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High Inflation and Real Wages

BENEDIKT BRAUMANN*

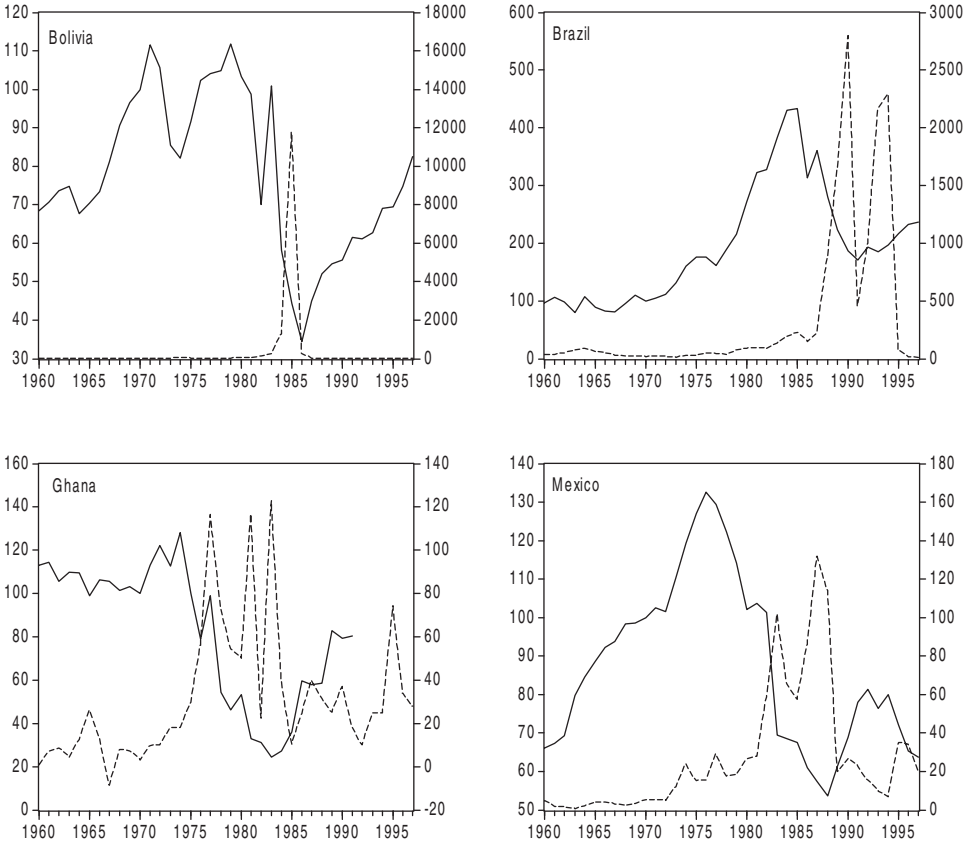
Empirical data show that real wages fall sharply during periods of high inflation. This paper suggests a simple general equilibrium explanation, without relying on nominal rigidities. It presents an intertemporal two-sector model with a credit channel of monetary transmission. In this setting, inflation reduces real wages through (1) a decline of the capital stock, and (2) a shift in relative prices. The two effects are additive and make the decline in real wages exceed the decline in per capita GDP. This mechanism may contribute to rising poverty during periods of high inflation. [JEL E44]

High inflation is a powerful agent of redistribution. It can reduce the real value of debt and tax revenues. In addition, it can impoverish large segments of the population by eroding their earnings. Figure 1 shows four recent examples: Bolivia, Brazil, Ghana, and Mexico. From the beginning to the peak of high inflation,[1] real wages fell by 55 percent in Bolivia, 61 percent in Brazil, 75 percent in Ghana, and 48 percent in Mexico. It is notable that these countries shared similar experiences. Their economies have few elements in common, and inflation rates varied widely. This suggests a robust empirical pattern. Indeed, a wider sample of inflation crises and more rigorous econometric tests confirm the relationship. In Braumann (2000), I studied 23 high inflation episodes in 17 different countries. The median decline of real wages was 24 percent. This and other macroeconomic patterns of high inflation are illustrated in Figure 2.

*Benedikt Braumann is an Economist in the IMF's Western Hemisphere Department. He gratefully acknowledges valuable comments from Bob Flood, Keiko Honjo, Monica Perez dos Santos, Thomas Reichmann, Evan Tanner, Bob Traa, and two anonymous referees.

[1]Bruno and Easterly (1998) speak of an inflation crisis when annual inflation rises over 40 percent for two consecutive years. I will follow their definition here, as in Braumann (2000).

Figure 1. Real Wages and Inflation in Selected Countries, 1960–97
(Real wages (1970=100), solid line and left scale; inflation, broken line and right scale)

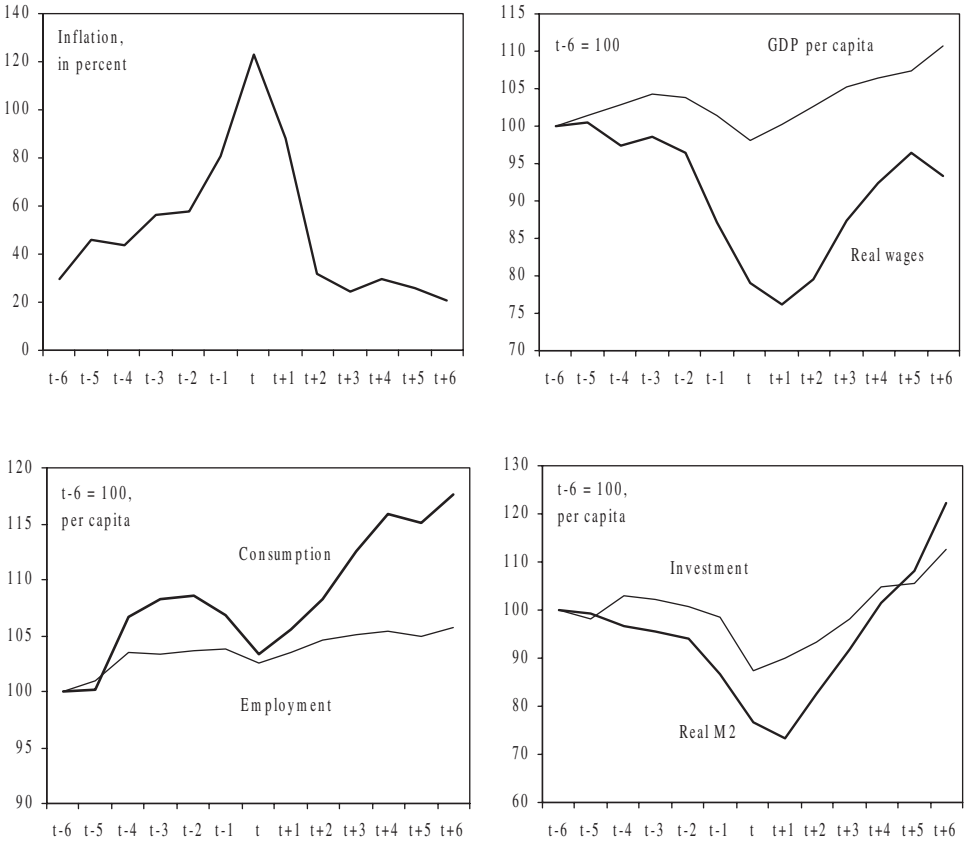


Sources: IMF, *International Financial Statistics;* and Braumann (2000).

On a closer examination, Figure 2 reveals a second important fact: *the decline in real wages was much larger than the decline in per capita GDP:* on average, real wages declined four times as much as per capita GDP. Thus, during inflation there is an important redistribution of income *away from labor,* apparently to the benefit of physical and human capital. In a similar vein, Menendez (1998) finds a widening dispersion of relative wages in a microeconometric study of the last hyperinflation in Argentina. Employees with higher skills were able to preserve the purchasing power of their wages, while workers with lower skills suffered heavy losses.

