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A Simple Monetary Model of a Shortage Economy

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Abstract

During the transition from a centrally planned economy to a market economy, many countries seem to have experienced some degree of macroeconomic instability. This paper attempts to provide a theoretical explanation of this phenomenon. The paper develops a simple monetary model and shows how macroeconomic stability can be achieved in a rigid centrally planned economy, despite the inherent structural imbalances and irrational price system. On the other hand, the study shows that without hardening enterprise budget constraints, wage and price decontrol tends to destabilize the economy and may lead to persistent budget deficits and inflation. The paper also provides a rigorous analysis of household savings and money demand in a shortage economy, and clarifies the somewhat confusing concept of "monetary overhang" in the literature.

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Summary

In the transition from centrally planned economies to market economies, many countries have experienced some degree of macroeconomic instability. This paper attempts to provide a theoretical explanation of the phenomenon.

The paper develops a simple monetary model and shows how macroeconomic stability can be achieved in a rigid centrally planned economy, despite structural imbalances and an irrational price system. The study also shows, however, that structural imbalances and an irrational price system may frustrate structural reform efforts. For example, price decontrol may benefit some firms at the expense of others, and in the presence of soft budget constraints on enterprises, these benefits may translate into wage pressures that could lead to persistent budget deficits and high inflation.

The paper also analyzes household savings and money demand in a shortage economy and suggests that the notion of "forced savings" or "monetary overhang" remains a concept in search of a rationale. The analysis shows that as long as some goods are in surplus or black markets exist, there are no involuntary money holdings. Households reserve money for official transactions, savings, or black market activities.

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I. Introduction

During the transition from a centrally planned economy to a market oriented economy, many governments seem to lose some degree of macroeconomic control (Blejer, et al. (1991), Khor (1991) and McKinnon (1991)). The purpose of this paper is to provide a theoretical explanation of this phenomenon. The paper develops a simple monetary model and illustrates how a centrally planned economy functions and how macroeconomic stability can be achieved under a rigid planning system. It shows that inherent structural imbalances and the irrational price system in a centrally planned economy may frustrate structural reform efforts. In the presence of soft budget constraints on enterprises, price reform that benefits some sectors at the expense of others may translate into wage pressures, that in turn may squeeze enterprise profits and lead to persistent budget deficits and high inflation.

The organization of the production and the distribution of goods and services in a centrally planned economy has been extensively documented in the literature (Chow (1985), Kornai (1992) and IMF, et al. (1991)). There are two important features that are widely recognized as being present in a classic centrally planned economy. The first is low efficiency. The planning, coordination and monitoring of economic activities of a large number of enterprises requires too much information about each and every economic agent. It implies unrealistic moral and ethical self-discipline, and is very difficult to implement efficiently.

The second important feature of a centrally planned economy is the inability of central planners to adjust prices, wages and production flexibly so that equilibrium can be maintained. This inability leads to constant tension between supply and demand and results in a chronic shortage of some consumer goods. Since the purpose of this study is to examine the relationships between key macro variables such as the money supply, the budget deficit, inflation, etc., the paper will abstract from efficiency issues, and focus instead on the imbalances between aggregate supply and aggregate demand and on price and wage policies.

The framework used is a cash-in-advance model with two perishable consumption goods, and four types of agents: households, firms, government and a central bank. In our model, government owns all firms and decides what quantity of productive resources should be allocated to each sector. In particular, it decides how much aggregate labor input is to be devoted to the production of one good versus another. Government determines wages and the prices of both goods in the model. Since the prices of both goods are rigidly fixed and resource allocation (to each sector) is considered arbitrary, the supply of goods does not necessarily reflect consumers' preferences (thus consumer demand), and the goods market does not necessarily clear under the administrative prices, with possibly one good in excess supply (the surplus good) and the other in excess demand (the deficit good).

Individuals are required to supply a fixed amount of labor each period. The rest of their time can be freely spent on leisure and/or black market activity. The existence of deficit goods implies that there are shortage

rents to be sought by economic agents. There are two main channels through which the shortage rents are allocated. One channel is through rationing, in which case the rents are directly transferred to households. The second channel is through random distribution to shoppers. More specifically, goods are randomly distributed to government-owned shops, which sell them to shoppers on a first-come, first-served basis. Our analysis assumes that the second channel is adopted by the government. 1/ Thus, an individual can spend time shopping for the deficit good and resell it in the black market to make a profit. In equilibrium, the payoff of engaging in such an activity must be equal the marginal utility of leisure.

Firms have no control over either employment of labor, the wages of workers, or over the prices of their products. On the other hand, they rely on government to balance their books. If a firm makes a profit, government taxes it all away; if a loss is incurred, government covers the entire loss through subsidies. This is the notion of soft budget constraints as posited by Kornai (1986). The government relies on its banker—the central bank—to finance its budget. If total tax revenue does not cover total spending, the shortfall will be financed by printing money. In the unlikely case that the government runs a budget surplus, the surplus money would be turned over to the central bank and total money in circulation would decrease.

The paper shows that in a classic centrally planned economy, as described above, if the aggregate wage level is moderate, a steady-state equilibrium exists in which the government budget is balanced, money supply and prices are stable, and there is no **monetary overhang**. 2/ In other words, despite the existence of tension between aggregate demand and aggregate supply under the administrative prices and the existence of deficit and surplus goods, macroeconomic stability can be achieved in a rigid planning economy and the system can be sustained. 3/ The existence of black markets diverts resources away from productive activity; however, it serves to bridge the imbalances in the economy and helps it to reach equilibrium. Thus, there has been perhaps too much emphasis to disequilibrium in rigid centrally planned economies such as China and the former Soviet Union. Our model seems to provide a reasonable description of the macroeconomic conditions in China before 1978 and in the former Soviet Union before 1985, when both countries enjoyed relative macroeconomic stability (McKinnon (1991) and IMF, et al. (1991)).

1/ Empirically, both methods have been observed and the first one seems to be more popular. However, to the extent that the first distribution measure is essentially equivalent to an increase in the wage rate and the two measures co-exist, our assumption would not affect the final conclusion.

2/ There are various definitions of "monetary overhang" (Cottarelli and Blejer (1992)). In this paper, a monetary overhang is defined as household money balances minus voluntary demand for money.

