



IMF Working Paper

High Inflation and Real Wages

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Abstract

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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 cash-in-advance constraint. 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.

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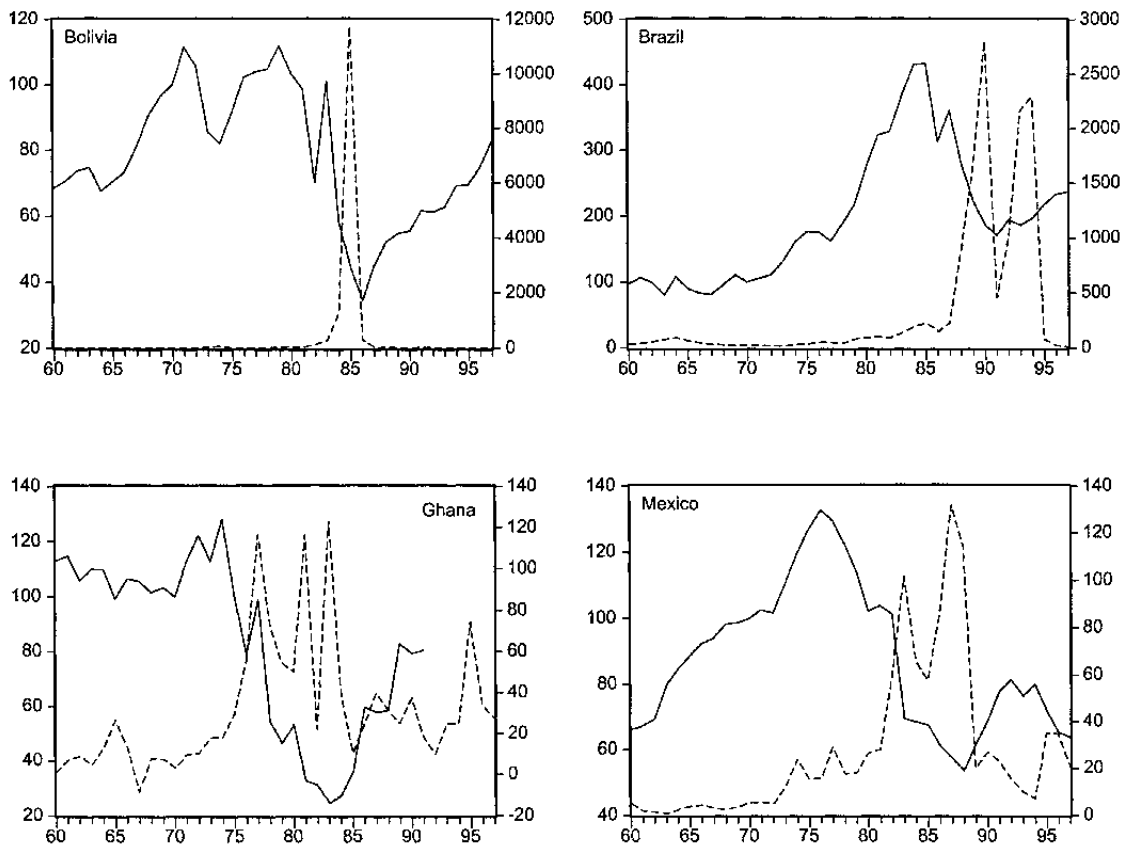
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1. INTRODUCTION

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 real wages. Figure 1 shows four recent examples: Bolivia, Brazil, Ghana and Mexico. From the beginning to the peak of high inflation², 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 despite their contrasting economic characteristics and different magnitudes of inflation, these countries shared similar experiences. 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.