The general erosion of real wages during high inflation was noted in earlier country studies of Dornbusch and Edwards (1992). Similarly, Braumann and Shah (1999) described a striking U-shaped pattern of real wages during an inflation period in Suriname. Cardoso (1992) stressed the link between falling real wages and increasing poverty during hyperinflations in Latin America. Real wages are an important component of wealth. They constitute the main source of income for

Figure 2. Macroeconomic Patterns in High Inflation Episodes
(23 episodes, median values)



Source: Braumann (2000).

many households, especially for the less well-off. The behavior of real wages therefore has a direct bearing on income distribution and the level of poverty.

Why do real wages decline during high inflation? Macroeconomic theory has given surprisingly little attention to this phenomenon. A commonly heard argument relies on backward-looking indexation. As inflation accelerates, the adjustment of nominal wages lags behind, and real wages fall. While this argument may explain the initial impact of surprise inflation, it has several weaknesses over the longer run. First, falling real wages might, all things being equal, lead to higher labor demand and activity. However, during high inflation one observes a decline in activity (see Figure 2 for real GDP and employment).[2] Second, the argument relies on *money illusion* on part of the workers. Rational workers would soon discover the erosion of their real wages, and negotiate accordingly. My previous paper (2000)

[2]Braumann (2000) also finds a negative effect of inflation on employment. A large literature on stabilization finds similar correlations; see, for example, the survey by Rebelo and Végh (1995).

found that the average duration of an inflation crisis is seven years. This seems ample time to correct errors in price expectations. Finally, the decline in real wages occurred even during repeated and closely spaced inflation crises—for example in Argentina, Brazil, and Uruguay. Learning effects should have eliminated money illusion by the second or third inflation crisis within a generation.

It therefore seems possible that the fall of real wages during high inflation is an *equilibrium* phenomenon. To explore this hypothesis further, this paper introduces a simple general equilibrium model. There is no uncertainty and no asymmetry of information, and there are no nominal rigidities. All markets clear, and inflation is fully expected. The idea is to explain the stylized facts of Figure 2 with as few and as standard assumptions as possible. The basic neoclassical model of monetary growth serves as a point of departure, with the addition of a second sector of production. This allows us to derive a relative price and to analyze the redistribution of income. The model yields an unambiguous and strong decline of real wages during inflation, and traces many other stylized facts reasonably well. The paper begins with an intuitive outline of the argument, before presenting the model in full detail. Then, it simulates both a permanent and a temporary increase in inflation and compares a central prediction of the model with the data. In the last section, the paper discusses the social consequences of the sharp fall in real wages, and then concludes.

I. Intuition

The intuitive results of the model can be summarized quickly. Let us assume a neoclassical two-sector economy that produces consumer and investment goods. There are two factors of production: capital and labor. Labor supply is exogenous, and capital is accumulated through the savings of households. The economy is closed, and all savings are invested in physical capital. The two sectors of production differ in factor intensities: consumer goods are more labor intensive than investment goods. Finally, a formal banking sector is needed to intermediate savings and investment. Reserve requirements create a transmission mechanism from monetary policy to the real economy. The structure could be classified as an intertemporal Heckscher-Ohlin model with a credit channel.

Assume now that the government begins to hand out lump-sum transfers and incurs a budget deficit. To finance the deficit, it resorts to money creation. As a result, inflation rises from zero to μ percent a year. This leads to financial disintermediation. If reserve requirements are not (fully) remunerated, deposit rates are not indexed and may turn negative in real terms. As inflation increases, households withdraw funds from the financial system and force banks to cut real credit.

With less credit available, investment contracts, and the capital stock declines over time. A lower capital stock reduces GDP and makes labor less productive. Therefore, labor demand declines and real wages fall.

In a two-sector economy, this effect is reinforced by a shift in the composition of GDP. Assume for a moment that relative prices are constant. In this case, the Rybczynsky theorem holds. A lower capital stock reduces the supply of the capital-intensive good, while the supply of the labor-intensive good expands. The capital-

intensive good (investment) becomes scarce; the labor-intensive good (consumption) becomes abundant.

Inflation thus leads to a change in relative prices. To clear the markets, the relative price of the labor-intensive good declines. In a two-sector economy, the Stolper-Samuelson theorem provides a link from goods prices to factor prices. As the price of the labor-intensive good declines, real wages must fall. In fact, the theorem predicts that real wages fall by more than relative prices. This is a second negative effect on real wages, which magnifies the first one. In combination, the two effects can be empirically important. While the lower capital stock leads to a proportional decline in output and real wages, the shift in relative prices makes real wages "overshoot." This is the model's interpretation of the stylized fact that real wages decline by more than per capita GDP.[3]

II. The Model

This section describes the model in detail. As noted above, a Heckscher-Ohlin supply side is combined with a credit channel and solved in a context of intertemporal optimization. The model assumes rational expectations for all agents, perfect competition, and the absence of nominal rigidities and uncertainty. The result is a dynamic general equilibrium, which can be analyzed with standard tools of macroeconomics, such as phase diagrams. The aim of this section is to explore how far a simple structure can go in explaining the observed patterns of real wages and inflation.

The model can be set into the general context of monetary growth theory, which studies the medium- and long-term effects of inflation on real variables. A classical survey of monetary growth theory is given by Orphanides and Solow (1990), and a more recent one by Capasso (1997). The discussion was initiated by Tobin (1965), who added money to the Solow growth model. His model showed that inflation had a *positive* effect on growth, since it induces people to lower money balances and step up capital accumulation. The Tobin effect has unsettling policy implications, and was contested by Sidrauski (1967) on theoretical grounds: first, it postulates exogenous savings and second, it provides no microfoundations for money holdings. Tobin assumed ad hoc that people hold money as an asset, despite the fact that capital always yields higher returns (unless there is deflation). In contrast, Sidrauski included real balances in the utility function, and solved the model with dynamic optimization. As a result, inflation no longer had any effects on real variables but was found to be *superneutral.*

Stockman (1981) noted that Sidrauski's treatment of money holdings was still not satisfactory. Money does not yield utility as such but is used mainly to facilitate transactions. When Stockman introduced a cash-in-advance constraint to the model, inflation turned out to have *negative* effects on capital accumulation and

[3]In an open-economy setting, the same forces can be expected to work. Investment goods can be linked to tradables, and consumer goods to nontradables. Nontradable goods are usually more labor intensive than tradables, and their relative price is the real exchange rate.

growth. In this setting, inflation acts as a tax on transactions, in particular on investment. The Tobin effect was thus turned on its head.

Overall, the direction of the real effects depends crucially on how money holdings are modeled. Empirical papers generally support a *negative* effect of inflation on growth—see, for example, Ghosh and Phillips (1998)—and suggest that the transaction function of money is most important. The model presented below follows this line of argument by focusing on the role of the banking sector in financing investment. As in Stockman's model, inflation has a negative impact on the capital stock—and, as a consequence, on real wages.

On a more specific level, the theoretical literature on real wages and high inflation is thin. Helpman and Leiderman (1989) develop a model in which staggered wage and price contracts lead to a *positive* correlation between inflation and real wages. Nonlinearities in the wage bargaining process accelerate inflation when unions increase their real wage demands. The results of the model contradict the empirical evidence presented above. Also, the causality is implausible, as inflation needs a monetary expansion to keep going.

Since the late 1980s, two-sector models have sometimes been used to analyze the real effects of money. A first series of papers, exemplified by Calvo (1986) and Calvo and Végh (1993), concentrated on disinflation programs, which often led to real appreciations and current account deficits. These models stressed credibility problems of the government (the "temporariness" hypothesis) and focused on the demand side of the economy. The supply side was treated in a rudimentary way, usually by assuming fixed endowments. Since these models abstracted from input factors, they could not explain the behavior of real wages.[4]

Closer to our question are papers by Roldós (1995), Rebelo and Végh (1995), Uribe (1997), and Lahiri (2001), who also examine disinflation programs. These authors use the specific-factor model for the supply side, which is, like Heckscher-Ohlin, a workhorse of external trade theory. Although the specific-factor model produces a decline in real wages during high inflation, its magnitude falls short of the evidence seen in Figures 1 and 2. This is due to the so-called neoclassical ambiguity: changes in relative prices have little or ambiguous effects on real wages, which are the reward of the mobile factor labor. They have strong effects on the rewards of specific factors. The decline of real wages in such models is mostly due to a decrease of the capital stock.