3/ This sustainability is only from a purely macroeconomic perspective. It does not imply political sustainability.

The second part of the paper addresses the issues of wage and price reforms in a centrally planned economy. In a traditional centrally planned economy, some firms are profitable and their profits are taxed away by the government to subsidize the unprofitable firms. Since resources are allocated largely through administrative means and prices are irrational, the line between profitable and unprofitable firms is arbitrary. Nevertheless, there are efficiency differentials among different enterprises and government's redistribution of the profits among firms does create tension. With economic decisions being decentralized, many profitable firms find themselves under pressure to increase wages. We consider two types of wage reform. The first allows profitable firms to retain a fixed percentage of their profits to be used as wage increases. The second reform proposal assumes that government still maintains rigid wage control, but allows some percentage of profits to be shared by workers as bonuses.

The study shows that the first type of wage reform leads to a continuous squeeze of total profits from profitable firms and a steady decline in tax revenues. Since government does not reduce its financial obligations to unprofitable firms, the budget deficit worsens, and the deficit-induced money printing may lead to an economy-wide shortage and plunge the economy into crisis. On the other hand, it is shown that the second reform proposal is sustainable. Even though the initial loosening of financial control has an expansionary impact and somewhat aggravates the shortage, it does not lead to continuous budget deficits and thus money printing, and from a macroeconomic perspective, it is sustainable. However, with production and prices still rigidly controlled by the government, both reforms tend to worsen shortage and reduce household welfare.

The third part of the paper examines price reforms with and without wage control. The analysis shows that price liberalization with rigid wage control leads to a temporary surge in the price level. Price decontrol would improve household welfare by eliminating shortage and by freeing resources from being wasted in nonproductive black market activity. However, owing to adjustments in relative prices, price decontrol tends to benefit some firms at the expense of others, which in turn puts pressure on profitable firms to loosen wage control, especially when there is a price surge that follows price liberalization. If government cannot reduce the pressure and accommodate workers' demands, there is a danger of rapid inflation or even hyperinflation.

Our study indicates a dilemma that governments of the reforming centrally planned economies have to face. To the extent that the old wage and price structures are irrational and impede efficiency, there is an urgent need to liberalize wages and prices. However, with most of the firms still in the hands of the state, price decontrol and decentralization of financial decisions may lead to a loss of macroeconomic control and destabilize the economy. The ultimate solution seems to lie in changing the incentive and control system via the privatization process.

The rest of the paper is organized as follows. Section II develops a basic cash-in-advance model of a centrally planned economy. Section III

uses the framework set out in Section II to analyze the relationships between key macro variables in a classic centrally planned economy in which the government maintains rigid control over production, employment, wages and prices. Section IV studies the macro implications of wage reform while maintaining rigid price control, and Section V studies price reform with and without wage control. Finally, Section VI provides a few concluding remarks.

II. The Basic Model

In this section, we develop a simple general equilibrium monetary model of a centrally planned economy in which there are two perishable consumption goods, x and y , and four types of agents: households, firms, government and a central bank. It is assumed that the government owns all firms, fixes wages and prices, and determines how much labor to employ in each firm. The model forms the basic building block for our analysis in later sections.

1. Financial flow patterns

Figure 1 describes the patterns of financial flow in our hypothetical centrally planned economy. In this economy, there are four types of players, as specified above. The cash flow patterns between players are illustrated by arrow signs in the figure. At the beginning of period t , firms hire labor to produce two types of non-storable consumer goods (depending on the specific firm), x and y . Firms do not pay workers until the end of period t . During time period t , firms turn out products that are sold in state shops at prices fixed by government. Individuals use the money accumulated in the previous period, M_{t-1} , to purchase goods available in the market. The revenue from the sale of output is used to pay the wage bill at the end of period t . For a specific firm, if the revenue exceeds the total wage payment, it makes a profit; if the revenue falls short of the total wage bill, it incurs a loss. Government taxes away all profits of profitable firms and with the surplus fully compensates for the losses of the unprofitable firms. If government's tax revenue from enterprise profits is less than its subsidies to unprofitable firms, it turns to the central bank for financing of the deficit. If government has a budget surplus, the surplus money would be turned over to the central bank.

Since government controls production and prices, imbalances between supply and demand are likely to occur, with possibly some goods in surplus and the others in deficit. The existence of a deficit good implies that there are shortage rents to be sought by individuals. There are two main channels through which the rents can be dissipated. The first is through rationing, in which case the shortage rents are directly transferred to individuals. The second is through random distribution to shoppers. That is, goods are randomly distributed to government-owned shops, which sell those goods according to availability and the early arrival of shoppers. This paper assumes that government adopts the second channel to distribute the deficit good. Hence, an individual can spend time shopping for the deficit good and resell it in the black market to make a profit.

Figure 1. Financial Flow Patterns

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2. Households

Individual households derive utility from leisure and the consumption of both goods x and y . Assuming that they have the following utility function:

$$U = \sum_{t=0}^{\infty} \beta^t u(h_t, x_t, y_t), \quad 0 < \beta < 1, \quad (1)$$

where β is the discount rate, h_t is leisure, and x_t and y_t are per household consumption of goods x and y in period t , respectively. In the following analysis, unless otherwise specified, all quantity variables are in per household terms.

The only asset in the economy is cash and there is no capital market to facilitate borrowing and lending. Consumers are subject to cash-in-advance constraints. Let p_t^x and p_t^y be the shadow prices of goods x and y in the black market. Noting that consumers can spend time queuing to purchase goods at lower prices at state shops (and thus earn shortage rent), we have

$$N_t + p_t^x x_t + p_t^y y_t \leq M_{t-1} + q_t R_t, \quad N_t \geq 0, \quad (2)$$

where N_t is the unused cash balance in period t , and M_{t-1} is the cash balance accumulated by individuals up to time period $t-1$, q_t is the time spent on queuing, and R_t is the rate of return from queuing. Here, we assume that unused money balances earn zero interest, and that the money balances in the initial period $t=0$, M_1 , are given.