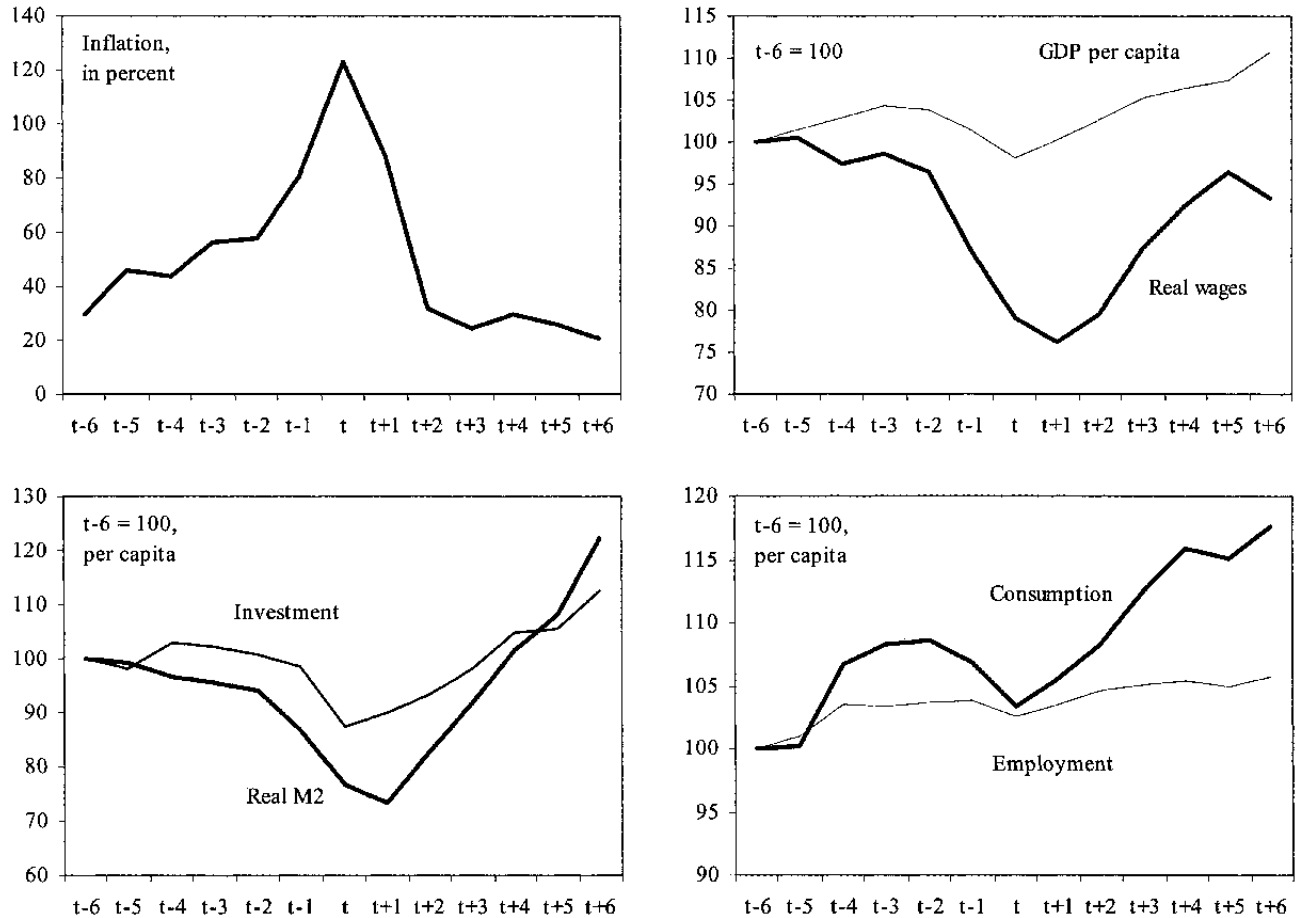
Figure 1. Real Wages and Inflation in Selected Countries, 1960-97.

Real wages (1970=100) solid line and left scale, inflation broken line and right scale.



² Bruno and Easterly (1995) define that an inflation crisis begins when annual inflation rises over 40 percent for two consecutive years. I will follow them here, as in Braumann (2000).

Figure 2. Macroeconomic Patterns in High Inflation Episodes.
 23 episodes, median values. Source: Braumann (2000)



On a closer examination, figure 2 reveals an interesting result: the decline in real wages is on average four times larger than the decline in per-capita GDP, which declines by only 6 percent. Thus, during inflation there is an important redistribution of income *away from labor*, apparently to the benefit of physical and human capital. In a related microeconomic study of the last hyperinflation in Argentina, Menendez (1998) finds a widening dispersion of relative wages. Employees with higher skills were able to preserve the purchasing power of their wages, while workers with low 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 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. If inflation accelerates, the adjustment of nominal wages lags behind, and real wages fall. This argument has several weaknesses. First, falling real wages would *ceteris paribus* lead to higher labor demand and activity. However, during high inflation one observes just the opposite (see figure 2 for real GDP and employment).³ Second, the argument assumes an important degree of *money illusion* on part of the workers. Rational workers would soon discover the erosion of their real wages, and act accordingly. My previous paper (2000) 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, e.g. in Argentina, Brazil and Uruguay. By the second or third inflation crisis within a generation the extent of money illusion is likely to be very limited.

