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Fiscal Policy During the Demise of Central Planning: The Transition to a Market Economy

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Abstract

This paper constructs an intertemporal general equilibrium model designed to examine an economy in transition from central planning to being market oriented. A numerical algorithm is developed to obtain a solution for the model. Simulations using stylized country-specific data examine the effects of price controls during the transition period, as well as of imposing taxes on returns to investment, and on interest earned on private savings. The paper concludes that, under certain circumstances, the taxation of investment as well as of private savings may have positive effects upon consumer welfare, if price distortions are sufficiently severe.

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Contents

I. *Introduction*

This paper constructs a theoretical model, and with a numerical implementation using stylized data, analyzes an issue that has become of considerable importance in recent years. This is how to carry out fiscal policy in a centrally planned economy in the process of becoming market oriented. There is a well established literature on the role of fiscal policy in market economies. In truly command economies fiscal policy has a very limited role, because prices have little allocative significance and the entire economy may be viewed as part of the public sector. Currently, however, there are a number of countries that are undergoing programs of economic liberalization, moving from the use of quantity signals to prices for determining economic activity. Obvious examples of such countries are Poland, Czechoslovakia, Hungary, and, before the events of Tiananmen Square, China.

We begin by discussing general issues of repressed markets and fiscal policy under central planning, reviewing the literature on repressed markets. We then describe the structure of a dynamic macroeconomic model that we use to analyze alternative fiscal policies. We demonstrate the existence of an equilibrium and we then examine the results of a numerical implementation of the model. The simulations incorporate certain stylized parameters derived from country-specific data. These simulations will be important for analyzing policy implications, since the model does not have an analytical solution. The results of these simulations will show that some rather unorthodox taxes may prove useful during the transition period. In particular, we will show that taxation of savings along with taxation of the returns to investment may reduce intertemporal distortions and may be welfare improving.

There is a diverse literature on price controls. Barro and Grossman (1971, 1974), Drazen (1980), Hool (1980), Howard (1976b), Muellbauer and Portes (1978), Portes (1979, 1981), Standaert (1985), Wiles (1973), and Wolf (1985a, b) look at macroeconomic consequences of price controls. 1/ Another direction of research has been to look at the microeconomic implication of price controls in the context of general equilibrium models. Among the papers in this literature are Dreze (1975), Feltenstein (1977, 1979, 1983), Katz and Owen (1988), Malinvaud (1967, 1972), Neary and Roberts (1980), and Portes and Winter (1977). Another approach has been to attempt to empirically estimate effects of price controls in specific countries, or to develop estimation techniques. Burkett (1987), Charemza and Gronicki (1984, 1988), Charemza and Quandt (1982), Chow (1987), Fair and Jaffee (1972), Feltenstein (1985), Feltenstein and Farhadian (1987), Feltenstein, Lebow and Van Wijnbergen (1990), Feltenstein and Ha (1990), Gardner and Strauss (1981), Gourieroux, Laffont, and Monfort (1980), Howard (1980), Marer (1981), Podkaminer (1982, 1989), Portes (1977, 1981), Portes and

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1/ It should be noted that most of these papers do not look at the issue of price controls in the context of central planning. Rather, they consider market economies with distortions caused either by controls or by rationing.

Winter (1978, 1980), Portes, Quandt, and Yeo (1987), Portes and Santorum (1987), Quandt (1978, 1982), and Wiles (1974) are among the many papers in this direction.

Our general approach is to suppose that in the initial phase of liberalization there are some markets in the economy which have had price controls lifted, while other markets are still subject to government-determined prices. In addition, interest rates are fixed by the government. All agents in the economy expect that in the near future there will be a complete liberalization of the price system. Because of the current price controls, some markets do not clear. The excess demand spills over into two channels. Part of the nominal excess demand is channeled into increased consumption of the free market good, while consumers also tend to increase their savings in anticipation of currently unavailable goods becoming available when prices are decontrolled. The rapid increase in savings reflects the expectation that these decontrolled prices will rise rapidly. 1/ Private investment at the same time tends to increase in anticipation of a high return on capital in the future, when output prices have been freed. In addition, the current controls on borrowing interest rates cause the cost of capital to be too low, also encouraging increased investment.

Prior to liberalization, investment is financed by central bank credit expansion, given the absence of private credit markets. Thus the high level of investment demand brings with it a correspondingly high rate of expansion in the money supply. This "monetary overhang" leads to further increases in nominal excess demand, leading to increased distortions in the relative prices of free and controlled market prices, as well as increased private savings. 2/ This is a stylized description of a phenomenon that may be observed in several planned economies currently undergoing transition, namely, "investment hunger" combined with extraordinarily high savings rates. 3/

1/ Feltenstein, Lebow, and Van Wijnbergen (1990) examine this type of savings spill-over in the context of a life cycle model applied to China.

2/ There is a great deal of current discussion of "Ruble overhang." To quote the New York Times of December 6, 1989, "The biggest economic obstacle to price reform is 'ruble overhang'. Soviet citizens are hoarding billions of rubles because - at the low, controlled prices - goods move instantly and there is nothing left on store shelves to buy." There has also been considerable work attempting to empirically estimate the extent to which there has been "Yen overhang" in China following the economic reforms of 1979. Among the papers looking at this issue are Feltenstein and Farhadian (1987), Feltenstein, Lebow, and Van Wijnbergen (1990), Feltenstein and Ha (1990), and Portes and Santorum (1987).

3/ The Chinese refer to the enormous nominal stocks of savings, represented by interest bearing bank deposits, that have accumulated since the beginning of liberalization as a "tiger in a cage", reflecting the fear of the consequences of large withdrawals of these savings deposits.