By assuming that the shortage rent earned through queuing can be immediately spent without delay, we essentially assume that black market transactions are frictionless since no money is demanded in the black market. Alternatively, we can assume that shortage rent earned in period t can only be spent in period $t+1$. ^{1/} With this friction, there is a transaction demand for money in the black market. In steady state, however, these two cases have identical implications for consumption. In the following analysis, we choose the frictionless case for presentational

^{1/} Hypothetically, one can imagine a case in which there is a large variety of the same consumer good. Each household can only stay in line to shop for a few varieties of the good at official prices. Since households would rather have a more diversified consumption package, they will resell the goods in the black market to make a profit and use the money to purchase other varieties of goods. Assume that consumers must have cash in advance to purchase goods in the black market, profits thus made can only be spent in the next period. In that case, household budget constraint becomes:

$$N_t + p_t^x x_t + p_t^y y_t \leq M_{t-1},$$

where $M_{t-1} = w_{t-1} + q_{t-1} R_{t-1}$.

simplicity. However, when there is an important difference, we will refer back to the friction case.

In every period, each representative household is required to supply a fixed amount of labor and earn wage w_t , which is determined by government. In addition, each household has one unit of time to be allocated between two activities—leisure and queuing. Let h_t and q_t denote the time spent on leisure and queuing, respectively, and we have:

$$h_t + q_t \leq 1. \quad (3)$$

The money balances accumulated by each household at the beginning of period $t+1$ are the wage earnings in period t plus the unused cash balances from the previous period, i.e.,

$$M_t = N_t + w_t. \quad (4)$$

At time period $t=0$, for given money balances M_1 , each individual household tries to maximize its utility expressed in equation (1), subject to the budget constraints (2)–(4). Taking the prices of both goods and the rate of return to queuing R_t as given, solving the maximization problem yields each household's demand for leisure, h_t , and the demand for consumption of goods x and y , x_t and y_t , respectively.

3. Firms

There are two types of firms in the economy, with one producing good x and the other producing good y . Labor is the only input and is rigidly planned by government to achieve certain production targets, say X for good x , and Y for good y . The government fixes wages and prices of both goods x and y . Denote the official prices for goods x and y by p^x and p^y , and the wage costs for firms of type j ($j=x,y$) by w_t^j , respectively, the profits of the two types of firms are,

$$\pi_t^x = p^x x_t - w_t^x, \quad x_t \leq X; \quad \pi_t^y = p^y y_t - w_t^y, \quad y_t \leq Y. \quad (5)$$

If π_t^j ($j=x,y$) is negative, firms of type j incur losses.

4. Government

In a classic socialist economy, all firms are owned by the government. If a firm makes a profit, it does not belong to the firm, rather, the government taxes most of it away in the form of turnover taxes. On the other hand, enterprises have soft budget constraints. If a firm incurs a loss, the government will cover the loss by providing subsidies. ^{1/} Assuming that profit taxes are the only source of tax revenue, and that the

^{1/} For instance, in China, the Government spent almost one fifth of its budget by subsidizing loss-making firms in 1991.

only expenditure of government is its subsidies to loss-making firms, then the budget deficit, D_t , is:

$$D_t = -(\pi_t^x + \pi_t^y). \quad (6)$$

As illustrated in Figure 1, if the government budget is in deficit ($D_t > 0$), the deficit would be financed by the central bank through money printing. For given D_t , the net money printing in period t is:

$$\Delta M_t = M_t - M_{t-1} = D_t. \quad (7)$$

5. Equilibrium

In a competitive dynamic economy, an equilibrium is usually defined as a sequence of prices that clear all markets in all time periods. In a centrally planned economy, such a definition no longer applies. Since government rigidly fixes prices and wages, the markets for goods do not necessarily clear. In the model set out above, for given wages $\{w_t\}$, if in a certain time period the demand for good j under the official price exceeds its supply, the black market activity would drive the shadow price above the official price until the market for good j is cleared. If, however, the demand for good j under the official price is below the supply of good j , the official price would prevail. In this case, we regard the official price as an "equilibrium" price since the price can be maintained by government without the use of other administrative means. Bearing this in mind, we define a dynamic equilibrium in our model as a sequence of prices $\{p_t^x \geq p^x, p_t^y \geq p^y\}$ that satisfies the following condition: if for some t , $p_t^j > p^j$ ($j=x,y$), the demand for good j must be equal to the supply of good j .

III. The Rigid Central Planning System

With the basic framework set out in the previous section, we are ready to examine the relationships between key macro variables such as money supply, the budget deficit, wage and pricing policies, etc. As will be seen later, we show that for a moderate wage level (relative to the official prices of goods), the economy converges to a steady state equilibrium in which one good is a deficit good, and the other is a surplus good. For the deficit good, the black market transaction bridges the imbalances between demand and supply that would have occurred under the official price. In the steady-state equilibrium, the government budget is balanced, and the money supply is constant. Thus, under the rigid system, macroeconomic stability can be achieved. The aggregate money balances are absorbed either through official transactions or through black market transactions, or both. There is no involuntary money hoarding.

For simplicity, we assume that under a rigid planning system government fixes prices of both goods at one, and the wages in firms of type x and y at w^x and w^y , respectively. That is,

$$p^x = p^y = 1; \quad w_t^x = w^x, \quad w_t^y = w^y. \quad (8)$$

Under such assumptions, the wage income in one period for an average household is $w=w^x+w^y$. The utility maximization problem of a household can be rewritten as:

$$\underset{\{h_t, x_t, y_t, N_t\}}{\text{Max}} \quad U = \sum_{t=0}^{\infty} \beta^t u(h_t, x_t, y_t), \quad (9)$$

subject to,

$$N_t + h_t R_t + p_t^x x_t + p_t^y y_t \leq M_{t-1} + R_t, \quad N_t \geq 0, \quad (10)$$

$$M_t = N_t + w, \quad (11)$$

where equation (10) is a combination of equations (2) and (3). Let J_t be the value function for period t . Obviously, J is only a function of the initial cash balances M_{t-1} , i.e., $J_t = J(M_{t-1})$. 1/ It follows from the principle of optimality that

$$J(M_{t-1}) = \underset{\substack{\{h_t, x_t, y_t, N_t\} \\ \text{s.t. (10)-(11)}}}{\text{max}} \quad \{u(h_t, x_t, y_t) + \beta J(M_t)\} \quad (12)$$