A Heckscher-Ohlin structure allows both capital and labor to shift between sectors, and yields unambiguous results for factor prices. The fact that this structure is not used more frequently is unfortunate, since the Heckscher-Ohlin model integrates easily into the kind of general-equilibrium framework that is a staple of macroeconomics. One of the few examples in the literature is Stockman (1985), who uses a Heckscher-Ohlin approach to study the real effects of inflation on trade patterns (but not on real wages). The approach is sometimes criticized on the grounds that intersectoral factor mobility requires a lot of time. While this serves as a caveat to interpret our results in a strictly qualitative way, most of the following analysis in fact concerns patterns that span up to a decade.

[4]See Braumann and Shah (1999) for a case study on inflation in Suriname and the limits of the temporariness approach.

In the model below, the supply side consists of two sectors of production, one for consumer goods and one for investment goods. There are two factors, labor and capital, and both are mobile across sectors. Consumer goods are labor intensive, and investment goods are capital intensive. Factor endowments and output prices determine the relative supply of each good. The output of a sector expands if its relative price increases. It also expands with an increase in the endowment of the input factor that is used more intensively. Therefore, the first step in solving the model is to derive aggregate supply. The resulting transformation curve links sectoral production to relative prices and factor endowments. The demand side of the model consists of households that maximize utility and decide on consumption and savings. Aggregate demand selects the equilibrium price on the transformation curve.

Finally, monetary shocks are transmitted to the real economy via a credit channel. Investment needs to be financed in the formal banking sector.[5] This assumption is in line with empirical observations in Latin America, and also in many other parts of the world. A credit channel produces similar results to a cash-in-advance constraint on investment, as in Uribe (1997), but may be more empirically appealing. The size of the formal financial sector is determined by the amount of deposits, which depends on the real interest rate paid by banks. As the real deposit rate declines, the amount of deposits falls and the volume of credit contracts. With less credit available, firms are forced to cut their investment plans.

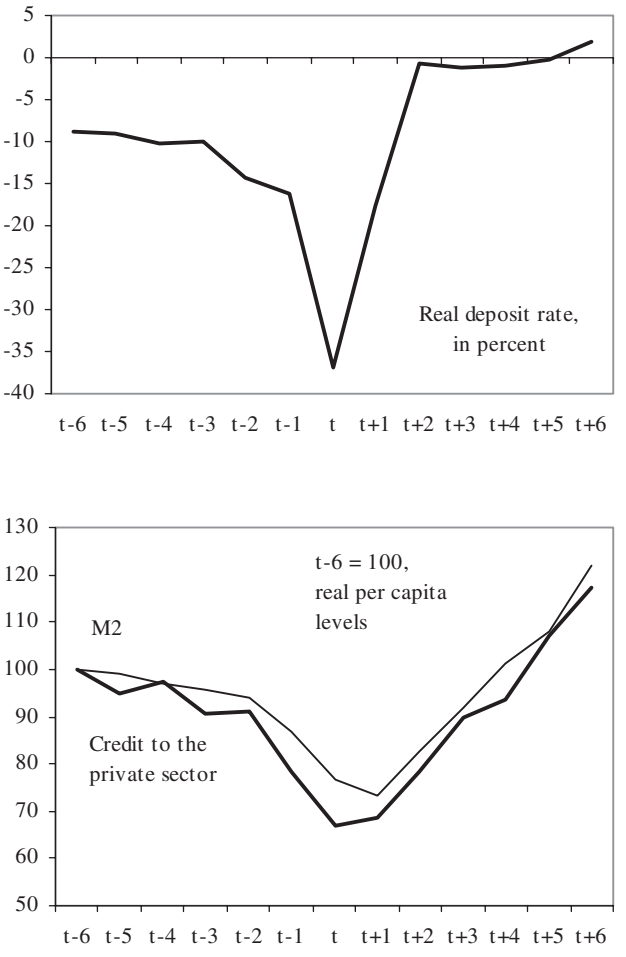
The government finances its deficit through the inflation tax. The tax base is central bank money, which is the sum of currency and reserve requirements of banks. In the following, we will assume that all central bank money consists of reserve requirements. To collect seignorage, the state pays no interest on reserve requirements. If inflation is greater than zero, banks thus incur negative real returns on an important part of their assets. This is the first incidence of the inflation tax. Competitive banks pass this tax onto households by lowering deposit rates below lending rates. With high inflation, deposit rates may become negative in real terms. Inflation combined with unremunerated reserves is an element of distortion or *financial repression* in the economy.

Figure 3 shows real deposit rates, real M2 (deposits and cash), and real credit to the private sector during the 23 inflation episodes mentioned above. In practice, financial repression comes in many forms. On average, the countries in the sample imposed reserve requirements of 35 percent. Argentina, Chile, and Venezuela had requirements of up to 100 percent. Several countries accompanied reserve requirements with explicit ceilings on deposit rates. Thus, real deposit rates turned sharply negative during high inflation. As a result, households withdrew funds from the formal banking system, causing real M2 and real credit to contract. High inflation led to a marked decline of financial intermediation.

For the sake of simplicity, we assume all seignorage revenues are reimbursed to the private sector via lump-sum transfers. This allows us to concentrate on the relative price distortions generated by the inflation tax. By excluding wealth effects, we can simplify the algebra without losing substance. Wealth effects lead to a reduction of steady-state consumption, but leave the qualitative effects on real wages unchanged.

[5]Bernanke and Gertler (1995) present a survey of the credit channel of monetary transmission.

Figure 3. High Inflation and the Financial System
(Median values of 23 inflation crises)



Source: IMF, *International Financial Statistics.*

Firms: Cost Minimization and Pricing

Firms in both sectors combine labor N_t and capital K_t to produce output. The consumer good C_t is assumed to be labor intensive, the investment good I_t is capital intensive. Labor and capital are mobile between the two sectors. Labor is supplied inelastically by households and normalized to 1. The accumulation of capital is endogenous, and will be determined by the utility maximization of households. In particular, the following sectoral production functions are used:

$$C_t = K_{C,t}^{\alpha} N_{C,t}^{1-\alpha} \tag{1}$$

$$I_t = K_{I,t}^{1-\alpha} N_{I,t}^{\alpha}, \tag{2}$$

where α is strictly smaller than 0.5. The sectoral production functions are mirror images of each other. This symmetry is introduced for the sake of simplicity and to save on notation. Markets are perfectly competitive and prices are flexible. The price of investment goods is chosen as numéraire. The variable p_t denotes the relative price of the consumer good, and can be thought of as the real exchange rate in an open-economy setting. Labor earns a real wage w_t and capital, a rental rate r_t. Factor prices are equalized across the economy, since both factors are perfectly mobile. Omitting the time subscript, cost minimization by firms leads to

$$\frac{K_C}{N_C} = \frac{\alpha}{1-\alpha}\frac{w}{r} \qquad \text{and} \qquad \frac{K_I}{N_I} = \frac{1-\alpha}{\alpha}\frac{w}{r}. \tag{3}$$

Next, we define the input-output coefficients as $n_i = N_i/i$ and $k_i = K_i/i$, with $i = C, I$. Inserting the minimum-cost combinations and carrying out a total differentiation yields:

$$\hat{n}_C = -\alpha(\hat{w} - \hat{r}) \tag{4}$$

$$\hat{n}_I = -(1-\alpha)(\hat{w} - \hat{r}) \tag{5}$$

$$\hat{k}_C = (1-\alpha)(\hat{w} - \hat{r}) \tag{6}$$

$$\hat{k}_I = \alpha(\hat{w} - \hat{r}), \tag{7}$$

where hats denote deviations from the initial steady state, e.g., $\hat{C} = (C - C^*)/C^*$. Perfect competition ensures that prices are equal to unit costs and profits are eliminated:

$$p_i = wn_i + rk_i, \qquad i = C, I. \tag{8}$$

Differentiating equation (8) and substituting equations (4)–(7) yields

$$\hat{p}_C = (1-\alpha)\hat{w} + \alpha\hat{r} \tag{9}$$

$$\hat{p}_I = \alpha\hat{w} + (1-\alpha)\hat{r}. \tag{10}$$

By subtracting equation (10) from equation (9), one arrives at the Stolper-Samuelson relation:

$$\hat{p} = (1-2\alpha)(\hat{w} - \hat{r}), \tag{11}$$

where p denotes the relative price of the labor-intensive consumer good. The following two expressions for factor prices follow as a corollary of equations (9), (10), and (11):

$$\hat{w} = \frac{1-\alpha}{1-2\alpha}\hat{p} \tag{12}$$

$$\hat{r} = -\frac{\alpha}{1-2\alpha}\,\hat{p}. \tag{13}$$

Resource Constraints

Flexible factor prices ensure that labor and capital are always fully employed. The input-output coefficients can be used to determine the allocation of the two factors among the two sectors of production. The full-employment conditions can be written as

$$\overline{N} = N_C + N_I = n_C C + n_I I = 1 \tag{14}$$

$$K = K_C + K_I = k_C C + k_I I. \tag{15}$$

To save on notation, we shall work with a symmetric initial steady state. From $N = 1$, $p = r = 1$, and $C = I$, it follows that $K_C/K = \alpha$, $N_C/N = 1 - \alpha$.[6] Differentiate (14) and (15) using these assumptions and equations (4)–(7) to obtain

$$\hat{N} = -2\alpha(1-\alpha)(\hat{w} - \hat{r}) + (1-\alpha)\hat{C} + \alpha\hat{I} = 0 \tag{16}$$

$$\hat{K} = 2\alpha(1-\alpha)(\hat{w} - \hat{r}) + \alpha\hat{C} + (1-\alpha)\hat{I}. \tag{17}$$

Subtracting equation (16) from (17) and inserting the Stolper-Samuelson relation (11) gives

$$(1-2\alpha)(\hat{I} - \hat{C}) = -\frac{4\alpha(1-\alpha)}{1-2\alpha}\,\hat{p} + (\hat{K} - \hat{N}). \tag{18}$$

This equation summarizes the supply side of the economy and can be interpreted as a transformation curve. If factor supplies are constant, the economy moves along the transformation curve according to changes in relative prices. The production of a good increases if its relative price increases. On the other hand, the transformation curve shifts out if factor supplies expand. A particularly interesting situation arises when relative prices are constant. In this case, equation (18) reduces to the Rybczynsky theorem: if the supply of a factor increases (e.g., capital), the sector using this factor intensively expands (e.g., investment goods) and the other sector contracts (consumer goods). To determine the equilibrium relative price and output, we turn to the demand side.

Financial System

The financial system intermediates savings to finance investment. Households deposit their savings in banks. Deposits D_t earn an interest rate i_t^D. Banks use these

[6] In this symmetric steady state, the equation for capital accumulation (26) yields $w = C = K$. From cost minimization in the consumer goods industry follows that $rK_C = \alpha/(1-\alpha)\, wN_C$. Equating revenues and total costs, $wN_C + rK_C = C$, and combining this with the two relations before yields $K_C = \alpha$ and $N_C = 1 - \alpha$.

deposits to extend credit Cr_t at an interest rate i_t^{Cr}. However, they are also required to hold a fraction ρ of deposits as reserves R_t at the central bank, earning no interest, $i_t^R = 0$. Thus, the balance sheet of banks reads

$$D_t = Cr_t + R_t$$

and profits are

$$\Pi_t = i_t^{Cr} Cr_t + i_t^R R_t - i_t^D D_t.$$

Perfect competition in the banking sector drives profits down to zero. From this it follows that

$$i_t^D = (1 - \rho) i_t^{Cr}.$$

Higher reserve requirements widen the spread between nominal lending and deposit rates. Deposit rates are not completely indexed to inflation, since a good part of the bank's assets earns no interest at all. Thus, at high levels of inflation real deposit rates become negative. In the following, we will simplify the algebra by assuming $\rho = 1$, or reserve requirements of 100 percent, as in Argentina, Chile, and Venezuela (see above). Nominal deposit rates become zero, and deposits are fully backed by central bank money.

Households

The economy is inhabited by a large number of identical households, which derive utility from consuming the consumer good C_t. They maximize the following logarithmic utility function

$$U = \sum_{t=0}^{\infty} \beta^t \ln C_t, \tag{19}$$

where β is the discount factor. Individuals hold two different types of assets, capital K_t and deposits D_t. They receive income from wages w_t, renting out capital r_t and government transfers Tr_t. Labor supply is inelastic and normalized to 1. Capital is assumed to depreciate within one period. Since the price of the investment good is taken as numéraire and fixed at unity, all real quantities are expressed in terms of investment good prices. Accordingly, households face the budget constraint

$$K_{t+1} + \frac{D_t}{P_t} = w_t + r_t K_t + Tr_t + \frac{D_{t-1}}{P_t} - p_t C_t. \tag{20}$$

Households accumulate deposits in the banking system to finance investment at the end of each period. Investment turns into productive capital at the beginning of the next period. Banks pool the deposits and organize the financing of large-scale projects. Such projects must be financed by a large formal banking sector

that is based on central bank money, and not by an informal curb market. To make this link explicit, we impose a deposit-in-advance constraint on investment. To start an investment project, households need to maintain deposits in the banking system:

$$\frac{D_{t-1}}{P_t} \geq I_t = K_{t+1}. \tag{21}$$

Investment is thus related to the size of the formal financial sector. Since capital yields a larger return than deposits, the constraint will hold with equality throughout the model. As noted above, we assume reserve requirements of $\rho = 1$, which implies that $D_t = R_t$. Deposits are fully backed by central bank money. Denoting monetary growth as μ_t, the following expression can be derived:

$$\frac{D_t}{P_t} \mu_t K_{t+1}. \tag{22}$$

Making use of the last two equations in the budget constraint (20), solving (20) for C_t, substituting the results in equation (19) and maximizing with regard to K_{t+1} yields the Euler equation:

$$\frac{C_{t+1}}{C_t} = \frac{p_t}{p_{t+1}} \frac{r_{t+1}}{\beta\mu_t}. \tag{23}$$

Differentiating around the steady state leads to

$$\hat{C}_{t+1} = \hat{C}_t + \hat{p}_t - \hat{p}_{t+1} + \hat{r}_{t+1} - \hat{\mu}_t. \tag{24}$$

Government

The only expenditures of the government are transfers to households. Since there are no taxes, the resulting deficit is completely financed by money creation. The budget deficit is thus the source of monetary growth, which in turn determines the inflation rate. Algebraically, the budget constraint of the government is given by

$$Tr_t = \frac{R_t - R_{t-1}}{P_t} = (\mu - 1) \frac{D_{t-1}}{P_t} (\mu - 1) K_{t+1}. \tag{25}$$

Next, we consolidate the government and household sectors by substituting for Tr_t in equation (20). This leads to the economy-wide equation of capital accumulation:

$$K_{t+1} = w_t + r_t K_t - p_t C_t. \tag{26}$$

Differentiating and linearizing equation (26) around the steady state yields

$$\hat{K}_{t+1} = \hat{w}_t + \hat{r}_t + \hat{K}_t - \hat{p}_t - \hat{C}_t. \tag{27}$$

By subtracting $\hat{K}_t$ from equation (27) we obtain an equation that expresses aggregate demand conditions in the economy:

$$\hat{I}_t - \hat{C}_t = \hat{w}_t + \hat{r}_t + \hat{K}_t - \hat{p}_t - 2\hat{C}_t. \tag{28}$$

General Equilibrium

The relative price p_t can be determined by equating aggregate demand (28) and aggregate supply (18). After substituting equations (12) and (13) for w_t and r_t in equation (28) and eliminating $(I_t - C_t)$, the relative price becomes

$$\hat{p}_t = \frac{1 - 2\alpha}{2(1 - \alpha)} \hat{K}_t + \frac{(1 - 2\alpha)^2}{2\alpha(1 - \alpha)} \hat{C}_t. \tag{29}$$

This expression can be used to derive the equations that determine the dynamic behavior of the model. The equation for capital accumulation becomes

$$\hat{K}_{t+1} = \hat{K}_t - \hat{C}_t. \tag{30}$$

The Euler equation (24) determines the dynamics of consumption. After substituting for r_{t+1}, p_t, and p_{t+1}, and collecting terms, it reads

$$\hat{C}_{t+1} = \frac{1 - \alpha + \alpha^2}{1 - \alpha} \hat{C}_t - \frac{\alpha^2}{1 - \alpha} \hat{K}_t - 2\alpha\mu. \tag{31}$$