If we accept the premise that political reality makes it impossible to immediately switch from price controls to free markets, we may then ask if fiscal policy can be used to mitigate the distortions caused by the structure of transition. 1/ Our model will therefore be used to look at the consequences both for consumer welfare as well as aggregate output of two different types of taxes. The first of these is a tax on interest income earned on personal savings accounts. This tax may be levied at a different rate than the tax on wage income. The second is a tax levied on capital income, possibly at a rate different, and higher, than the corporate profit tax. These taxes are thus quite different from those recommended by the usual prescriptions of public finance, which caution against taxing savings or investment.

Since our model does not have an analytical solution, we will develop an algorithmic method based on the use of fixed-point techniques to derive numerical solutions corresponding to different fiscal parameter values. This methodology will then permit us to make quantitative comparisons between different fiscal regimes.

II. Fiscal Issues Under Central Planning

In centrally planned economies, the plan carries out the roles played by both the price system and taxes in a market economy. In general, central plans have not been successful in this function, leading to the current pressure for reform. The use of central planning also has tended to obscure the role of fiscal policy. What, for example, are the correct definitions of tax revenues, public spending, and the budget deficit? Revenues, for example, usually include the transfer of profits to the government. These transfers would, in a market economy, be paid as dividends to stockholders or used to finance investments. In planned economies they are generally used to finance the centrally determined investment program. In China, for example, until the economic reform of 1979 there was a 100 per cent profit tax. The resulting collection was used to finance capital formation. Treating these profit remittances as ordinary revenues causes the estimate of the size of tax revenues to be higher than would be the case if the economy operated under market rules.

What revenue instruments are typically available to the government in a planned economy? Direct personal taxes are generally not used for ideological reasons. Since income distribution is already believed to be correct, there is no need to carry out any redistribution using taxes. A major source of revenue has been the corporate profit tax mentioned earlier. The underlying belief is that investment should be part of the central plan and hence controlled by the government. Any autonomous capital formation

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1/ We thus do not claim that the partial liberalization of price controls has been implemented as the result of any type of optimizing behavior. Rather, we view the pattern of price controls as being an exogenously imposed constraint.

could compromise the success of the plan. If the remittances of profits is insufficient to finance the planned level of investment, then the residual is financed by monetary expansion, leading to the connection between investment and inflation often observed in economies with price controls. 1/

Several issues arise because of distortions in the price system. First, how much revenue is being lost because of price controls? Next, what is the meaning or usefulness of the concept of tax incidence when relative prices bear little or no relationship to scarcities? What happens when, as is the case during the transition to becoming a market economy, part of the economy is permitted to set its own output prices while the remainder is required to operate at controlled prices? An important source of government revenue is seignorage, or similarly, the inflation tax. If, however, prices are repressed so that the official rate of inflation underestimates the "true" rate of inflation, then there is a tendency to consistently overestimate seignorage, since real cash balances continue to grow over time. 2/ It is generally impossible to repress inflation indefinitely, so that eventual price increases will cancel the apparent real revenues that the government has been collecting. Price controls also place another type of restriction on government policy, in this case in financing the budget deficit. The unavailability of consumer goods at official prices may cause consumers to apparently increase their real savings, thereby allowing the government to temporarily finance larger budget deficits than it could before. This increase is, however, again only temporary since the public eventually withdraws its labor from the market, if there is nothing to buy, or withdraws its money from savings accounts, putting intolerable pressure on the price level. At this point the government's ability to finance itself drops sharply.

A planned economy uses taxes in order to redistribute resources between firms. Certain firms, typically in sectors that are viewed as being crucial to the economy, are permitted to run losses that are financed by taxes levied on profit-making firms. The losses are often caused by these firms being told to maximize non-price incentives, such as volume of output, which cause them to operate at a level that is far beyond the profit-maximizing point. In order to ensure market clearing, it is possible to demonstrate that the government must have unlimited power to tax not only the profits of enterprises, but also the wealth, including non-labor income, of consumers. Such power to tax is usually beyond the grasp of the government of even the most controlled economy. 3/ In addition, even if the government does have this power, there may still, under plausible circumstances, be insufficient revenues to finance loss-making firms.

1/ It should be noted that indirect taxation has generally been the most important source of revenue in planned economies. This partly reflects ideological beliefs that the current distribution of income is correct.

2/ This phenomenon is quite apparent in China where, between 1979 and 1983, M2 grew by 223 per cent while the cumulative increase in the consumer price index was only 17 per cent.

3/ See Feltenstein (1979) for a proof of this result.

Let us now turn to a simple model designed to capture some of the issues we have brought up here.

III. The Model

We assume that there are two periods and two production sectors. In the first period there is one sector that is permitted free market pricing, while the second sector faces a fixed output price. The output of the free market sector in period i is denoted good G_i, while the output of the controlled sector is denoted G_i'. In the second period both firms are free to determine output prices. There are two factors of production, capital and labor, which have market determined prices in both periods and there is single financial asset, money. Financial markets are repressed in the first period in that the borrowing interest rate, r_1, is fixed by the government.

We will suppose that there is a single consumer who has perfect foresight. The government finances investment in the first period by monetary expansion and taxation, while in the second period investment is financed entirely from consumer savings. The government also collects certain taxes and hires workers at the market wage.

We will let the following notation denote prices.

P_{Mi} = price of money in period i (period 1 money is the numeraire).

P_{Ki} = price of capital in period i.

P_{Li} = price of labor in period i.

P_{Gi} = price of free market good in period i.

$\bar{p}_{G'1}$ = controlled price, in terms of money, of the controlled sector good in period 1.

$P_{G'2}$ = market price of good G' in period 2, that is, after price controls on the good have been removed.

Let us now turn to the specifics of the model.

