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MONETARY AND FINANCIAL MARKET INTERVENTION AROUND THE WORLD[‡]

China's Gradualistic Economic Approach and Financial Markets[†]

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A key approach successfully employed by China to reform its economy in the past 30 years is the so-called "crossing the river by touching the stones" approach, a gradualistic method that optimizes policy through experimentation. The government will start with an initial (usually small) policy change, and gradually modify the policy based on the reaction from the economy to this change. This approach has worked well because it typically takes months, and even quarters, for the economy to react to a change in policy. This gives policymakers enough time to study the economy's reaction, and to discern appropriate policy adjustments. With China still largely a combination of central planning and free markets, the government continues to play a central role in many aspects of the economy. After 30 years of rapid growth, however, its economy has become increasingly complex. Realizing its limitation in managing this complex economy, the government has made it a high priority to fully develop China's financial system and, in particular, to let financial markets play a greater role in determining the allocation of capital and economic resources. Can China continue to use its gradualistic approach in the presence of active financial markets?

China's post 2008 stimulus program provides a salient example of how financial markets may cause a temporary policy initiative to have a larger and more permanent impact on the economy than the government intended. In response to the global financial crisis in 2008, the Chinese government loosened financial regulations to allow local governments to fund infrastructure investment by borrowing from banks and a shadow banking system. This led to a rapid expansion of this shadow banking system, which in turn, substantially increased leverage across the economy, not just through the credit received by local governments for infrastructure investment.[1] The liberated financial system did not allow the government to experiment with a temporary stimulus that could be reversed easily soon after its inception.

The breakdown of the new installed circuit breakers in China's stock market in January 2016 illustrates that the speed with which financial markets react undermines the gradualist approach. The circuit breakers were activated on their first day of being put in place, and then again two days later, even though they were intended only for extreme situations. This fast reaction brought frequent disruptions to the stock market. As a consequence, the circuit breakers were discarded after only four days, which greatly embarrassed policymakers and

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[1] See Hachem and Song (2015); Chen, Ren, and Zha (2016); Bai, Hsieh, and Song (2016); Cong and Ponticelli (2016); Chen, He, and Liu (2016); Acharya, Qian, and Yang (2016); Huang, Pagano, and Panizza (2016); Liang et al. (2016); and Wang et al. (2016) for a series of studies on the expansion of shadow banking and private sector leverage in China.

led to the removal of the chairman of the China Securities Regulatory Commission (CSRC). This fast reaction demonstrates that policymakers may not have adequate time to gradually adjust underdeveloped policy schemes in reforming the financial system.

In this paper, we present a simple model to illustrate a tension between the government's gradualistic approach and the incentive of financial market participants to front-run gradual policy changes. As financial markets offer participants greater flexibility to obtain financing and to trade, market participants can actively engage in speculation about future policy changes. This may, in turn, render the government's gradualistic approach ineffective. Our model builds on several key ingredients. First, a policymaker uses investment decisions taken by private agents in the economy as a signal to infer their information about economic fundamentals, and more gradual investment reduces the noise in this signal. This feature motivates the policymaker to adopt gradual policy changes, even though they are inefficient ex post after the private agents make their investment decisions.

Second, the availability of financial markets alters the timing of actions taken by private agents and the policymaker. In the absence of financial markets, private agents make investment decisions only after the policymaker announces his policy decision. In this case, the policymaker can use gradual policy changes to optimize the information extracted from private agents' investment decisions. When private agents have access to financial markets, however, the greater financing flexibility allows them to choose investment ahead of the policymaker's policy decision. In this case, the effectiveness of the policymaker's gradual policy changes depends crucially on whether the policymaker can precommit to a policy rule. If the policymaker can commit, the timing of actions is irrelevant as the policymaker can precommit to a gradual policy rule, and later adhere to this rule by ignoring the potential gain from using an ex post efficient policy after private agents have made their investment decisions. In this way, the gradual policy rule would still force private agents to adopt gradual investment decisions, and thus allow the policymaker to efficiently extract information.

If the policymaker cannot commit to a policy rule, however, there arises the well-known time-inconsistency problem, highlighted in Kydland and Prescott (1977) and Barro and Gordon (1983). As it is ex post efficient for the policymaker to abandon the gradual policy change after private agents have made their investment decisions, private agents, in turn, anticipate the policymaker to do so, and choose to front-run the policymaker. This front-running by private agents renders the policymaker's gradualistic approach ineffective.