With these two equations of motion, a phase diagram can be constructed. The demarcation lines are

$$\Delta\hat{K} = 0: \qquad \hat{C} = 0 \tag{32}$$

$$\Delta\hat{C} = 0: \qquad \hat{C} = \hat{K} + 2\mu(1 - \alpha)/\alpha. \tag{33}$$

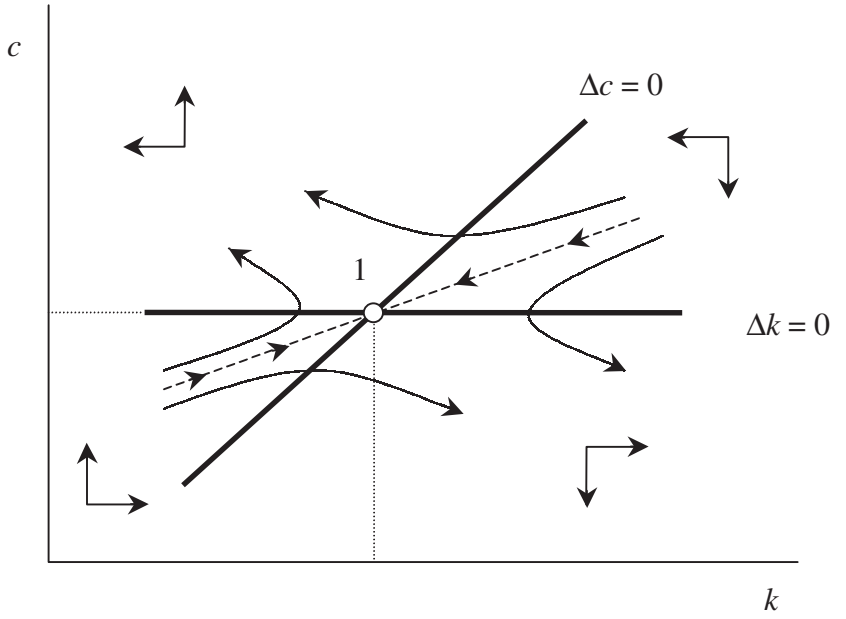
A graphical interpretation of the model is given in the phase diagram of Figure 4. The equilibrium is a saddle point and the stable transition path has a positive slope. In this economy, money is not superneutral. The parameter μ enters the demarcation line for consumption (33) as a shift factor. As inflation increases, this line shifts up, causing the capital stock to decline and output to contract.

III. The Effects of Inflation

A Permanent Increase in Inflation: Long-Run Effects

Assume that the government increases transfer payments to households permanently. The resulting fiscal deficit is financed by money creation. As a first step, it helps to abstract from short-run dynamics and concentrate on the new steady state.

Figure 4. The Dynamics of the Model in the *c*/*k*-Space

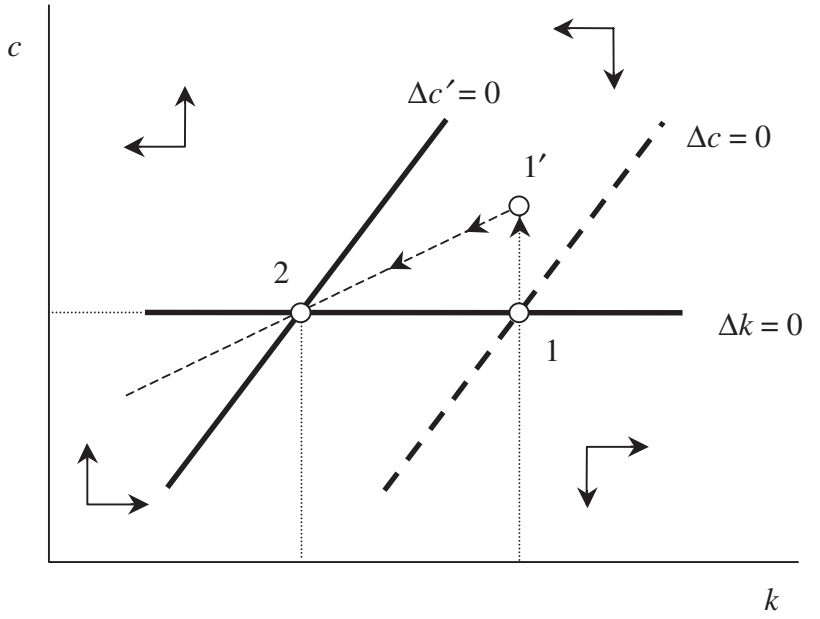


The monetary expansion drives up the inflation rate from 0 to μ. The effects on the real economy are shown in Figure 5. As the demarcation line for consumption shifts up, the economy moves to the new equilibrium 2. Solving equations (32) and (33) yields the following steady-state values:

$$\hat{K} = -2(1 - \alpha)\mu/\alpha$$
$$\hat{w} = -(1 - \alpha)\mu/\alpha$$
$$\hat{p} = -(1 - 2\alpha)\mu/\alpha$$
$$\hat{Y} = -(1 - 2\alpha)\mu/2\alpha = \hat{I} + \hat{p} + \hat{C}$$
$$\hat{C} = 0$$
$$\hat{r} = \mu$$

Inflation has negative effects on almost all macroeconomic variables. An inclusion of wealth effects would result in a negative effect on consumption as well. The steepest decline occurs in the capital stock (and for that matter, investment), followed by real wages. Since the model is highly stylized, these results are of a qualitative nature. Nevertheless, one can perform a little numerical exercise, for example, by calibrating the parameter α to 1/3, as suggested by the macro literature on developing countries (e.g., Mendoza and Uribe, 1999), and μ to 2.2, the median inflation peak (123 percent) in the empirical sample. The ordering of the inflation effects is closely in line with the empirical values: the decline in relative prices is twice as deep, and the decline in real wages four times as deep as the decline in

Figure 5. A Permanent Increase in Inflation



GDP. In the sample of 23 inflation episodes, real GDP declines by 6 percent, the relative price of investment goods by 10 percent, and real wages by 24 percent. The simulation gives a decline of real GDP of 1.1 percent, which falls short of the observations. However, this magnitude is quite sensitive to the choice of the technology parameter α, and the symmetry imposed on the two sectors of production. The model imposes an average capital intensity of 0.5, which is a high value. With a lower average capital intensity, especially with a lower α in the labor-intensive sector, the decline in GDP deepens.

As noted above, the large fall in real wages is the result of two mutually reinforcing effects. First, higher inflation leads to a decline in the capital stock and to a lower marginal product of labor. Second, the sectoral composition of output changes, producing an excess supply of labor-intensive goods. This causes relative prices to decline, and via the Stolper-Samuelson theorem, real wages to fall. Equation (11) expresses the Stolper-Samuelson effect: a fall in relative prices leads to a (magnified) fall in real wages. As the labor-intensive sector contracts, it releases a large number of workers, which cannot easily be absorbed by the capital-intensive sector as this contracts as well. Accordingly, a large adjustment of real wages is necessary to clear the labor market.

Short-Run Effects and Transition Dynamics

The severe contraction that inflation causes over the medium term is often masked by an initial short-run boom. This has been a familiar pattern in several Latin American countries, where governments used inflationary policies to engineer

a redistribution of income towards urban labor. Often, such policies resulted in immediate rapid GDP growth and real wage gains. The following quotes from a collection of articles in Dornbusch and Edwards (1992) give a vivid account of this phenomenon. Sturzenegger (1992, p. 80) writes about Perón's third administration in Argentina in 1974:

> After a year, the results of the program had been so spectacular that even those most strongly opposed to the government had to give credit to the economic policy being implemented.

Larraín and Meller (1992, p. 194) note about Allende's socialist-populist experiment in Chile:

> The Chilean economy experienced an unprecedented boom in 1971. This generated a . . . sense of total success among *Unidad Popular* leaders. The labor share in GDP increased from 52.2% (1970) to 61.7% (1971), . . . with an overall average [increase in real wages] of 22.3%.