1. Production

There are two firms producing good G and good G'. Firm G has a constant returns to scale production technology, while firm G' has decreasing returns to scale. Our rational is that the free price firm is a traditional sector, such as agriculture, where there are no constraints not included in our model. The controlled price sector is, say, manufacturing where there is some scarce factor input, such as managerial labor, that is not included in our model. Thus outputs, y_{Gi}, $y_{G'i}$ of the two sectors in period i are given by:

$$y_{Gi} = x_{Ki}^{\beta} x_{Li}^{1-\beta} \qquad 0 \leq \beta \leq 1 \tag{3.1}$$

$$y_{G'i} = x_{Ki}^{\tau} x_{Li}^{\tau'} \qquad \tau + \tau' < 1$$

We will suppose that each firm pays taxes on its use of capital and labor. The interpretation of these is as profit and a personal income tax that is withheld at the source. In addition, firm G' pays a tax on its pure profits, which may be positive due to its decreasing returns to scale returns technology. It is then assumed that in period 1 the government levies a 100 percent profit tax on firm G'. In period 2 we will suppose that a tax rate $z < 1.0$ is levied on its profits. Let the tax rates on capital and labor in period i be given by t_{Ki}, t_{Li} respectively. Let

$$P'_{Ki} = (1 + t_{Ki})\, P_{Ki} \qquad P'_{Li} = (1 + t_{Li})\, P_{Li} \tag{3.2}$$

Because of price controls, output and price determination is different for the two firms. Firm G determines its output price from the zero-profit condition, combined with cost minimization. Accordingly, its output price, P_{Gi}, is given by:

$$P_{Gi} = P'_{Ki} A^{\beta-1} + P'_{Li} A^{\beta} \tag{3.3}$$

where

$$A = \frac{(1 - \beta)\, P'_{Ki}}{\beta\, P'_{Li}}$$

Firm G', on the other hand, profit maximizes subject to its controlled output price. Accordingly it sets its factor inputs as:

$$x_{K1} = - \frac{B^{-\tau'} P'^{1/(\tau+\tau'-1)}_{K1}}{\tau P_{M1} \bar{P}_{G'1}} \tag{3.4}$$

$$x_{L1} = \frac{\tau' P'_{K1} x_{K1}}{\tau P'_{L1}}$$

$$x_{K2} = \frac{B^{-\tau'} P'^{1/(\tau+\tau'-1)}_{K2}}{\tau P'_{G'2}}$$

$$x_{L2} = \frac{\tau' P'_{K2} x_{K2}}{\tau P'_{L2}}$$

where

$$B = \frac{\tau' P'_{K1}}{\tau P'_{L1}}$$

Given the firm's decreasing returns to scale, pure profits are possible and are given in period i by:

$$\pi_i = (1-z)\ \{P_{G'i}y_{G'i} - P_{Ki}x_{Ki} - P_{Li}x_{Li}\} \tag{3.5}$$

Thus the declining profit tax rate reflects the coming of economic liberalization in that profits will be partially paid out as dividends to the consumer.

2. Consumption

We suppose that there is a single representative consumer who maximizes an intertemporal utility function of the form:

$$U(x) = x_{G1}^{\alpha} x_{G'1}^{1-\alpha} \{x_{G2}^{\alpha} x_{G'2}^{1-\alpha}\}^{1/(1+\delta)} \qquad 0 < \alpha < 1 \tag{3.6}$$

where x_{Gi}, $x_{G'i}$ represent consumption of goods G and G' in period i and δ is his rate of time preference. We suppose that the consumer saves by holding a quantity of money, x_{Mi} which earns interest as bank deposits. He pays a tax on these interest earnings in period i at a rate, t_{si}, that may be different from his tax rate on labor income. Accordingly, his budget constraints become:

$$(1+t_1)P_{G1}x_{G1}+(1+t_1')P_{M1}\tilde{P}_{G'1}x_{G'1}+ P_{M1}x_{M1} \tag{3.7}$$

$$\leq P_{L1}L_0+ P_{M1}(1+r_0(1-t_{s1}))M_0+ TR_1$$

$$(1+t_2)P_{G2}x_{G2}+(1+t_2')P_{G'2}x_{G'2}+P_{M2}x_{M2}+ C_{H2}$$

$$\leq P_{L2}L_0 + (1-t_{H2})P_{K2}H_1+ P_{M2}(1+r_1(1-t_{s2}))x_{M1} + TR_2 + (1-z)\pi_2$$

Here t_i, t_i' represent the sales tax rates on goods G and G' in period i, respectively, TR_i represents transfers made by the government to the consumer in period i, while $(1-z)\pi_2$ represents the share in profits, i.e. dividends, received by the consumer in period 2. H_1 represents the quantity of new capital produced by investment in period 1. The returns on this capital in period 2 accrue to the consumer, reflecting the economic

liberalization, although returns on the initial capital stock continue to go to the government. The government taxes the returns on new capital at a rate t_{H2}. The term C_{H2} in the second period budget constraint represents the non-monetary savings by the consumer in period 2 and is set equal to the value of private investment in that period. The determination of investment is given in the next section.

