 = (1+\theta\vartheta)^2[(\lambda_1+\lambda_2)^2 - 4\lambda_1\lambda_2] = (2-\mu-\rho-\eta\theta+\phi\vartheta+2\theta\vartheta)^2 - 4(-\eta\phi-\eta\theta+(1-\mu)(1-\rho)+\phi\vartheta+\theta\vartheta)$, we have $\left[\frac{\rho+\eta\theta+\phi\vartheta-\mu}{(1+\theta\vartheta)(\lambda_1-\lambda_2)}\right]^2 - 1 = \frac{-4(\eta-\rho\vartheta)(\phi+\theta\mu)}{[(1+\theta\vartheta)(\lambda_1-\lambda_2)]^2}$.

Thus,

$$\left|\frac{\rho+\eta\theta+\phi\vartheta-\mu}{(1+\theta\vartheta)(\lambda_1-\lambda_2)}\right| < 1, \ \text{if} \ \eta - \rho\vartheta > 0 \ \text{or} \ \rho < \frac{\eta}{\vartheta}. \quad \text{(A.4)}$$

Furthermore, since $\lambda_1^i > \lambda_2^i$, both $\lambda_1^i + \lambda_2^i$ and $\lambda_1^i - \lambda_2^i$ converge to λ_1^i as *i* increases. Therefore $\mathbf{F}^{\mathrm{i}}_{11} > 0$ and $\mathbf{F}^{\mathrm{i}}_{11} > 0$ if $\rho < \frac{\eta}{\vartheta}$. When $\rho > \frac{\eta}{\vartheta}$, $\mathbf{F}^{\mathrm{i}}_{11} < 0, \mathbf{F}^{\mathrm{i}}_{22} > 0$ if $\mu < \rho + \eta\theta + \phi\vartheta$; $\mathbf{F}^{\mathrm{i}}_{11} < 0, \mathbf{F}^{\mathrm{i}}_{22} > 0$ if $\mu > \rho + \eta\theta + \phi\vartheta$.