To characterize the dynamic equilibrium of the economy, we divide our analysis into two parts. First, we focus our analysis within one period. Recall that in every time period t , the resource available for an individual household, $M_{t-1} + R_t$, is decomposed into two components, the household's consumption of goods as well as of leisure, measured in terms of shadow prices, $h_t R_t + p_t^x x_t + p_t^y y_t$, and the unused cash balances, N_t . Noting that

1/ In general, J should be only a function of real variables. In our model, government fixes prices of consumer goods in official markets. A different initial nominal money balance implies a different degree of shortage and thus black market activity, which has a real impact on household welfare.

the income from black market transactions is equal to the total shortage rent, $\frac{1}{2}$

$$q_t R_t = (\max\{p_t^x, 1\} - 1)X + (\max\{p_t^y, 1\} - 1)Y. \quad (13)$$

Substituting (13) into (2), it follows that:

$$N_t + x_t + y_t = M_{t-1}. \quad (14)$$

In other words, $M_{t-1} - N_t$ is the amount of money a representative household spends in state shops.

In the following, we show that, for any time period t , if one knows the amount of $M_{t-1} - N_t$, the equilibrium prices for the two goods, p_t^x and p_t^y , the wage rate in black market transaction, R_t , the demand for leisure, h_t , and the demand for consumption goods, x_t and y_t , are all determined in that particular time period.

More specifically, taking p_t^x , p_t^y and R_t as given, each individual household maximizes its utilities $u = u(h_t, x_t, y_t)$, subject to the following budget constraint:

$$R_t h_t + p_t^x x_t + p_t^y y_t \leq I_t + R_t, \quad (15)$$

where $I_t = M_{t-1} - N_t$. Since there are three choice variables, h_t , x_t and y_t , solving the maximization yields three first-order conditions. These three first-order conditions, together with constraints (3), (13) and the two

$\frac{1}{2}$ If demand for at least one good at the official price exceeds the supply of that good, the economy faces shortage and there are shortage rents to be sought. To model how the shortage rents are dissipated, we follow the approach in Osband (1991). Assuming that good x is in shortage, and that the shadow price of x , p^x , is higher than its official price $p=1$, i.e., $p^x > 1$, then, households can stay in line to buy good x at the official price and resell it in the black market to make a profit. Let R be the marginal utility of leisure measured in currency units, q^j the queuing time for shopper j , Q_{-j} the total queuing time of all shoppers other than j , and N the total number of households in the economy. With a total NX units of good x for sale in official markets, a shopper chooses q^j to maximize:

$$NX(p^x - 1) \frac{q^j}{Q_{-j} + q^j} - Rq^j,$$

which is the expected shortage rent received minus costs. For a large enough N , competition assures that in equilibrium, $RNq^j = NX(p^x - 1)$, or $Rq^j = X(p^x - 1)$. That is, all shortage rents are dissipated. If both goods x and y are in shortage, then, in equilibrium, (13) holds.

market clearing conditions for goods x and y , uniquely determine the seven unknowns, h_t , q_t , x_t , y_t , p_t^x , p_t^y and R_t . 1/

The shadow prices of goods x and y as determined are a function of the cash balances spent in state shops, I_t . Under moderate restrictions on preferences, it can be shown that both prices are nondecreasing in I_t , i.e., the more an average household spends, the higher the prices of goods x and y . Here we state without proof the following lemma:

Lemma 1. Let $p_t^x = p^x(I_t)$, $p_t^y = p^y(I_t)$. Then, $dp^x/dI_t \geq 0$, $dp^y/dI_t \geq 0$, with at least one strictly positive.

To complete our characterization of the dynamic equilibrium, we next turn to the intertemporal consumption and saving decisions of households. For given initial cash balances M_1 and wage rate w , we need to determine each household's savings, $\{N_t\}$, from time $t=0$ to infinity. If $\{N_t\}$ is determined, $M_{t-1} - N_t$ is known for all t . Therefore, from the above analysis, the equilibrium prices for every time period (and thus for the whole equilibrium path) are determined.

Before we proceed, some discussion on the aggregate wage level set by government is necessary. In our hypothetical central planning economy, the per household output valued at state prices is $X+Y$ in every period. The wage paid out to each household is w . If $w > X+Y$, firms' revenues never cover their wage bills. Consequently, government has to continuously turn to printing money to cover the losses. In the frictionless case, there is no demand for money in black market transactions. The official market transactions cannot absorb all the cash balances of households. No equilibrium exists. 2/

If there is a cash-in-advance constraint on black market transactions, black market activities will absorb part of the cash balances held by households and an equilibrium exists. In the long run, however, as the money supply keeps growing without bound, all goods are in shortage and the black market prices for both goods will continue to rise. As shortage grows more and more acute, individual households will spend more and more time queuing and their welfare will worsen continuously (see Barro and Grossman (1974), Bennett and Phelps (1988) and Osband (1991)).

If $w = X+Y$, initially, before all goods are sold in state shops at official prices (i.e., there are surplus goods), the revenues of firms do

1/ Owing to the rigid control of prices, if demand at official prices does not exceed the supply, we regard the market as "cleared." As an illustration, assume that $I=2.5$, $X=1$, $Y=2$, and the utility function $u(h,x,y)=\ln h+\ln x+\ln y$. By solving the problem, one can uniquely determine $h=3/4$, $q=1/4$, $x=1$, $y=1.5$, $p^x=1.5$, $p^y=1$ and $R=1/4$. Obviously, good x is in shortage, and good y is in surplus.

2/ In this kind of hypothetical situation, disequilibrium could be characterized as an emerging monetary overhang or "forced" saving.

not cover their wage bills, and government has to print money to bail out some firms. Over time, as households' money balances grow, demand for goods at the official prices grows and eventually all goods are in shortage. 1/ Similar to the case of $w > X+Y$, if there is no friction in the black markets, no equilibrium exists.

If there is a transaction demand for money in the black market, an equilibrium may exist. The main difference here is that money supply will not necessarily grow without bound. The reason is that after all goods are in shortage, the sale revenue of products at official prices is $X+Y$, which is exactly equal to the wage payment w . At that point, the government's budget is balanced and there is no increase in money supply. The economy reaches a steady-state equilibrium.