We must impose a closure rule on the consumer so as to have money holdings in the final period. Accordingly, we shall suppose that money holdings are determined in period 2 as a constant fraction of the consumer's wage plus capital income. 1/ Accordingly:

$$P_{M2}x_{M2} = s(P_{L2}L_0 + P_{K2}H_1) \qquad 0 \leq s \leq 1 \tag{3.8}$$

The consumer's maximization problem may be solved analytically to yield:

$$x_{G1} = \frac{I_1 + (P_{M1}I_2 / S_{10}P_{M2})}{S_8 + (P_{M1}S_9/S_{10}P_{M2})} \tag{3.9}$$

where we make the following definitions:

$$S_{10} = 1 + r_1(1-t_{s2}), \quad S_9 = (1+t_2)P_{G2}S_7 + (1+t_2')P_{G'2}S_1S_3S_7$$

$$S_8 = (1+t_1)P_{G1} + (1+t_1')P_{M1}\tilde{P}_{G'1}S_1S_2, \quad S_7 = \frac{S_4(1+t_1)P_{G1}S_5}{(1+t_2)P_{G2}S_6}$$

$$S_6 = (S_1S_2)^{(1-\alpha)}(S_1S_3)^{(1-\alpha)/(1+\delta)}$$

1/ Thus money holdings in period 1 are determined so as to maximize intertemporal utility. In period 2 they are determined as a constant fraction of income.

$$S_5 = \frac{\alpha}{1+\delta} (S_1S_2)^{(1-\alpha)} (S_1S_3)^{(1-\alpha)} (S_1S_3)^{-(1-\alpha)\delta/(1+\delta)} (S_1S_3)^{-(1-\alpha)\delta/(1+\delta)}$$

$$S_4 = \frac{P_{M2}\{1+r_1(1-t_{s2})\}}{P_{M1}}, \quad S_3 = \frac{(1+t_2)P_{G2}}{(1+t_2')P_{G'2}}$$

$$S_2 = \frac{(1+t_1)P_{G1}}{(1+t_1')P_{M1}\tilde{P}_{G'1}}, \quad S_1 = (1-\alpha)/\alpha$$

$$I_1 = P_{L1}L_0 + P_{M1}\{1+r_0(1-t_{s1})\}M_0 + TR_1$$

$$I_2 = (1-s)(P_{L2}L_0 + P_{K2}(1-t_{H2})H_1 + TR_2) + (1-z)\pi_2 - C_{H2}$$

We then derive his remaining choice variables as:

$$x_{G'1} = S_1S_2x_{G1}$$

$$x_{G2} = S_7x_{G1} \qquad x_{G'2} = S_1S_3x_{G2}$$

Money holdings in period i, x_{Mi}, are then determined by the corresponding budget constraints.

In addition, we shall suppose that market disequilibrium in sector G' in period 1, caused by the price control on good G', is compensated for by increases in both money holdings and consumption of the free market good G. Thus the consumer must compare the utility from increasing his current consumption of good G against the utility to be obtained in period 2 from increased consumption of both goods purchased out of current savings. Let us now denote the solutions to equations (3.9) as

$\tilde{x}_{Gi}$, $\tilde{x}_{G'i}$, $\tilde{x}_{Mi}$.

Accordingly, suppose that:

$$\tilde{x}_{G'1} > y_{G'1}$$

That is, the demand for the fixed-price good in period 1 is greater than the supply of that good. We will then suppose that the consumer sets his consumption of good G',

$\tilde{x}_{G'1}$, as:

$$\tilde{x}_{G'1} = y_{G'1}$$

His new maximization problem then becomes: 1/

$$\max x_{G1}^{\alpha} \tilde{x}_{G'1}^{(1-\alpha)} \{x_{G2}^{\alpha} x_{G'2}^{(1-\alpha)}\}^{1/(1+\delta)} \tag{3.10}$$

such that:

$$P_{M1}\tilde{P}_{G1}(1+t_1)x_{G1} + P_{M1}x_{M1} = P_{M1}\tilde{P}_{G1}(1+t'_1)(\tilde{x}_{G'1} - y_{G'1}) \tag{3.11}$$

$$P_{G2}(1+t_2)x_{G2} + P_{G'2}(1+t'_2)x_{G'2} = P_{M2}(1 + r_1(1 - t_{s2}))x_{M1}$$

1/ The consumer thus recognizes the market demand shortage of good G' and reduces his demand to equal the current market supply.

Thus the consumer's new problem is to distribute the value of his excess demand for good G' in period 1 on good G and on savings. He thus realizes that the market for the controlled price good will not clear. The principal plus interest, net of taxes, earned on his money savings will then be spent on both goods in period 2 when their prices will have been de-controlled. The solution to this second stage problem is given by:

$$x = \frac{R_6 - R_7}{R_5} \quad \text{where:} \quad R_5 = (1+\delta)P_{G1}(1+t_1)R_4P_{M2}R_1 + R_3P_{M1} \tag{3.12}$$

$$R_6 = I + \tilde{x}_{G1}P_{G1}(1+t_1)$$

$$R_7 = (1+\delta)P_{G1}(1+t_1)R_4R_2$$

$$R_4 = \frac{\alpha}{P_{G2}(1+t_2)}$$

$$R_3 = \frac{P_{M2}R_1P_{G1}(1+t_1)}{P_{M1}P_{G2}(1+t_2)}$$

$$R_2 = P_{G2}(1+t_2)\tilde{x}_{G2} + P_{G'2}(1+t'_2)\tilde{x}_{G'2}$$

$$R_1 = 1 + r_1(1-t_{s2})$$

$$I = P_{M1}\tilde{P}_{G'1}(1+t'_1)(\tilde{x}_{G'1} - y_{G'1})$$

We may then derive the remaining consumer choice variables as:

$$x_{G1} = \frac{I - P_{M1}x_{M1}}{P_{G1}(1+t_1)} + \bar{x}_{G1} \qquad (3.13)$$

$$x_{G2} = \frac{\alpha}{P_{G2}(1+t_2)} \{P_{M2}R_1x_{M1} + R_2\}$$

$$x_{G'2} = \frac{P_{M2}R_1x_{M1} - P_{G2}(1+t_2)(x_{G2} - \bar{x}_{G2})}{P_{G'2}(1+t'_2)}$$

Thus there is a kink in the consumer's demand curve depending upon whether or not the supply of the controlled market good is binding in period 1.