China is now facing many challenges in developing and managing its financial system, ranging from rising leverage across the country and increasing capital outflows to large volatility in the stock market and growing instability in the housing market. A common theme of these challenges is the intensive interaction between market participants and government policies. In particular, financial markets provide market participants not only financing for their investments, but also instruments to engage in speculation about government policies. This paper describes a mechanism through which market speculation can render the government's gradualistic approach of policy making ineffective. In a companion paper, Brunnermeier, Sockin, and Xiong (2016) develop a model to illustrate another type of interaction—intensive government intervention in financial markets can induce market participants to acquire information about persistent noise in the government's policy, and distracts them from analyzing economic fundamentals. Through this mechanism, the well-intentioned government intervention to stabilize markets may lead to reduced, rather than improved, information efficiency of asset prices. Taken together, these two papers highlight that, in financial development, it is important for the government to account for the private incentives of market participants to speculate and front-run government policies.

I. The Model Setup

Consider an economy with three dates $t = 0, 1, 2$, in which a large, strategic policymaker and a continuum of identical private firms learn the fundamentals that govern the economy over time. The economy is subject to two fundamental shocks, θ and ε. The shock θ, which can be thought of as a technological shock capturing the strength of the economy, affects payoffs of both the policymaker and firms, while ε only directly affects firms.

The policymaker makes two policy choices a_1 and a_2 on date 1 and 2, respectively, to maximize a quadratic objective function

$$(1) \quad U_0 = \max_{a_1, a_2} E\left[-\left(\theta - a_1\right)^2 - \left(\theta - a_2\right)^2\right].$$

Mapping this setting to China's post 2008 economic stimulus program discussed earlier, one may think of a_1 as the initial scale or, alternatively, duration of the credit stimulus program. At $t = 0$, the fundamentals θ and ε are unobservable to the policymaker and the private agents who operate the firms. From their perspective, θ and ε are independently and normally distributed random variables: $\theta \sim N\left(\bar{\theta}, 1/\tau_\theta\right)$ and $\varepsilon \sim N\left(0, 1/\tau_\varepsilon\right)$. The mean of the prior belief $\bar{\theta}$, with $\bar{\theta} > 0$, represents the public information at $t = 0$ about θ.

Private agents choose a level of capital k for a continuum of identical firms. Each firm produces output $y(k)$ according to a linear technology $y(k) = e^{\theta}k$, subject to a quadratic cost $c(k) = \frac{1}{2}\left(e^{-\varepsilon}\right)^{a_1}k^2$, with ε as a shock to the firm's cost of capital. Notice that the policymaker's action a_1, which private firms either observe or anticipate, also affects firms' investment cost. Unlike the policymaker, agents observe both θ and ε at $t = 1$ before making their investment decisions. Thus, they choose k to maximize the profit $\Pi = y(k) - c(k)$:

$$(2) \qquad \Pi = \max_k \; e^{\theta}k - \frac{1}{2}\left(e^{-\varepsilon}\right)^{2a_1}k^2.$$

The first order condition implies that $\log k = \theta + 2a_1\varepsilon$. Consequently, firm output is

$$\log y = 2\left(\theta + a_1\varepsilon\right),$$

and profit $\Pi = \frac{1}{2}e^{2\theta + a_1\varepsilon}$.

After the policymaker observes firm output y at $t = 2$, he updates his belief about θ. This inference is imperfect, however, since output is also affected by ε, which acts as noise in the inference problem.

A. *Defining Gradualism*

Given the policymaker's quadratic objective function, one might expect him to choose in both periods an action that corresponds to his best prediction of θ. Gradualism, in this context, refers to the decision of the policymaker to deliberately underreact to his initial information $\bar{\theta}$.

DEFINITION: *Under the gradualistic policy approach, the policymaker's action at $t = 1$ is below the best prediction of θ. That is, $a_1 < \bar{\theta}$.*

B. *The Perfect-Information Benchmark*

As a benchmark, we first illustrate the case in which θ and ε are publicly observable to private agents and the government at $t = 0$. One may associate this benchmark with developed economies, in which policymakers face less uncertainty about economic fundamentals than in emerging economies such as China. In this case, it is straightforward from the government's objective that the policymaker chooses $a_1 = a_2 = \theta$, and private agents choose $\log k = \theta + 2\theta\varepsilon$. With the fundamentals directly observable to the policymaker, there is no need for any policy gradualism.

Next, we analyze the case in which the policymaker cannot observe the fundamentals θ and ε at $t = 0$, and contrast settings absent and with financial markets.

II. Government Gradualism Absent Financial Markets

In the absence of fully developed financial markets—our baseline model—we assume that private agents in the economy must receive financing from state-controlled banks, which wait until the policymaker has chosen his policy a_1 at $t = 1$. This corresponds to a game between the policymaker and private agents in which the policymaker moves first. He chooses a_1 at $t = 1$ before private agents make their investment decision k, which leads to output $y(k)$ at the end of $t = 1$.