The above cases indicate that, under assumption $w \geq X+Y$, all goods will eventually be in short supply and the situation is explosive. While this may resemble the extreme disequilibrium situation in the former Soviet Union in late 1991—when real wages went beyond government's control and grew at much higher rates than labor productivity, and shortage became more acute and widespread—we normally observe more stable economic conditions in a centrally planned economy. More importantly, the assumption violates the fundamental planning philosophy in a classic socialist economy which states that the social aggregate demand and aggregate supply must be balanced. In the rest of this section, we restrict the analysis to the case in which government has perfect control over wages and $w < X+Y$. 2/

Lemma 2. Suppose that an equilibrium exists. If $M_1 \leq w$, then $N_0 = 0$.

Proof. Suppose that $I_0 < M_1$, $N_0 = M_1 - I_0 > 0$. Then, the cash balances available for a representative household to spend in period $t=1$ are $N_0 + w > M_1$. We claim that a household would spend no more than I_0 in period $t=1$, i.e., $I_1 \leq I_0$. Otherwise, goods prices in period $t=1$ would be higher (Lemma 1). A rational household could have increased period $t=0$ spending by a small amount, while decreasing its spending in period $t=1$ by the same amount, to raise its utility level. Apply the same argument to periods $t=2, 3, 4, \dots$, we conclude that the spending level decreases over time. In other words, an average household would accumulate cash balances without bounds. This is inconsistent with utility maximization, since an individual household could have increased consumption and thus its utility level by reducing cash balances. ■

1/ Here, we implicitly assume that as income rises, household demand for goods x and y will eventually exceed their supply. Otherwise, the analysis is identical to the case of $w > X+Y$.

2/ Assumption $w < X+Y$ essentially says that the aggregate wage level is smaller than the aggregate output measured at official prices. Considering some products are not sellable, or do not even enter household utility function (such as excessive military goods), the assumption is not as restrictive as it appears.

Lemma 2 says that in period $t=0$, if the initial cash balances are smaller than the permanent wage earnings, w , a household would simply spend all of its cash balances and save nothing.

Lemma 3. Suppose that an equilibrium exists. If $M_{-1} > w$, then a $T > 0$ exists, such that $N_t > N_{t+1}$, $0 \leq t \leq T$, and $N_t = 0$, for $t > T$.

Proof. Note that in each period t , household consumption of leisure and consumer goods are a function of spending $M_{t-1} - N_t$. Substituting them into (12) and differentiating both side of the equation yields the following (Levhari and Srinivasan (1969) and Schechtman and Escudero (1977)):

$$\frac{dJ(M_{t-1})}{dM_{t-1}} = \frac{du(h_t, x_t, y_t)}{dM_{t-1}}; \quad \frac{dJ(M_{t-1})}{dM_{t-1}} = \beta \frac{dJ(M_t)}{dM_t}, \quad (16)$$

where the first equation says that the marginal utility of initial cash balances in period t is equal to the marginal utility of consumption from spending an extra unit of cash, provided that the entire consumption and saving policy is optimal; the second equation says that if savings are positive, $N_t > 0$, the marginal utility of cash balances in the present period must be equal to the marginal utility of cash balances in the next period, discounted by a factor β .

Suppose that no integer T exists, such that $N_t = 0$, for $t > T$, it follows from Lemma 2 that savings must be positive every period, i.e., $N_t > 0$, for all t . ^{1/} Hence,

$$\frac{dJ(M_0)}{dM_0} = \beta^t \frac{dJ(M_t)}{dM_t}, \quad \forall t > 0. \quad (17)$$

Noting that $dJ(M_0)/dM_0 > 0$ and $\beta < 1$, it follows that:

$$\lim_{t \rightarrow \infty} \frac{dJ(M_t)}{dM_t} = \lim_{t \rightarrow \infty} \frac{du(h_{t+1}, x_{t+1}, y_{t+1})}{dM_t} = \infty. \quad (18)$$

Following the proof of Lemma 2, we know that, in each period t , the spending in state shops, $M_{t-1} - N_t$, must be at least as high as one period's wage earning, w . Obviously, the marginal utility that can be derived from an extra unit of spending is bounded from above, which is a contradiction of equation (18).

Let T be the smallest integer that satisfies the following: $N_t = 0$, for $t > T$, then, $N_t > 0$, for $t \leq T$. Since savings are strictly positive up to period T and $\beta < 1$, the marginal utility of consumption is increasing until period T , which implies that real consumption and savings are decreasing until period T . That is, $N_t > N_{t+1}$, for $t \leq T$. ■

^{1/} According to Lemma 2, if a $T > 0$ exists, such that $N_T = 0$, then $N_t = 0$, for all $t \geq T$.

Lemma 3 says that if the initial cash balance exceeds per period wage income, w , households would run down excessive money balance, $M_1 - w$, in finite periods. After that, households simply spend the entire wage earning from the previous period, plus the black market rent earned through queuing in every period. Combining Lemmas 2 and 3, we have shown that if an equilibrium exists, it converges in finite periods to a steady state. For simplicity, in the rest of this section we limit our analysis to the case in which the initial cash balances do not exceed w . 1/

Proposition. Suppose that $w < X + Y$ and $M_1 \leq w$. Then, there exists a steady-state equilibrium and the economy converges to it in one period. In the steady state, at least one good is a surplus good. 2/

Proof. Let $N_t = 0$, for all $t \geq 0$. Then, $I_0 = M_1$, $I_t = w$, $t \geq 1$. It can be readily checked that $\{p^x(I_t), p^y(I_t), t \geq 0\}$ is an equilibrium. Obviously, starting from period $t = 1$, the equilibrium coincides with the steady-state equilibrium $\{p^x(w), p^y(w)\}$. It is also clear that in the steady-state equilibrium, at least one good is a surplus good. Otherwise, both goods would be sold out in state shops (at prices $p^x = p^y = 1$), bringing in revenue $X + Y$. Since an average household's spending in state shops is only w , this is a contradiction. ■

The above analysis has shown that for a moderate wage level, $w < X + Y$, the economy converges to its steady-state equilibrium in which at least one good is a surplus good. In the steady state, firms of type j ($j = x, y$) make a profit of:

$$\pi^x = x - w^x, \quad x \leq X; \quad \pi^y = y - w^y, \quad y \leq Y. \quad (19)$$

Noting that $N_t = 0$, it follows from (14) that:

$$\pi^x + \pi^y = 0. \quad (20)$$

Hence, in the steady state, government's tax revenue exactly covers its expenditure and there is no money printing, $\Delta M = 0$. Intuitively, the story is as follows. If initial household money balances are higher than wage income w , households will initially dissave (Lemma 3) and their spending at state shops will exceed wage income. In other words, the overall revenues of firms exceed total wage payments and firms make a net profit. The profit is also the government's surplus, which is turned over to the central bank. Over time, as households' "excessive" balance dissipates, the profits of firms fall to zero and the government budget surplus disappears. On the other hand, if initial household money balances are below wage income, total

1/ The results hold for any initial cash balances M_1 .