Suppose, on the other hand, that:

$$\bar{x}_{G'1} < y_{G'1}$$

That is, there is excess supply of the fixed-price good in period 1. In this case the consumer's demand will remain at the solution given by equation (3.9). The excess supply, that is:

$$y_{G'1} - \bar{x}_{G'1} \qquad (3.13a)$$

is then purchased by the government and the value of the excess supply is added to total government expenditures

3. Investment

We assume that investment is carried out in both periods by the private sector. The financing of investment is different, however, in the two periods. In period 1 we suppose that investment is entirely financed by tax revenues and monetary expansion. In period 2, however, it is financed from consumer savings. Thus, during the period of price controls the government is the sole source of funds for financing, while after liberalization has taken place we will close the model by imposing the condition that non-monetary savings equals investment.

In order to derive a single valued investment decision we will suppose that the investment production function exhibits decreasing returns to scale. Hence the quantity of investment in period i, H_i, is given by:

$$H_i = y_{Ki}^{\alpha} y_{Li}^{\beta} \qquad \alpha + \beta < 1 \tag{3.14}$$

We will suppose that the government levies a tax on income derived from investment. Since all capital belongs to the government in period 1, this tax, t_{H2}, will be levied only in period 2 on capital produced in period 1 which comes on line in period 2. Accordingly, the cost of investment in period 1 is determined by discounting the net return on new capital in period 2 by the fixed interest rate from period 1. Thus:

$$C_{H1} = \frac{(1 - t_{H2})\, P_{K2} H_1}{(1 + r_1)} \tag{3.16}$$

Here C_{H1} is the cost of investment in period 1 and r_1 is the fixed interest rate in period 1. Hence the investor uses inputs of capital in period 1 given by:

$$y_{K1} = \{(1 - t_{H2}) P_{K2} A^{\beta} / (B P_{K1} (1 + r_1))\}^{1/(1-\alpha-\beta)} \tag{3.17}$$

where: $A = \beta P_{K1}/(\alpha P_{L1})$, $B = 1 + \beta/\alpha$,

and:

$$y_{L1} = \frac{\beta P_{K1}}{\alpha P_{L1}} y_{K1} \tag{3.18}$$

In period 2 we will suppose that the rate of investment is equal to the exogenously given growth rate of the economy, μ. Hence:

$$H_2/(K_1 + H_1) = \mu \tag{3.19}$$

where $K_1 = (1 - \sigma)K_0$

where σ is the rate of depreciation on capital and K_0 is the initial capital stock. We then derive inputs of capital and labor into period 2 investment as:

$$y_{K2} = \{A_2 A_1^{-(\alpha+\beta)}\}^{1/(\alpha+\beta)} \tag{3.20}$$

where: $A_1 = \frac{\beta P_{K2}}{\alpha P_{L2}}$ $A_2 = \mu\{(1 - \sigma)K_0 + H_1\}$

$$y_{L2} = \frac{\beta P_{K2}}{\alpha P_{L2}} y_{K2} \tag{3.21}$$

Recall that in equation (3.7) the consumer has non-monetary savings in period 2 equal to the cost of period 2 investment, C_{H2}.

4. Government

We will suppose that the government acts as a tax collector and as a purchaser of labor services. We do not attempt to model any optimizing behavior. In period 1 the government receives revenue from capital, reflecting our assumption that it owns the initial capital stock. It also receives tax revenue from capital and labor inputs, from the tax on interest income, and from the 100 percent tax on corporate profits. Accordingly, if T_i represents tax revenues in period i, we have:

$$T_1 = P_{K1}K_0 + P_{M2}t_{s1}(r_0M_0) + t_{K1}P_{K1}y_{K1} + t_{L1}P_{L1}y_{L1} + \pi_1 \qquad (3.22)$$

$$+ t_1P_{G1}x_{G1} + t_1'P_{M1}P_{G'1}x_{G'1}$$

$$T_2 = (1-\sigma)P_{K2}K_0 + P_{M2}r_1t_{s2}x_{M1} + t_{K2}P_{K2}y_{K2} + t_{L2}P_{L2}y_{L2} + t_{H2}P_{K2}H_1 + z\pi_2$$

$$+ t_2P_{G2}x_{G2} + t_2'P_{G'2}x_{G'2}$$

Hence in period 2 the government continues to receive revenue on the initial, depreciated, capital stock. It also receives the tax levied on returns to new capital as well as on interest income. Recall also that z is the profit tax rate in period 2.

The government pays interest on money holdings in both periods, while in period 1 it also finances private investment by monetary expansion and taxation. It pays market wages for inputs of labor to its own activities in both periods. Thus government spending in the two periods, G_i, is given by:

$$G_1 = P_{M1}r_1M_0 + C_{H1} + P_{L1}\tilde{y}_{GL1} + P_{M1}\tilde{P}_{G'1}(y_{G'1} - \tilde{x}_{G'1}) \qquad (3.23)$$

$$\text{if } (y_{G'1} - \tilde{x}_{G'1}) > 0$$

$$= P_{M1} r_1 M_0 + C_{H1} + P_{L1} y_{GL1} \quad \text{otherwise}$$

$$G_2 = P_{M2} r_1 x_{M1} + P_{L2} \bar{y}_{GL2}$$

where $\bar{y}_{GLi}$ denotes the exogenously determined level of government purchases of labor in period i.

Finally, the budget deficit in period i, D_i, is given by:

$$D_i = G_i - T_i \tag{3.24}$$

If the government incurs a positive budget deficit, then it is financed by issuing money. If, on the other hand, the government runs a surplus, then the surplus is paid out as a lump sum transfer to the consumer. Thus the term TR_i in the consumer's maximization problem will, at equilibrium, be equal to the budgetary surplus. Hence, in particular, $TR_i = 0$ if there is a budget deficit.