It seems therefore 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, no asymmetry of information, and 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 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. I begin with an intuitive outline of the argument, before presenting the full model in section 3. Section 4 simulates a permanent and a temporary increase in inflation and checks a central prediction of the model with the data. Section 5 discusses the social consequences of the sharp fall in real wages, and section 6 concludes.

2. INTUITION

The intuition of the model can be summarized quickly: Let's 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 to become capital. The two sectors of production differ in their factor intensities: Consumer goods are more labor intensive than investment goods. And finally, money is needed for transactions. Real balances reduce the cost of transactions. This structure could be classified as an intertemporal Heckscher-Ohlin model with a cash-in-advance constraint.

Assume now that the government begins to hand out lump-sum transfers and incurs a budget deficit. To finance the deficit, it sets the printing press in motion. As a result, inflation

³ Braumann (2000) also finds a negative effect of inflation on employment. A large literature on stabilization finds similar correlations, see e.g. the survey e.g. by Rebelo and Végh.

picks up from zero to μ percent a year. Because holding money becomes more expensive, people reduce their real balances. This increases transaction costs for both consumer and investment goods. The more significant implications arise in the case of investment goods, as Stockman (1981) points out. As inflation increases, investment falls, and the capital stock declines over time. While consumption may decline as well, this has no direct bearing on capital accumulation. The declining capital stock reduces GDP and makes labor less productive. Therefore, labor demand declines and real wages fall.

In a two-sector economy, inflation also changes relative prices. Imagine for a moment that all prices remained constant. Since we assumed a two-sector economy, the Rybczynski theorem is expected to hold. With a lower capital stock, the supply of the capital intensive good contracts, while the supply of labor intensive good expands. The capital intensive good (investment) becomes scarce, the labor intensive good (consumption) becomes abundant. To clear the markets, now allow for price changes: excess supply will drive down the relative price of labor intensive goods.

Next, the Stolper-Samuelson theorem provides for a link between goods prices and factor prices. Whenever the price of the labor intensive good declines, real wages should fall. In fact, the Stolper-Samuelson theorem predicts that the decline in real wages is larger than the decline in relative prices. Therefore, we have a second negative effect on real wages, which reinforces the first one. In combination, the two effects can be a potent force to reduce real wages. A lower capital stock leads to a proportional decline in output and real wages. In addition, the shift in relative prices lets real wages “overshoot”. This is the model’s interpretation of the stylized fact that real wages decline by more than per-capita GDP.⁴

3. THE MODEL

This section describes the model in detail. As noted above, a Heckscher-Ohlin supply side is combined with a cash-in-advance constraint and set 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 explore how far such a simple structure can go in explaining the observed pattern of real wages and inflation.

The theoretical literature on real wages and high inflation is quite 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 bargain 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.

⁴ In an open-economy setting, the same forces can be expected to work. Investment goods can be relabeled as tradables, and consumer goods as non-tradables. Non-tradables goods are usually more labor intensive than tradables, and their relative price is the real exchange rate.

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. By abstracting from input factors, these models could not explain the behavior of real wages.⁵

Closer to our question are papers by Roldós (1995), Rebelo and Végh (1996) and Uribe (1998), who also examine disinflation programs. These authors use the specific-factor model for the supply side, 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 figure 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 is 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 less ambiguous results for factor prices. The fact that this structure is not yet used more frequently is unfortunate, since the Heckscher-Ohlin model integrates easily into the kind of general-equilibrium framework that is the staple in 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 on not real wages).

In the following model, 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, which 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 supply of a good expands if the factor it uses intensively becomes more abundant, and if its relative price increases. 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 on the transformation curve.

Finally, money is introduced via a cash-in-advance constraint. Individuals demand money in order to purchase goods, and the government supplies money in order to finance its budget deficit. For the sake of simplicity, all seignorage revenues are reimbursed to the private sector via lump-sum transfers. This allows to concentrate on the relative price distortions generated by the inflation tax. By excluding wealth effects, we can simplify the algebra without losing much substance. Wealth effects lead to a reduction in steady-state consumption, but leave the qualitative effects on real wages unchanged.

⁵ See Braumann and Shah (1999) for a case study on inflation in Suriname and the limits of the temporariness approach.