Lago (1992, p. 275) describes the initial phase of Alán García's rule in Peru as follows:

> After a few months of initial sluggishness, the response of the economy to the program was an unprecedented output expansion. Real wages grew by 24 percent over the two-year period [of 1986–87]. Private sector confidence in and support of the government's economic policies could only be described as unanimous.

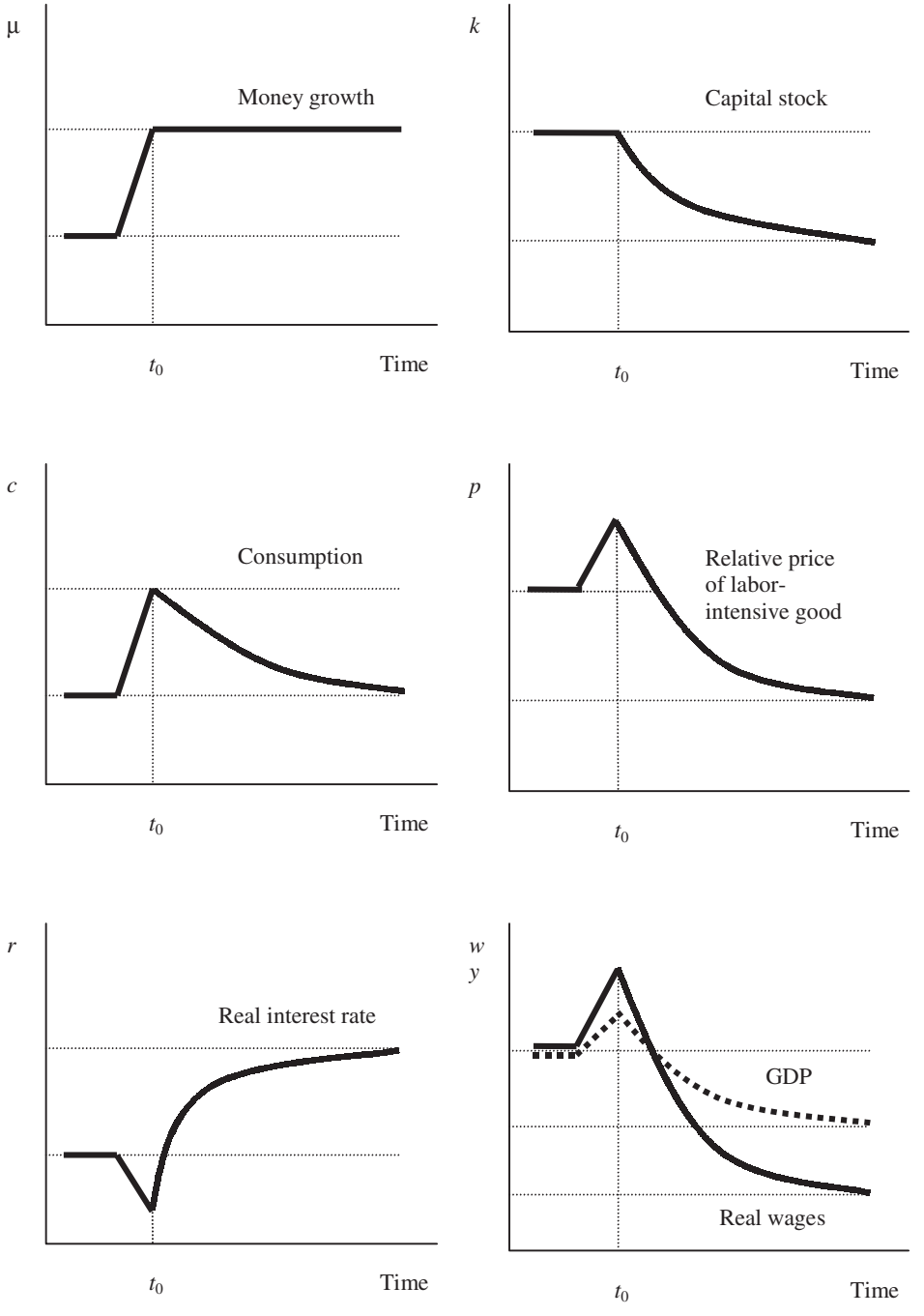
A short-term boom and its painful collapse is also implied in the transition dynamics of the model. Figure 6 shows the trajectories of the main macro variables over time. By taxing financial intermediation, inflation raises the effective price of investment goods on impact. Households react by investing less and consuming more. Consumption jumps from steady state 1 to point 1′. Since total factor supplies are fixed in the short run (capital is the state variable), production cannot increase as fast as demand. A shortage of consumer goods develops, leading to an increase in their relative price. Because consumer goods are labor intensive, real wages temporarily rise via the Stolper-Samuelson effect.

However, the brief consumption boom comes at the expense of lower investment, and therefore of future output. From the second period onward, the capital stock declines, and the economy contracts. Everything now works against labor, and the initial gains dissipate quickly. The long-run consequences were described above: in the new steady state, the levels of GDP and real wages are lower than before. Thus, the attempt to redistribute income via expansionary policies is self-defeating, and wage earners are the principal losers from inflation.

A Temporary Increase in Inflation

A weakness of the previous analysis is the assumption that inflation increases permanently. Historical experience suggest that high inflation seldom lasts for long. The median duration of 23 high inflation episodes in my previous (2000) paper

Figure 6. Dynamic Effects of a Permanent Increase in Inflation



was about seven years. Consider therefore a temporary increase in inflation. While the qualitative results do not change much, the trajectories of key variables resemble the empirical patterns of Figure 2 a bit better.

In contrast to before, the public anticipates that the government will return to stability after a certain time *T*. The dynamic behavior of the economy is illustrated in Figures 7 and 8. As inflation begins, the demarcation line for *C* shifts up to position $\Delta c'$ (broken line). From time 0 to *T* the dynamic field is in an inflationary state. After *T,* the demarcation line for *C* returns to its original position.

At the beginning, the model yields again an ephemeral boom. Consumption jumps up to point 1′, then falls continuously along an unstable trajectory towards point 1″. It hits the saddle path *SS* at time *T,* when the economy is stabilized, and climbs back to the original equilibrium. This time path for consumption fits the stylized facts better than Figure 6 with a permanent increase in inflation. Consumption decreases even without invoking wealth effects. The shorter the expected duration of inflation *T,* the smaller is the initial consumption boom. As $T \to \infty$—if stabilization is unlikely—the dynamics converge to the permanent case described before.

The trajectories of other macroeconomic variables are illustrated in Figure 8. As can be seen, the capital stock starts to recover slightly *before* the end of inflation. The same is true for output and real wages. The mere *expectation* of an imminent stabilization can revive the economy. The sooner the public expects the government to end inflation, the milder and shorter the recession will be.

Finally, the model yields a deteriorating income distribution during high inflation, as real wages fall and real interest rates rise. This can be related to the results of Menendez (1998). "Capital" can be interpreted as "human capital," and "real