IV. Model Solution

The solution to the model entails finding three market clearing prices in period 1, P_{M1}, P_{K1}, P_{L1} and four market clearing prices in period 2, P_{M2}, P_{K2}, P_{L2}, $P_{G'2}$. Factor prices determine the price of good G in both periods due to the constant returns to scale production technology in that sector. In period 1 sector G' has a fixed output price, while in period 2 its price must be determined as part of the general model solution, given the sector's decreasing returns to scale technology. The model we have constructed satisfies the necessary conditions to have a fixed point, determining market clearing prices. These prices will not be truly market clearing in the competitive sense as the market for good G' typically exhibits excess demands. The market artificially clears, however, given the consumer's behavior when faced with the shortage of good G'. Thus the equilibrium is clearly non-optimal.

It is straightforward to show that excess demands are homogeneous of degree 0 and are convex and continuous, although not differentiable (because of the kink in demand curves when consumers are supply constrained in good 2

in period 1). We therefore need only show that Walras' law holds in both periods. 1/

V. Some Numerical Examples

Our model does not permit an analytical solution, so we will use a numerical approach to study its properties. This approach will be useful for several reasons. First, it will indicate just how large the distortions are that can be introduced by the first period price controls. Second, it will show how certain standard policies have quite counter-intuitive implications when used in the presence of price controls. Third, it will serve as a useful instrument for analyzing the effects of government policies that attempt to reduce the intertemporal distortions caused by the price controls.

We have therefore written a computer program that solves for a fixed-point of the model. Thus the 7 market prices and excess demands are simultaneously calculated, and excess demands converge to 0. The algorithm stops when excess demands are less that .001 percent of the corresponding supplies. The program is written in FORTRAN for the PC and a listing is available upon request from the author. 2/

We use certain aggregate averages derived from annual data for Czechoslovakia to generate parameter values for our model. Given the essential arbitrariness of some of our aggregations, the absence of any financial asset other than money, the incomplete description of government behavior, as well as a variety of other simplifications, we would not claim that our results have more than a very tenuous relationship to any country-specific reality. Nonetheless, the simulations may give some qualitative ideas about the consequences of various programs for liberalization.

In order to use country-specific data we need first carry out a sectoral aggregation to correspond to the two sectors of our model. We have arbitrarily chosen to let sector 1 (free output price) comprise the agriculture, construction, trade and catering, and other sectors from the national accounts. Sector 2 (fixed price in period 1) comprises the industrial sector.

Suppose that, as in equation (3.1), we have the production coefficients of sector 1, ß, 1-ß are given by 0.533, 0.467, respectively. The coefficients of sector 2, which has output price controls in period 1, τ, τ' are

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1/ A derivation of Walras' law for the model is available upon request from the author.

2/ We use the Lahey F77L 32EM compiler for a 386 computer. On a 20 Mz 386 the program takes approximately 40 seconds to converge.

given by 0..414, 0.186, respectively. 1/ There will be a 0 percent tax rate levied on capital inputs to private production, and an 18 percent tax on labor inputs in both periods, corresponding to equation (3.2). 2/ We will suppose that the government spends an amount equal to 50.8 percent of consumption plus private investment on labor in both periods, 3/ and we will also suppose that the coefficients of capital and labor in the investment function, as in equation (3.14), are 0.566, 0.434 respectively. 4/

The depreciation rate of capital is set at 5 percent, while the population growth rate is 0.2 percent. 5/ The consumer, as in equation (3.6), has utility weights 0.405, 0.595 for goods 1 and 2 in each period. 6/ As in equation (3.7), we shall suppose that the consumer pays sales tax rates of 19.2 percent on both goods in each period. 7/ The consumer has initial allocations of labor and money of 2.95, 5.32, respectively, while the initial stock of capital, owned by the government, is 3.11. 8/ We will set the long run savings rate of the consumer, as in equation (3.8), at 6.1 percent. 9/ We will also suppose that the consumer has a very high rate of time preference and will take δ in equation (3.6) to be equal to 0.6.

We will suppose for the first simulation that the government sets the tax rates on both interest income and returns to investment, t_{Si}, t_{Hi}, at 0.0. In addition, it sets the price control on good 2 in period 1, $P_{G'1}$, high enough so that there is no excess demand for the good in period 1.

1/ The source of all our data is Statisticka Rocenka Ceskoslovenske Socialisticke Republiky 1989. For production coefficients we take the coefficient of labor to be the 1988 share of the wage bill in sectoral value added. The remainder is the share of capital. For sector 2 we have arbitrarily scaled the coefficients by 0.6 in order to have decreasing returns to scale.

2/ This is derived by dividing the total wage tax in 1988 by total wage income.

3/ This is the 1988 share of government spending in C + I.

4/ These are the shares of capital and labor in the construction industry in 1988. We arbitrarily scale them by 0.4 to obtain a decreasing returns to scale production function.

5/ To this we add the rate of depreciation of capital to arrive at a figure of 0.052 as in equation (3.19). This number may be adjusted if we wish to permit short-run capital deepening.

6/ These are derived as the shares of net output of the corresponding sectors in total net output, since we do not have access to satisfactory consumption data.

7/ This is derived as the 1988 value of domestic taxes on goods and services divided by GDP.

8/ These are in 100 billion koruny. A unit of labor is defined as that amount which earned 1 koruny in 1988. Capital is defined similarly. Money is the stock of M2 at the end of 1988.

9/ This is derived as financial savings divided by the wage bill (1988 figures). This figure can also be adjusted for different closure rules.