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:

$$C_t = K_{C,t}^\alpha N_{C,t}^{1-\alpha} \quad (1)$$

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

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*. 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

$$\frac{K_C}{N_C} = \frac{\alpha}{1-\alpha} \frac{w}{r} \quad \text{and} \quad \frac{K_I}{N_I} = \frac{1-\alpha}{\alpha} \frac{w}{r} \quad (3)$$

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:

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

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

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

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

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,

$$p_i = wn_i + rk_i, \quad i = C, I \quad (8)$$

Differentiating (8) and substituting equations (4)-(7) yields

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

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

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

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

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

$$\hat{w} = \frac{1-\alpha}{1-2\alpha} \hat{p} \quad (12)$$

$$\hat{r} = -\frac{\alpha}{1-2\alpha} \hat{p} \quad (13)$$

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:

$$\bar{N} = N_C + N_I = n_C C + n_I I = 1 \quad (14)$$

$$K = K_C + K_I = k_C C + k_I I \quad (15)$$

To save on notation, we shall work with a symmetric initial steady state. In particular, the following assumptions are made: $N = 1$, $C = I$, $K_C/K = \alpha$, $N_C/N = 1-\alpha$. Differentiate (14) and (15) using these assumptions and equations (4)-(7) to obtain

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

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

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

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

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 factor increases (e.g. capital), the sector using this factor intensively expands (e.g. investment goods). The other sector contracts (consumer goods). To determine the equilibrium relative price and output, we turn to the demand side.

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:

$$U = \sum_{t=0}^{\infty} \beta^t \ln C_t \quad (19)$$

where β is the discount factor. Individuals hold two different types of assets, capital K_t and money M_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

$$K_t + \frac{M_t}{P_t} = w_t + r_t K_t + Tr_t + \frac{M_{t-1}}{P_t} - p_t C_t \quad (20)$$

Money is introduced to the model via a cash-in-advance constraint. This stresses the role of money in facilitating transactions, and at the same time allows for tractability. In his original contribution, Stockman (1981) applied the cash-in-advance constraint to both consumer and investment goods. However, Abel (1985) showed that a cash-in-advance constraint on consumer goods has no consequence on capital accumulation, since it does not affect savings. The real effects of money in Stockman's model result only from the need to hold money for investment purchases, however small such an amount might be. We thus abstract from a cash-in-advance constraint on consumer goods, noting that this assumption has no influence on the main qualitative results:

$$\frac{M_{t-1}}{P_t} \leq I_t = K_{t+1} \quad (21)$$

Since capital yields a positive return, the constraint will hold with equality throughout the model. Denoting monetary growth as μ_t , the following expression can be derived:

$$\frac{M_t}{P_t} = \mu_t K_{t+1} \quad (22)$$

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

$$\frac{C_{t+1}}{C_t} = \frac{p_t}{p_{t+1}} \frac{r_{t+1}}{\beta \mu_t} \quad (23)$$

Differentiating around the steady state leads to

$$\hat{C}_{t+1} = \hat{C}_t + \hat{p}_t - \hat{p}_{t+1} + \hat{r}_{t+1} - \hat{\mu}_t \quad (24)$$

Government

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

$$Tr_t = \frac{M_t - M_{t-1}}{P_t} = (\mu - 1) \frac{M_{t-1}}{P_t} = (\mu - 1)K_{t+1} \quad (25)$$

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

$$K_{t+1} = w_t + r_t K_t - p_t C_t \quad (26)$$

Differentiating and linearizing (26) around the steady state yields

$$\hat{K}_{t+1} = \hat{w}_t + \hat{r}_t + \hat{K}_t - \hat{p}_t - \hat{C}_t \quad (27)$$

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

$$\hat{I}_t - \hat{C}_t = \hat{w}_t + \hat{r}_t + \hat{K}_t - \hat{p}_t - 2\hat{C}_t \quad (28)$$

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 (28) and eliminating $(I_t - C_t)$, the relative price becomes

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

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

$$\hat{K}_{t+1} = \hat{K}_t - \hat{C}_t \quad (30)$$

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:

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

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

$$\Delta\hat{K} = 0: \quad \hat{C} = 0 \quad (32)$$

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

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.