At the beginning of $t = 2$, the policymaker observes output y, which serves as a signal about θ. By Bayes' rule, given his Gaussian prior distribution about θ and the normally distributed signal $\log y = 2\left(\theta + a_1\varepsilon\right)$, his posterior is also Gaussian: $\theta \,|\, \log y \sim N\left(\hat{\theta}, 1/\hat{\tau}_1\right)$, with conditional mean $\hat{\theta}$ and conditional belief precision $\hat{\tau}_1$, given by

$$\hat{\theta} = \bar{\theta} + \frac{\tau_\varepsilon}{a_1^2\tau_\theta + \tau_\varepsilon}\left(\frac{1}{2}\log y - a_1\bar{\varepsilon}\right),$$

$$\hat{\tau}_1 = \tau_\theta + \frac{1}{a_1^2}\tau_\varepsilon.$$

Notice that $\frac{\tau_\varepsilon}{a_1^2\tau_\theta + \tau_\varepsilon}$ is the signal-to-noise ratio of the output signal, which is decreasing with a_1. That is, a smaller a_1 leads to a more precise signal about θ, which helps the policymaker improve his policy choice a_2 in $t = 2$. Formally, after updating his belief, the policymaker chooses a_2 at $t = 2$ to maximize the continuation problem: $\max_{a_2} E\left[-(\theta - a_2)^2 \mid a_1, \log y\right]$.

By backward induction, the policymaker chooses a_1 at $t = 1$ to maximize his objective function in (1) by internalizing the impact of a_1 on the precision of the output signal. His optimal choice a_1^* trades off the tracking error of choosing $a_1^* \neq \bar{\theta}$ with the increased informativeness of the output signal $\log y = 2(\theta + a_1^*\varepsilon)$. In equilibrium, he chooses $a_1^* < \bar{\theta}$ at $t = 1$, and a_2^* at $t = 2$ to match the updated expectation of θ after observing $\log y$: $a_2^* = \hat{\theta}$. We derive the equilibrium in the following proposition with the proof appearing at the end of Section IIIB.

PROPOSITION 1: *In the absence of financial markets, the policymaker chooses a gradual policy* $\{a_1^*, a_2^*\}$, *with* $a_1^* < \bar{\theta}$ *as the unique, positive root of*

$$(3) \qquad (\bar{\theta} - a_1^*)(a_1^{*2}\tau_\theta + \tau_\varepsilon)^2 = a_1^*\tau_\varepsilon,$$

and $a_2^* = \hat{\theta}^*$, *and private agents choose* $\log k = \theta + 2a_1^*\varepsilon$.

The policymaker does not fully adjust a_1 to $\bar{\theta}$, which would be the ex post optimal policy, because a lower choice of a_1 reduces the noise in the output signal about θ. This "experimentation benefit of small steps" motivates policy gradualism. The gradual adjustment toward the ex post optimum, however, also gives rise to a time-inconsistency issue when we introduce financial markets in the next section. As we will see, this can lead to unintended consequences of financial market liberalization for policy gradualism.

III. Time Inconsistency with Financial Markets

Financial markets give private agents financial flexibility to make investment decisions even before the policymaker chooses the policy a_1. Instead of having to rely on state-controlled banks for financing, they can obtain financing from financial markets. Competition among private agents for limited real investment opportunities, however, forces them to act before the policymaker chooses a_1. As before, the policymaker only observes the output of firms at the end of $t = 1$. The presence of financial markets has a profound impact on the game between the policymaker and private agents. Agents make investment decisions ahead of the government policy. Consequently, the policymaker faces the well-known time-inconsistency problem in setting its optimal policy.

We will distinguish between a setting in which the policymaker can precommit to a policy rule prior to any information revelation, say at $t = 0$, which we refer to as the "principled approach," and a setting in which the policymaker cannot precommit, which we call the "pragmatic approach."

A. *"Principled Approach" with Commitment*

Suppose that the government has a commitment technology that allows it to credibly set policies ex ante that may not necessarily be optimal ex post. In this case, the timing of actions by the policymaker and private agents is irrelevant, and the equilibrium coincides with that outlined in Proposition 1. The policymaker precommits to choosing a_1^*, despite that private agents now make their investment decisions earlier. Since private agents form rational expectations, they choose their investment conditional on a_1^*, correctly anticipating that the policymaker will choose a_1^* at $t = 1$. With commitment, the Chinese government can implement a stimulus policy of slowly expanding credit availability, leading to a gradual expansion of leverage and China's shadow banking system.