Figure 7. A Temporary Increase in Inflation

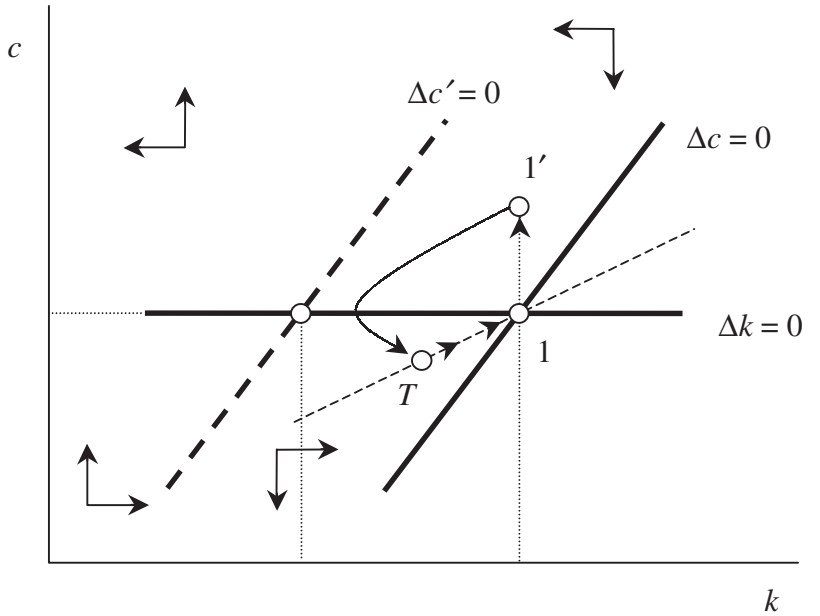
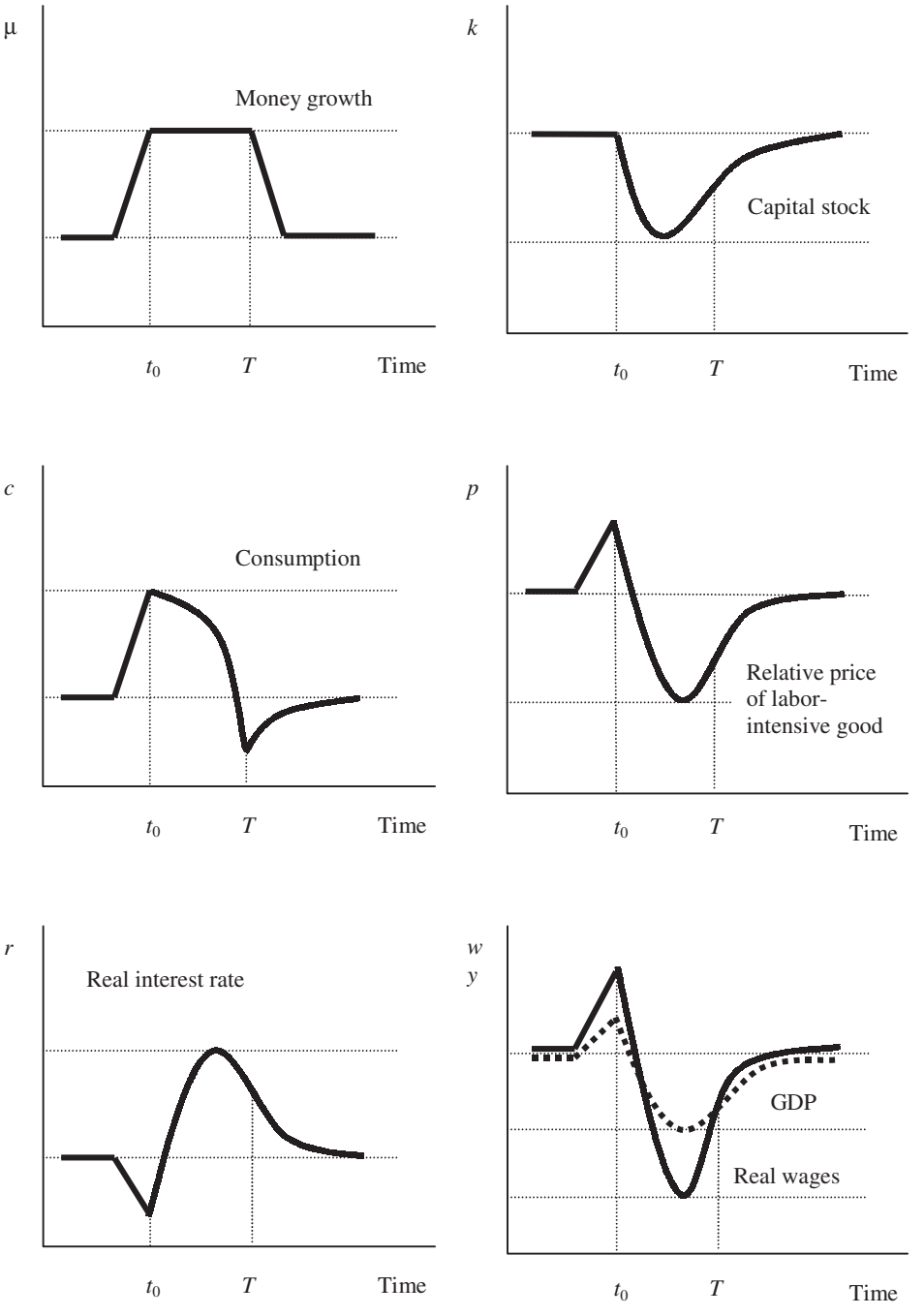


Figure 8. Dynamic Effects of a Temporary Increase in Inflation



interest rates" as the salary of high-skilled professionals. During high inflation, real interest rates and real wages do in fact move apart.

An Empirical Illustration of Relative Price Effects

A central mechanism in the model is the decline of the relative price of labor-intensive goods. It ultimately causes the "overshooting" of real wages. Does a relative price effect show up in the data? While this is not the place for an exhaustive empirical study, a brief illustration may be useful. Since there is no straightforward empirical equivalent to the relative price of the model, approximations have to be constructed. A first proxy is the real internal exchange rate (defined as nontradable over tradable prices). Nontradables are generally more labor intensive than tradables. In Braumann (2000), I proxied tradables by the price of clothing and nontradables by the price of housing services in the consumer price index. During the 23 inflation crises analyzed in that paper, the median internal real exchange rate declined by 35 percent (Figure 9). Another proxy for the relative price is the ratio of consumption to investment deflators, as taken from the national accounts. Owing to data restrictions, the sample is limited to 15 inflation crises. Figure 9 shows that the relative price of consumption declined by about 10 percent during high inflation. In a rough and preliminary way, the data seem to support the relative price effect of the model.

IV. Real Wages and Poverty

The model above can be applied to a closely related question: Can lowering inflation reduce poverty? The wave of market-oriented reforms in Latin America during the late 1980s and early 1990s coincided with a sharp increase in poverty in the region. Based on casual evidence, it has been argued that the poor bore the brunt of the adjustment process. Poverty was seen as the dark side of market-oriented reforms. Monetary stabilization, downsizing of the government, selling of public assets, and trade liberalization were all portrayed as having regressive effects on income distribution.[7]

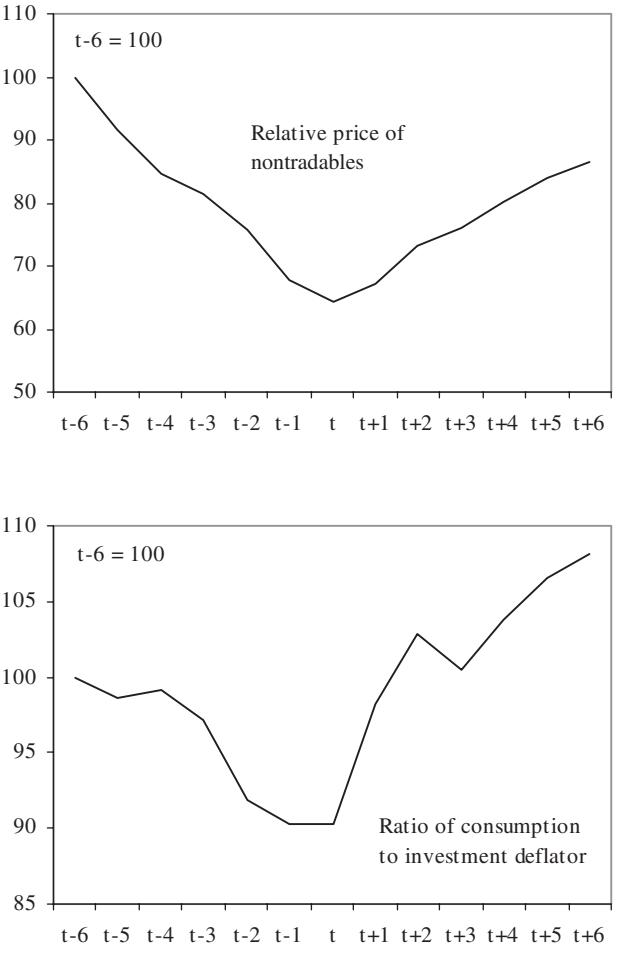
The model of this paper suggests a different perspective. Both data and theory support the notion that inflation leads to a sharp decline in real wages. If real wages are an important part of lower-class income, they can be expected to correlate with the level of poverty, as Cardoso (1992) argues. Therefore, it seems likely that not adjustment itself but the previous bout of high inflation caused the rise in poverty. Inflation led to a sharp decline in real wages, pushing many households below the poverty line.