4. 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. 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 (32) and (33) yields the following steady-state values:

$$\hat{K} = -2(1-\alpha)\mu/\alpha$$

$$\hat{w} = -(1-\alpha)\mu/\alpha$$

$$\hat{p} = -(1-2\alpha)\mu/\alpha$$

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

$$\hat{C} = 0$$

$$\hat{r} = \mu$$

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

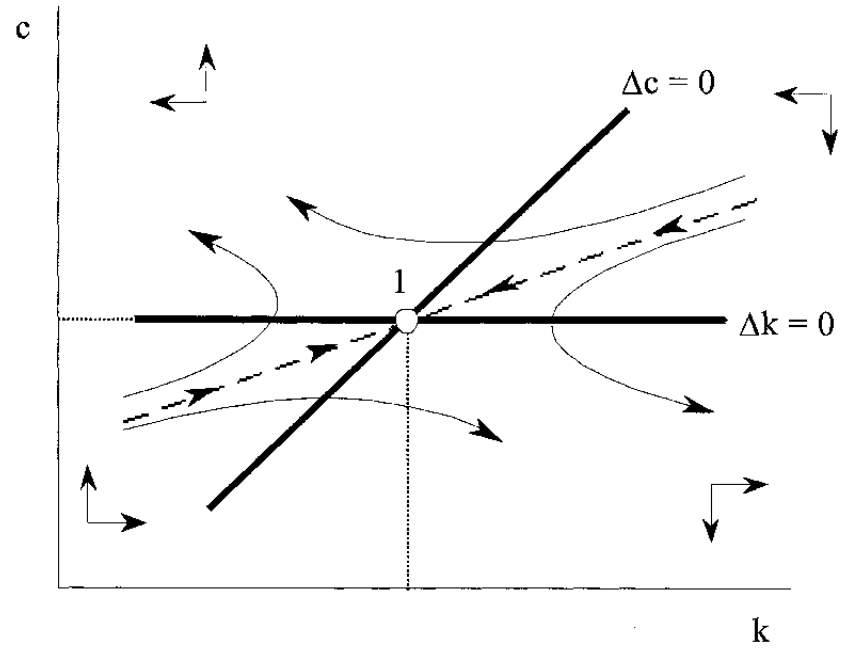
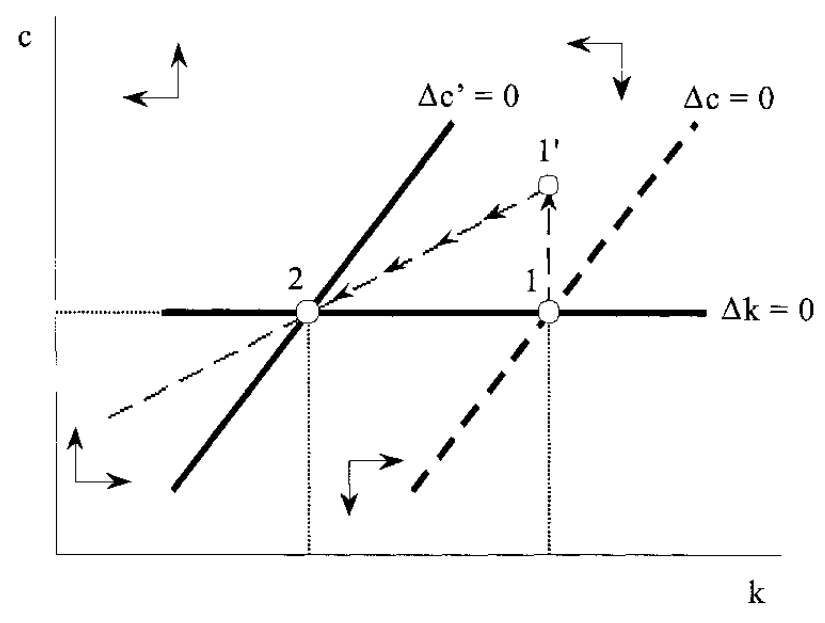


Figure 5. A Permanent Increase in Inflation.



Inflation has negative effects on almost all macro variables. An inclusion of wealth effects would result in a negative effect on consumption as well. The steepest decline occurs in the capital stock (or for that matter, investment), followed by real wages. Note that the decline in real wages is more than twice as large as the decline of GDP. The model thus reproduces the key stylized facts of figure 2.

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 capital 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. Labor demand in the capital intensive sector is too weak to pick up the slack, since this sector has contracted 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 is caused by inflation over the medium term is often masked by a deceptive short-run boom. This has been a familiar pattern in several Latin American countries, where populist governments tried to engineer a redistribution of income towards urban labor with the help of inflationary policies. Often, such policies resulted in immediate and fast GDP growth, while achieving the redistributive goals at the same time. The following quotes from a collection of articles in Dornbusch and Edwards (1992) give a vivid account of this phenomenon. Sturzenegger (1992) 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.