2/ It is clear that as long as the per household wage level is not too low and the official prices are not market-clearing prices, at least one good will be in shortage.

household spending at state shops is below firms' total wage payments. The net profit of all firms is negative and the government runs a budget deficit, which implies an injection of money into the economy. As household money balances rise, however, the demand for goods at official prices increases and eventually reaches a level equal to wage income. At that point, the sale revenue of firms exactly covers their wage payments and the government budget is balanced.

The steady-state money supply is the wage payment firms make to each individual household, i.e., $M=w$. All the money stock is absorbed by transactions in the official markets, and there is no monetary overhang. In the case of a cash-in-advance constraint in the black market, the steady-state money supply would be the wage payments plus rents earned through black market transactions, i.e., $M=w+qR$. Obviously, part of the money stock is absorbed in the official transaction (w) and the other part is absorbed in the black market (qR). Again, there are no involuntary money holdings (or "forced" savings).

Thus, we have shown that under a rigid central planning system like the one described in our model, the economy converges to a steady-state equilibrium that exhibits macroeconomic stability. In the steady state, the government budget is balanced, money supply and prices (both official and black market) are stable. Although rigid planning may create tension between demand and supply, the black market serves to bridge the imbalances. The analysis suggests that the notion of "monetary overhang" or "forced savings" is incompatible with an equilibrium model. As long as there are surplus goods or black markets, no involuntary money holdings exist in a shortage economy. ^{1/} Households hold money either for (official) transactions, savings, or for engaging in black market activities.

IV. Wage Reform under Price Control

In the 1970s and 1980s, many centrally planned economies embarked on reforms that aimed at liberalizing prices and decentralizing the financial decisions and wage policies of enterprises. The results have not been entirely successful. In this section, we will examine how a reforming centrally planned economy, in its rush to decentralize decision making, may upset the pre-existing system that sustains macroeconomic equilibrium, and which eventually leads to a loss of macroeconomic control.

To make the analysis more focused, here we only consider wage reform, leaving the study of price reform for the next section. Specifically, we

^{1/} This result contrasts with the considerable discussion about disequilibrium and "monetary overhang" (or "repressed inflation") in a centrally planned economy in the literature (Nutti (1986) and Portes (1989)). Our findings are consistent with Cottarelli and Blejer (1991), where they found little evidence about monetary overhang in the former Soviet Union between 1964 and 1985.

consider two types of wage reform: the first allows profitable firms to retain a fixed percentage of their profits as funds for wage increases; the second type of reform is to allow profitable firms to share profits with workers (some kind of bonus scheme). 1/ Under the first wage reform, firms' profits are continuously squeezed by upward wage pressure. If a fraction of state firms are fundamentally insolvent and require continuous subsidies from the state, the profit squeezing leads to continuous deterioration of the government's budget, money printing, and eventually widespread shortage in the economy. On the other hand, a moderate profit sharing between firms and workers is shown to be sustainable.

1. Profit-based wage increase

Suppose that type x firms are profitable (i.e., $\pi^x > 0$), and that the government allows these firms to retain a fraction, δ , of their profits to be used to increase workers' wages. For notational simplicity, assume that the economy has been in a steady-state equilibrium up to period $t=-1$ and that government begins its wage reform in period $t=0$. An average household's wage income in period t is:

$$w_t = w_t^x + w^y, \quad w_t^x = w_{t-1}^x + \delta \pi_t^x; \quad 0 < \delta < 1, \quad t \geq 0, \quad (21)$$

where w_t^x is the wage rate in type x firms, and π_t^x is the profit of type x firms in period t (calculation based on the wage rate in period $t-1$), i.e.,

$$\pi_t^x = x_t - w_{t-1}^x, \quad t \geq 0, \quad (22)$$

and $w_{-1}^x = w^x$. Noting that, as long as the demand for consumption good x, x_t , is increasing in income, the wage income of an average household increases over time because the profits of type x firms are always positive.

From our assumption, type y firms are loss makers. However, if, as household incomes rise, the demand for good y becomes high enough and its sales at state shops exceed wage payments in type y firms, w^y , then firms of type y are fundamentally solvent. In that case, the post-reform economy converges to a steady-state equilibrium in which the profit (or loss) of all firms is zero, and the money supply is constant. Thus, similar to the pre-reform, steady-state equilibrium, the economy exhibits macroeconomic stability and there is no monetary overhang.

To verify the above claim, note that starting from the old steady state, money balances are equal to households' income, $M_1 = w_0$. Let $N_t = 0$, $t \geq 0$, then $I_0 = M_1$, $I_t = w_{t-1}$, $t \geq 1$, and it can be readily checked that $\{p^x(I_t), p^y(I_t)\}$ is an equilibrium. Also note that $\{I_t\}$ is increasing and bound from above because profits of type x firms converge to zero, it is easy to see that $\{p^x(I_t), p^y(I_t)\}$ converges to a steady-state equilibrium in which all firms make zero profits.

1/ For a discussion of various wage control proposals, see Lane (1992).

Suppose that either $Y < w^y$, or $y_t < w^y$, $t \geq 0$, is true, then firms of type y are fundamentally insolvent, since the sale revenues at official prices never cover their wage costs. Under the above wage reform, the profits of type x firms are continuously squeezed and eventually fall to zero. Hence, in the long run, the government will resort to money printing to finance its subsidies to type y firms and money supply will grow without bounds. If black market transactions are frictionless and there is no demand for money, similar to the analysis of the case in which $w > X + Y$, ultimately the money injected by government cannot be absorbed in the economy and no equilibrium exists.