Figure 10 combines the inflation rates in four countries with recent time series data on poverty from ECLAC (1999) and Londoño and Székely (1997). Poverty is measured as the percentage of population that lives on less than US$2 a day. Despite some gaps in the data record, a clear pattern emerges: poverty peaked roughly at the height of the inflation maximum. After the end of inflation, real wages rebounded

[7]For an explicit and quite thorough presentation of this argument see Morley (1995).

Figure 9. Relative Price of Labor Intensive Goods During High Inflation

(Median behavior of two empirical proxies)

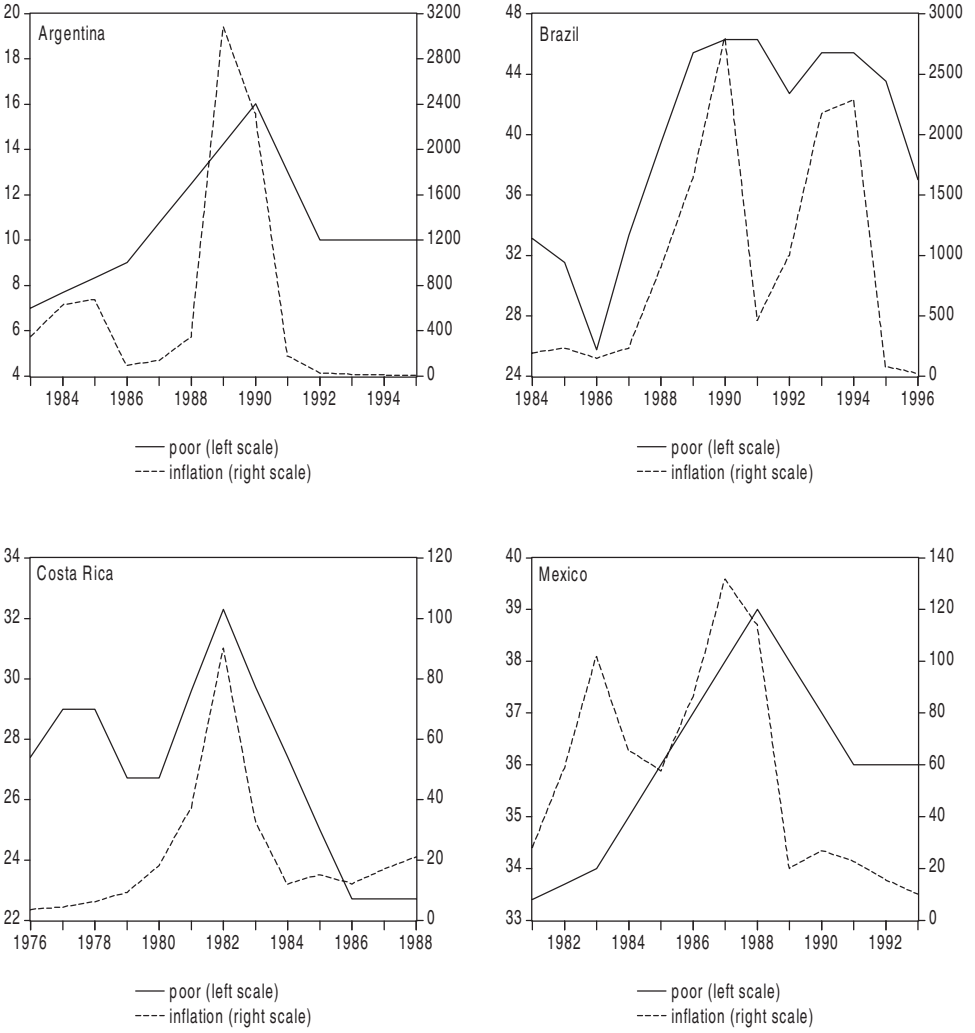


Sources: Braumann (2000); and UN National Accounts Statistics.

and poverty decreased. This picture continues to hold in a wider sample of observations. Figure 11 shows the median poverty rate of six inflation crises in Argentina, Brazil, Costa Rica, Mexico, Peru, and Uruguay. Poverty peaks at time *t*, the year of the inflation maximum. The sharp decline of real wages was instrumental in increasing poverty.

A more rigorous study by Bulíř (2001) confirms this finding. The author analyzes the question of why income distribution in Latin America is more unequal than in Asia. He finds that much of this difference is due to higher inflation rates in Latin America, after controlling for variables like per capita income and public transfers.

Figure 10. Poverty and Inflation in Selected Countries
(In percent)



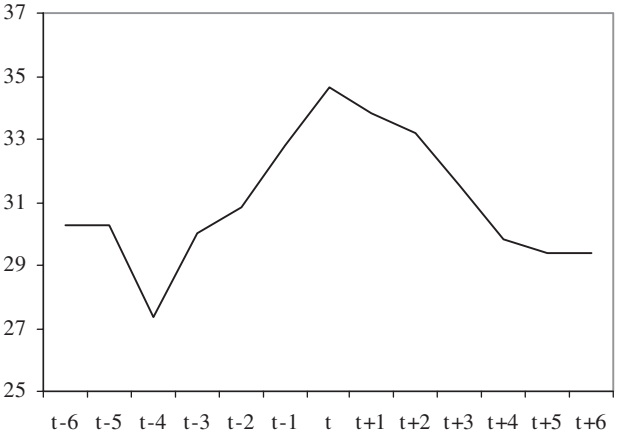
Sources: IMF, *International Financial Statistics* for inflation; poverty: Londoño and Székely (1997) for Brazil and Costa Rica; ECLAC (1999) for Argentina, Mexico, Peru, and Uruguay.

Lower-income countries are shown to benefit most from stabilization, which Bulíř recommends to them as a "free lunch" without costs over the medium term.

V. Conclusions

This paper examined the theoretical relation between inflation and real wages. A sharp decline in real wages is an important stylized fact of many inflationary episodes, but has so far received little attention in the literature. The often-heard

Figure 11. Median Poverty
(Population living below the poverty line, in percent)



Sources: ECLAC (1999); and Londoño and Székely (1997).

argument that this is a result of incomplete indexation is not empirically convincing and poses some theoretical problems. The paper explores a model that portrays the strong fall in real wages as an equilibrium phenomenon. The supply side consists of two sectors of production similar to the Heckscher-Ohlin model of external trade. Savings are derived from intertemporal utility maximization, and investment is financed by a banking sector that is subject to the inflation tax. Inflation produces a fall in real wages via two channels. First, it reduces the capital stock and lowers the productivity of labor. Second, it causes relative prices to shift against the labor-intensive good. This causes a decline in real wages via the Stolper-Samuelson effect. Both channels combine to form a potent force in lowering real wages.

For reasons of tractability, this paper has focused on a closed economy. A natural extension would be to open the model to international trade and capital flows. The main results can still be expected to hold. Investment goods might be likened to tradables, and consumption goods to nontradables. The relative price of nontradables would be the real exchange rate. In a previous paper, I found that real depreciations (falling nontradable prices) and trade surpluses are common empirical patterns during inflation periods. This observation can be interpreted in light of the model above. As inflation makes investing at home less attractive, trade surpluses help a country move some of its capital abroad.

The fall in real wages during inflation can also be linked to increasing poverty in Latin America during the last two decades. An examination of recent data shows that poverty maxima coincided with inflation maxima. Neither stabilization nor market-oriented reforms were the main culprits for rising poverty. On the contrary, the living standards of the poor were most hurt by inflationary macro policies that intended to favor them. Fighting inflation might thus be an important step towards reducing poverty.

APPENDIX

Data Sources

Ratio of poor: Londoño and Székely (1997) for Brazil and Costa Rica; ECLAC (1999) for Argentina, Mexico, Peru, and Uruguay.
Inflation rates, deposit rates, credit to private sector: International Financial Statistics, IMF.
Real wages, GDP, investment, consumption, M2: Braumann (2000).
Relative prices: Braumann (2000).
Relative deflators: Braumann (2000) and UN National Accounts Statistics.

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