This occurs at $P_{G'1} = 45.0$. Thus the outcome to this exercise may be viewed as an non-price constrained solution to the economy operating under the tax regime we have chosen. The government sets the interest rate in period 0 at 5.65 percent and in period 1 at 6.37 percent. 1/ In period 2 the government collects 55 percent of the profits of firm 2 and allows 45 percent to be paid out as dividends to the consumer (recall that 100 percent of profits are taxed in period 1). 2/ The solution outcomes are given in Table 1.

As might be expected, the structure of relative prices and consumption changes only slightly between periods. Nominal GDP is calculated as C+I+G. The price level is the CPI with weights given by the coefficients of each of the two goods in the consumers utility function. Real GDP is then nominal GDP divided by the price level. We see that there is a deflation caused the high rate of time preference, combined with the government surplus which has caused the money supply to remain constant in the face of increasing output. Government revenues decline in the second period as it loses part of its collection of profits from sector 2, as well as the depreciation of the initial capital stock which it continues to own.

Suppose now that we turn to an example in which the government has imposed binding price controls in period 1. This simulation will thus correspond to the transition scenario we described in the introduction. Accordingly, we will impose a price control in period 1 on sector 2 of 20.0. All other parameters stay the same. The outcome reported in Table 2 occur.

We thus notice that the consumer is severely supply constrained in good 2 in period 1. The structure of consumption changes dramatically in period 2, as consumption of good 1 falls while consumption of good 1 rises sharply in response to the increased supply of the good. The increased supply results from the large increase in the real price of good 2 in period 2. The price of good 1, on the other hand, has fallen in real terms. Thus the behavior of demand is quite different that what one might expect. The government runs a budget surplus in both periods, although the surplus falls in period 2 as the government loses 45 percent of the profits of sector 2, as well as the decline in income on the initial capital stock due to depreciation.

If we compare these results with those of the unconstrained case reported in Table 1, we see that there are significant changes in certain aggregate values. The values for real GDP and the price level may indicate the difficulties in calculating these indices when the structure of demand changes so dramatically. There is an apparent sharp decline in the price level in period 1, as compared to the unconstrained case. Accordingly,

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1/ Thus 5.65 percent is paid in period 1 on initial money holdings, while 6.37 percent is paid in period 2 on money held at the end of period 1. These are the interest rate for 1988 and 1989, respectively, for investment credits for enterprises. The price control has been chosen at random.

2/ This corresponds to the profit tax rate introduced in Czechoslovakia in 1989. The rate was reduced from previous levels of between 75 and 85 percent.

Table 1. $P_{G'1}$ = 45.0 (Price control is non-binding)

	Period 1	Period 2
Consumer demand for good 1	0.895	0.971
Consumer demand for good 2	0.877	1.018
Unconstrained demand for good 2 1/	0.877	1.018
Price of good 1	30.002	18.404
Price of good 2	45.000	25.790
Price level	38.926	22.799
Nominal GDP	110.883	84.795
Real GDP	2.849	3.719
Government revenues 2/	70.822	34.653
Government expenditure	44.563	22.886
Government surplus (deficit)	26.259	11.767
Real investment 3/	0.168	0.195
Capital stock at end of period	3.110	3.122
Utility of consumer 4/	0.8827	

1/ This is the level of demand that the consumer would have if the price control in period 1 did not induce a supply constraint.

2/ Recall that the government owns the initial capital stock, from which it receives revenue.

3/ Measure in physical units of real capital.

4/ The utility of the consumer depends upon his consumption in both periods.

Table 2. $\bar{P}_{G'1} = 20.0$

	Period 1	Period 2
Consumer demand for good 1	1.689	0.991
Consumer demand for good 2	0.500	1.034
Unconstrained demand for good 2 1/	1.636	1.034
Price of good 1	22.968	17.640
Price of good 2	20.000	24.832
Price level	21.202	21.919
Nominal GDP	75.352	75.262
Real GDP	3.554	3.434
Government revenues 2/	41.783	33.180
Government expenditure	26.551	22.415
Government surplus (deficit)	15.232	10.765
Real investment 3/	0.293	0.205
Capital stock at end of period	3.110	3.248
Utility of consumer 4/	0.8323	

1/ This is the level of demand that the consumer would have if the price control in period 1 did not induce a supply constraint.

2/ Recall that the government owns the initial capital stock, from which it receives revenue.

3/ Measured in physical units of real capital.

4/ The utility of the consumer depends upon his consumption in both periods.

there is a rise in the computed value of real GDP. The difficulty in making this calculation arises from the fact that we use the controlled price, 20.0, for good 2 in period 1 in forming the price index. This price does not, however, incorporate the positive shadow price caused by the shortage of good 1, and thus underestimates the "true" price level. Accordingly, the level of real GDP in period 1 is overestimated. Consumption in period 2 is slightly higher than before, reflecting the spillover of excess demand from the first period. Hence the apparent decline in real GDP, as compared to Table 1, is also misleading.

We see that the imposition of the price control has brought about a decline in consumer welfare, as compared to the unconstrained case, since supply of good 2 in period 1 has dropped sharply. Suppose now that we wish to introduce the taxes we discussed earlier, while keeping the price control on good 2 in period 1 at its original level of 20.0. In particular, we will introduce a tax on investment in period 1 that is levied on the returns in period 2. This tax rate is set at $t_{H2} = 0.4$. The government might wish to introduce this tax to make up for the revenue lost by the reduction in the profit tax rate, as well as to change the structure of relative prices and reduce investment. We will then, separately, introduce a tax on savings in period 2 set at $t_{S2} = 0.4$. These experiments are thus designed to determine if a welfare improvement can be achieved by taxing either returns to investment or savings income. The outcome of this simulation is given in Table 3.