If, however, there is demand for money in black market transactions, the black market will absorb part of the money in circulation and an equilibrium may exist. For instance, if there is a cash-in-advance constraint on black market transactions, let $N_t = 0$, for $t \geq 0$, then $I_0 = M_{-1}$, $I_t = w_{t-1} + q_{t-1}R_{t-1}$, and $(p^x(I_t), p^y(I_t))$ is an equilibrium. In equilibrium, each household simply spends all the cash balances it accumulates in the previous period either at state shops or in the black market, or both. With the money supply (or household demand) growing without bound, all goods will eventually be in shortage. Moreover, the shortage will grow more and more acute, and more and more productive efforts will be diverted to nonproductive black market activity, which leads to a continuous worsening of household welfare.

2. Profit-based bonuses

Since wages are rigid downward, the problem with the profit-based wage increase proposal examined in the proceeding subsection is that the upward wage pressure on profitable firms continuously squeezes their profits and thereby drains the tax base on which the government relies to finance its subsidies to loss-making firms. In this section, we will examine the other popular wage reform policy that strictly controls wages, but allows profitable firms to distribute a fixed percentage of their profits to workers as bonuses. We will show that if the percentage is not too high, the pre-reform macroeconomic stability can be maintained.

Suppose that the government allows the profitable type x firms to distribute a fixed proportion, ρ , of their profits to workers as bonuses. Again, we assume that the economy has been in a steady-state equilibrium up to period $t = -1$ before government initiates wage reform in period $t = 0$. Let w_t^x be the wage rate in type x firms, then,

$$w_t^x = w^x + \rho \pi_t^x, \quad 0 < \rho < 1; \quad \pi_t^x = x_t - w^x, \quad t \geq 0. \quad (23)$$

The wage income of an average household in period t is $w_t = w_t^x + w^y$, $t \geq 0$. Assuming that a household's demand for good x, x_t , is increasing in income, it follows from (23) that w_t is increasing over time and converges to some constant W. Let $\pi = x - w^x$ be the profit of a type x firm before reform takes place, since households will not spend the entire increase in their income on good x, one can show that $W < w + \pi[\rho/(1-\rho)]$.

Recalling that $w < X+Y$, if ρ is small enough $W < X+Y$ still holds. It follows from our analysis in Section III that an equilibrium exists. In equilibrium, each household simply spends all cash balances accumulated in the previous period. As an average household's income w_t converges to W , the equilibrium converges to a steady state equilibrium. In the steady state, at least one good is in surplus, the government budget is balanced, and money supply is constant.

Thus, the reform proposal is sustainable from a macroeconomic perspective. However, household welfare is lowered because a higher income exacerbates the shortage and diverts more efforts to nonproductive black market activity.

V. Price Reform

The analysis in Section IV has indicated that, with government maintaining rigid control over production and prices, financial reforms that give enterprises discretion on wage policy may disrupt the stable pre-reform macroeconomic equilibrium. As mentioned above, the lack of financial discipline on the part of enterprises tends to raise workers' wages, exacerbating shortage and inducing households to shift more productive efforts to nonproductive black market activities.

In this section, we will examine the macroeconomic implications of price liberalization. In particular, we will examine two types of price reform. The first liberalizes all prices, while maintaining rigid control over wages. The second type of price reform liberalizes all prices, but allowing some degree of wage flexibility to compensate for possible price jumps. The study shows that if government can control wages, price liberalization would eliminate unproductive black market transactions and thereby improve households' welfare. If wage control is politically implausible, especially at a time of rising prices and rising profits for some enterprises, the government must take measures to control its subsidies to loss-making firms. Otherwise, the economy may plunge into rapid inflation or even hyperinflation.

1. Price reform with rigid wage control

Assume that the economy has been in a steady-state equilibrium up to period $t=-1$, and that in period $t=0$ government liberalizes all prices, while maintaining rigid control over wages. Let P_t^j ($j=x,y$) denote the price of good j ; an average household faces the following budget constraint:

$$N_t + P_t^x X_t + P_t^y Y_t \leq M_{t-1}, \quad N_t \geq 0, \quad t \geq 0, \quad (24)$$

where $M_{t-1} = w + N_{t-1}$, $t \geq 0$, is the nominal money balance accumulated in period $t-1$ and $M_{-1} = w$. Maximizing (8), subject to (24) and $h_t \leq 1$, yields an individual household's demand for goods x and y , and savings N_t .

With all prices freely determined through the markets, we have to slightly modify the definition of equilibrium given in Section II. A dynamic equilibrium of the economy is defined to be a sequence of prices $\{P_t^x, P_t^y\}_{t \geq 0}$ that clears goods markets in every time period t , $t \geq 0$.

Since price liberalization eliminates black market activity, each household would spend all of its free time on leisure, i.e., $h_t=1$. Let $I_t=M_t-N_t$, I_t is an average household's expenditure on goods x and y in period t . Similar to the two-step analysis in Section III, taking I_t , P_t^x and P_t^y as given, and solving the following maximization problem yields a household's demand for goods x and y ,

$$\text{Max}_{(x_t, y_t, N_t)} U = u(1, x_t, y_t), \quad (25)$$

subject to,

$$P_t^x x_t + P_t^y y_t \leq I_t. \quad (26)$$

Suppose that P_t^x and P_t^y are the market clearing prices in period t . P_t^x and P_t^y are a function of household spending in period t , I_t , i.e.,

$$p_t^x = p_t^x(I_t), \quad p_t^y = p_t^y(I_t). \quad (27)$$

Clearly, price sequence $\{P_t^x(w), P_t^y(w)\}_{t \geq 0}$ is a dynamic equilibrium of the economy.

Thus, if the initial money balance is the same as the (permanent) wage earning, which is also the desired level of spending, the moment the government liberalizes prices, there is a one-time change in prices, and the economy reaches a steady-state equilibrium afterward. The new steady-state prices could be higher or lower, depending on whether the goods are in surplus or in deficit. If a good is in shortage, the new market clearing price would be higher than the official price and lower than the black market price. If a good is in surplus, the new market price tends to be lower than the official price. Therefore, if one uses black market prices in calculating price index, the post-reform price level tends to be lower instead of higher (Cochrane and Ickes (1991)).