Notice, however, that the policymaker's choice of a_1^* is not ex post efficient. After private agents make their investment choices, the policymaker would prefer to choose $a_1 = \bar{\theta} > a_1^*$. This gives rise to a time-inconsistency problem for a government that cannot commit.

B. *"Pragmatic Approach" without Commitment*

A government without a commitment technology cannot credibly announce a policy rule before the agents choose their investment decisions. Now, private agents must form rational expectations about what policy a_1 the policymaker will choose. In this case only policies that are optimal ex post (i.e., $a_1 = \bar{\theta}$) can arise in equilibrium. To see this, we recognize that once the agents make their investment choice based on this expectation, the informativeness of the output signal is determined. Consequently, the policymaker finds it best to choose the ex post efficient $a_1^{**} = \bar{\theta}$, which, in turn, justifies the agents' expectation. As is well known, the equilibrium without commitment delivers a lower ex-ante expected utility to the policymaker. The next proposition summarizes this equilibrium, and we omit the proof.

PROPOSITION 2: *When the government cannot commit to policies, no gradualism emerges. The policymaker chooses* $a_1^{**} = \bar{\theta}$ *and* $a_2^{**} = \hat{\theta}^{**}$, *and private agents choose* $\log k = \theta + 2a_1^{**}\varepsilon$. *Furthermore, the policymaker has an expected utility (weakly) lower than that in the case of commitment.*

In the absence of commitment by the government, private agents invest more aggressively and the signal-to-noise ratio of the output signal $\log y$ is lower, relative to the case with government commitment, which is also equivalent to the case without financial markets. As such, while the government achieves its ex post optimal policy $a_1^{**} = \bar{\theta}$, the reduced informativeness of the output signal induces a loss to the policymaker, lowering the policymaker's expected utility. In a realistic world where the Chinese government cannot commit to a gradual credit stimulus policy, leverage rises faster since financial markets anticipate the policy's subsequent abandonment. As a result, China's shadow banking system expands quicker than it would in the absence of financial markets, and at the expense of the informativeness of real signals useful for future policy adjustments.

Proposition 2 shows that, by giving private agents greater flexibility in financing their investment decisions, financial markets present a challenge to the gradualistic approach preferred by the policymaker. When the policymaker cannot precommit to a policy rule, he faces a time-inconsistency problem. This renders the gradualistic approach through experimentation, China's "crossing the river by touching the stones" approach, ineffective.

PROOF OF PROPOSITION 1:

Given the policymaker's posterior belief at $t = 2$, his optimization problem is

$$\sup_{a_2} -\left(\hat{\theta} - a_2\right)^2 - \hat{\tau}_1^{-1}(a_1).$$

Since $\hat{\tau}_1^{-1}(a_1)$ is independent of a_2, we have $a_2^* = \hat{\theta}$. Working by backward induction, we substitute a_2^* into the policymaker's objective at $t = 1$ to derive a_1:

$$U_0 = \sup_{a_1} -\left(\bar{\theta} - a_1\right)^2 - \tau_\theta^{-1} - \hat{\tau}_\theta^{-1}$$

$$= \sup_{a_1} -\left(\bar{\theta} - a_1\right)^2 - \tau_\theta^{-1} - \left(\tau_\theta + a_1^{-2}\tau_\varepsilon\right)^{-1}.$$

The first order condition gives that the optimal choice a_1^* satisfies equation (3), which is a quintic polynomial equation.

Suppose $a_1 > 0$, then the right-hand side of equation (3) is positive, which implies that $a_1 < \bar{\theta}$. Suppose instead that $a_1 < 0$. Then the right-hand side of equation (3) is negative, but the left-hand side is always positive, which is a contradiction. Thus, any real root of equation (3) satisfies $0 < a_1 < \bar{\theta}$. Further note that the right-hand side of (3) is strictly increasing in a_1 from 0 to $\bar{\theta}$, and the left-hand side is decreasing in a_1 by directly computing its derivatives. Thus, if a real, positive root exists, it is unique and strictly positive. Define $f(a_1) = a_1\tau_\varepsilon - \left(\bar{\theta} - a_1\right)\left(a_1^2\tau_\theta + \tau_\varepsilon\right)^2$, which is a continuous function with $f(0) = -\bar{\theta}\tau_\varepsilon^2$ and $f(a_1) = \bar{\theta}\tau_\varepsilon$. Thus, by the intermediate value theorem, there exists a_1^* such that $f(a_1^*) = 0$. Taken together, there exists a unique positive, real solution a_1^* to equation (3), satisfying $0 < a_1^* < \bar{\theta}$. ∎

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