We thus observe that the imposition of the 40 percent tax on returns to investment has sharply lowered the level of investment in period 1, as compared to the results of Table 2. A similar outcome, although to a lesser extent, has been caused by the tax on savings. The government surplus has risen in both periods in both cases. The price level is lower in period 1 and higher in period 2 in both cases than in Table 2. The lower level of investment in Table 3, as compared with Table 1, has reduced the capital stock in period 2, thereby causing the increase in the price level in that period. At the same time, the tax has caused there to be an increase in supply in period 1 brought about by the reduction in investment, thereby reducing the price level. Perhaps the most interesting result is that there is an increase in the level of consumer utility, as the increase in period 1 consumption of good 2 outweighs the decline in period 2 consumption of both goods. Thus we have the unexpected conclusion that the imposition of a either a capital tax or a savings tax during the transition period may be welfare improving.

As a final example, let us consider the imposition of both the taxes we discussed in the introduction, that is, a tax on returns to investment and a tax on interest earned on savings. We will set these two tax rates at: $t_{H2} = 0.15$ and $t_{S2} = 0.15$. These taxes are thus diametrically opposed to standard public finance recommendations of taxing consumption, rather than savings and investment. We will keep the price control on good 2 in period 1 at 20.0, as in the examples of Tables 2 and 3. The outcome of this simulation is given in Table 4.

Table 3. $\tilde{P}_{G'1} = 20.0$, $t_{H2} = 0.4$ $(t_{S2} = 0.4)^*$

	Period 1		Period 2	
Consumer demand for good 1	1.654	(1.668)	0.979	(0.983)
Consumer demand for good 2	0.552	(0.533)	1.024	(1.028)
Unconstrained demand for 1/ good 2	1.617	(1.638)	1.024	(1.028)
Price of good 1	21.515	(22.007)	18.371	(17.888)
Price of good 2	20.000	(20.000)	25.781	(25.135)
Price level	20.613	(20.813)	22.780	(22.200)
Nominal GDP	71.239	(72.647)	77.906	(79.153)
Real GDP	3.456	(3.491)	3.420	(3.566)
Government revenues 2/	39.988	(40.591)	35.143	(33.789)
Government expenditure	24.613	(25.277)	23.039	(22.547)
Government surplus (deficit)	15.375	(15.314)	12.104	(11.242)
Real investment 3/	0.214	(0.247)	0.199	(0.201)
Capital stock at end of period	3.110	(3.110)	3.169	(3.202)
Utility of consumer 4/		0.8656		(0.8545)

* The figures in the left hand columns refer to the simulation with $t_{H2} = 0.4$, $t_{S2} = 0.0$. The figures in parenthesis refer to the simulations with $t_{H2} = 0.0$, $t_{S2} = 0.4$.

1/ This is the level of demand that the consumer would have if the price control in period 1 did not induce a supply constraint.

2/ Recall that the government owns the initial capital stock, from which it receives revenue.

3/ In physical units of real capital.

4/ The utility of the consumer depends upon his consumption in both periods.

Table 4. $\bar{P}_{G'1} = 20.0$, $t_{H2} = 0.2$, $t_{S2} = 0.2$

	Period 1	Period 2
Consumer demand for good 1	1.641	0.975
Consumer demand for good 2	0.567	1.021
Unconstrained demand for good 2 1/	1.610	1.021
Price of good 1	21.125	18.386
Price of good 2	20.000	25.783
Price level	20.456	22.787
Nominal GDP	70.133	84.899
Real GDP	3.429	3.726
Government revenues 2/	39.510	34.853
Government expenditure	24.134	22.961
Government surplus (deficit)	15.376	11.892
Real investment 3/	0.192	0.197
Capital stock at end of period	3.110	3.146
Utility of consumer 4/	0.8736	

1/ This is the level of demand that the consumer would have if the price control in period 1 did not induce a supply constraint.

2/ Recall that the government owns the initial capital stock, from which it receives revenue.

3/ Measured in physical units of real capital.

4/ The utility of the consumer depends upon his consumption in both periods.

We see that the imposition of the combined investment and savings taxes has led to a welfare-improving solution, as compared to the imposing either tax individually at a higher rate. In particular, we see that the overall budget surplus of the government is now very close to that achieved by imposing the single tax $t_{H2} = 0.4$. Thus, from the point of view of the budget, the government would be indifferent between the two tax regimes. The combined taxes are, however, clearly preferable to the single taxes from a welfare point of view.

We see that there has been a considerable increase in consumer welfare, as compared to the case reported in Table 2; price controls and no investment or savings taxes. We also can observe that this has been, at least partially, a result of the reduction in investment caused by the new taxes. Factor inputs have been transferred to current output, thereby increasing period 1 consumption. Although it is difficult to make cardinal comparisons between utility levels, it is interesting to note that the consumer's welfare has been brought relatively close to its level in the non-price constrained case reported in Table 1.

VI. Conclusion

We have constructed an intertemporal general equilibrium model designed to examine an economy in transition from central planning to being market oriented. The model considers one sector facing an output price control in the transition period, while the other sector has free output pricing. Interest rates are also controlled during the transition. In the period after the transition all prices are fully liberalized. The model has an equilibrium, although we are not analytically able to solve the model.

We then develop a numerical algorithm that solves for a fixed point of the model. We then carry out simulations using stylized country data that examine the effects of imposing taxes, during the transition period, on returns to investment and on interest earned on private savings. We conclude that, in the presence of price controls, taxation of investment as well as of private savings may have positive effects upon consumer welfare. These results are thus contrary to standard public finance tax prescriptions which recommend taxing consumption, rather than savings. The results should be taken as having illustrative value, rather than having any positive implications for any specific country, given the simplifications we have made in model construction and given the fact that we have not carried out statistical estimations of any of the structural parameters of the model.

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