The above case is extreme in that we assume black market transactions are frictionless and the initial money balances are equal to the permanent desired level of spending. Under the more realistic assumption that there is friction in the black market, and black market transactions absorb a fraction of the aggregate money balances, the initial money balances will be higher than the permanent desired spending level. A release of the "excessive" money balances would trigger a price jump, as compared to the official prices. For instance, if there is a cash-in-advance constraint in black market transactions, the initial money balance is $M_1=w+R$. After price decontrol, the long-run average spending is w . Similar to the reasoning in Lemma 3, "excess" money balance R would be dissipated in finite periods. Immediately after prices are liberalized, prices jump upward, and then come

down gradually until they reach their long-run levels (Lin and Osband (1992)).

Finally, it is noteworthy that whether price liberalization leads to inflation or not, if the official prices are different from the equilibrium market prices, households' welfare, measured in utility level, improves unambiguously. The post-reform utility level for each household is $u(1, X, Y)$ in one period, while the pre-reform utility level is $u(h_t, x_t, y_t)$ in period t , where $h_t \leq 1$, $x_t \leq X$, $y_t \leq Y$, with at least one inequality strictly held.

2. Price reform without rigid wage control

So far, we have assumed that households are identical, and that government can control wages during price liberalization. In practice, the government is under pressure to loosen financial control. First, price liberalization leads to increases in prices of shortage goods and in the profits of some firms. For those profitable firms, there is pressure to increase wages, especially at a time of price surge owing to price decontrol. Second, noting that all firms are owned by the government and soft budget constraints are still in place, even for the unprofitable firms, there is pressure to increase wages, in part to catch up with the wage increase in profitable firms, and in part to compensate for price increases. In the following, we will show that if the government cannot impose wage discipline, price reform may lead to rapid inflation or even hyperinflation.

For simplicity, assume that there are no excessive money balances before the government liberalizes prices in period $t=0$, i.e., $M_1 = w$. ^{1/} It follows from the above analysis that if government maintains rigid wage control, price liberalization will result in a one-time price change, and the economy will jump to its new steady-state equilibrium $\{P^x(w), P^y(w)\}$ in one period. In the steady state, the sum of profits of type x and type y firms is zero,

$$\pi^x + \pi^y = P^x(w)X - w^x + P^y(w)Y - w^y = P^x(w)X + P^y(w)Y - w = 0. \quad (28)$$

Suppose that $\pi^x > 0$, and that government allows firms of type x to retain a fraction, δ , of their profits for wage increases. Consequently, the price level rises and the wage gap between the two types of firms widens. Without loss of generality, we assume that the government compensates workers in type y firms by raising their wages by a fraction of the increase in type x firms, i.e.,

^{1/} If there are "excessive" money balances at the time of price decontrol, the qualitative nature of our analysis would change. The release of the excessive money balances may speed up inflation initially, but its effect on long-run inflation is minimal.

$$\Delta w^y = \gamma \Delta w^x, \quad 0 \leq \gamma \leq 1, \quad (29)$$

where Δw denotes a change in w . Hence, the wage income of an average household in period t is:

$$w_t = w_{t-1} + \delta \pi_t^x + \gamma \delta \pi_t^x = w_{t-1} + \delta (1+\gamma) \pi_t^x, \quad (30)$$

where the profit of type x firms, π_t^x , is

$$\pi_t^x = p_t^x X - w_{t-1}^x; \quad w_t^x = w_{t-1}^x + \delta \pi_t^x; \quad t \geq 0. \quad (31)$$

Anticipating that nominal wages will grow over time, rational households will spend all of their money balances in every time period. Let λ be the share of household income spent on good x . If $\lambda(1+\gamma) > 1$, it can be shown that the profits of type x firms are growing exponentially as time goes to infinity. The reason is that the revenue increase that arises from the rise in household income more than compensates for the increase in wages,

$$\lambda [\delta (1+\gamma) \pi_t^x] > \delta \pi_t^x. \quad (32)$$

In fact, one can calculate the growth rate to be $\lambda[\delta(1+\gamma)-1]$. The budget deficit that is financed by money printing is:

$$D_t = \delta (1 + \gamma) \pi_t^x, \quad (33)$$

which also grows at an exponential rate, $\delta[\lambda(1+\gamma)-1]$.

In our discrete time cash-in-advance model, the velocity of money is constant. With the budget deficit and the money supply growing at a rate of $\delta[\lambda(1+\gamma)-1]$, the long-run inflation rate will converge to $\delta[\lambda(1+\gamma)-1]$, which could be high but would not be explosive. In a more realistic model—in which the velocity of money depends on inflation—relying on money printing to finance the growing budget deficit, as in equation (33), may trap the economy in a high inflation equilibrium, or even lead to hyperinflation (Bruno and Fisher (1990)).

If $\lambda(1+\gamma) \leq 1$, then the profits of type x firms either stay constant or converge to zero. In the former case, money supply and price level would grow without bounds, but at rates converging to zero. In the later case, both the money supply and the price level would stabilize in the long run.

VI. Concluding Remarks

This paper has developed a rigorous equilibrium monetary model of a centrally planned economy. The study shows the important role played by black markets in bridging the structural imbalances that arise from rigid control of production, wages and prices in a shortage economy. It has also demonstrated how macroeconomic stability can be achieved under a rigid planning system.

The paper shows that the inherent structural imbalances and irrational price system may frustrate structural reform efforts in a centrally planned economy. For instance, owing to irrational production and price structure, price decontrol may benefit some firms at the expense of others. In an atmosphere of decentralization, these benefits may translate into wage pressure, which can in turn lead to persistent budget deficits and high inflation.

The analysis seems to suggest that the notion of "monetary overhang" or "forced savings" remains a concept in search of a rationale. Our study shows that as long as some goods are in surplus or that black markets exist, there are no involuntary money holdings. Households hold money either for (official) transactions, savings, or for engaging in black market activities. To the extent that black markets may absorb part of the money in circulation, there may be "excessive" money balances in the economy in the sense that once prices are decontrolled, the part of money balances that was originally absorbed in the black market has to be released to other markets.

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