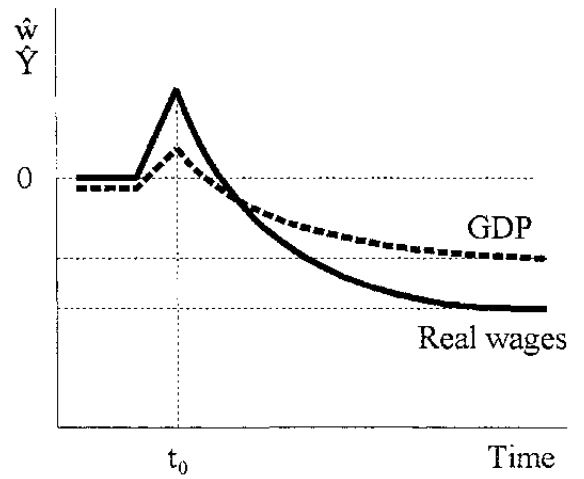
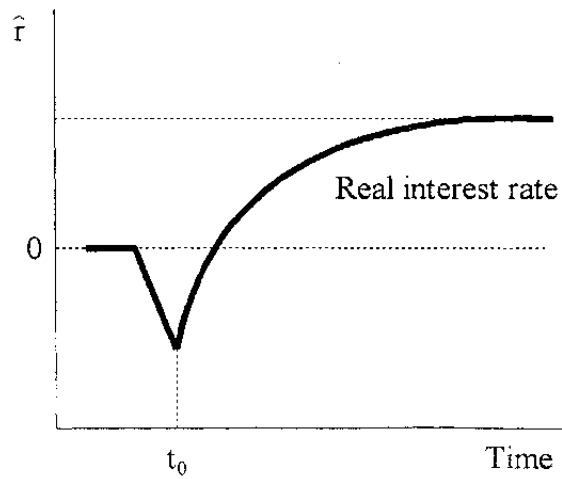
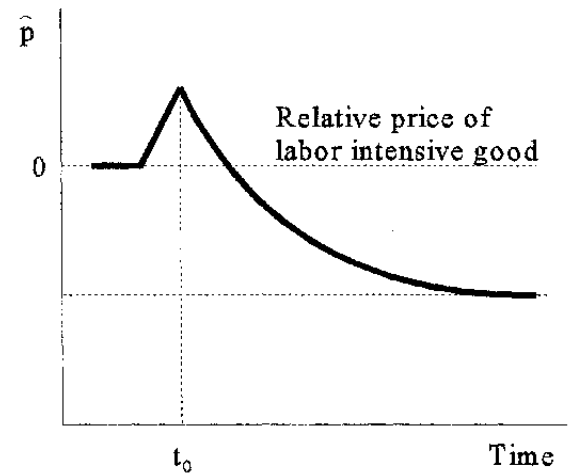
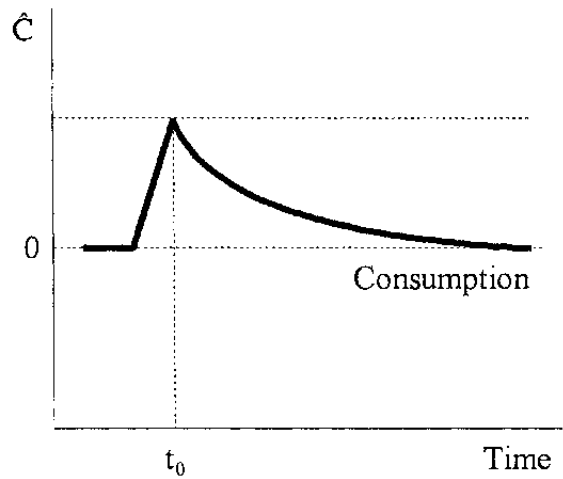
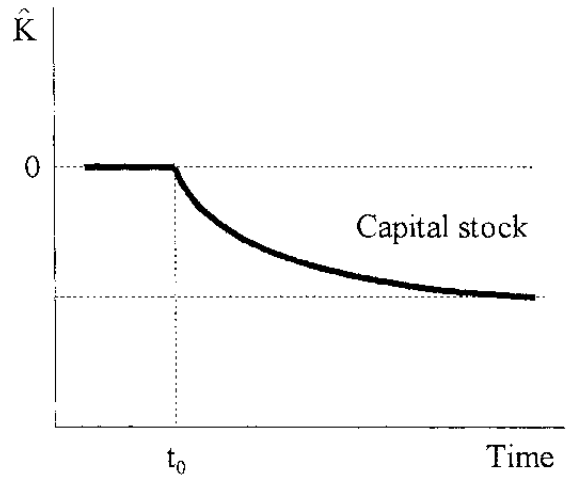
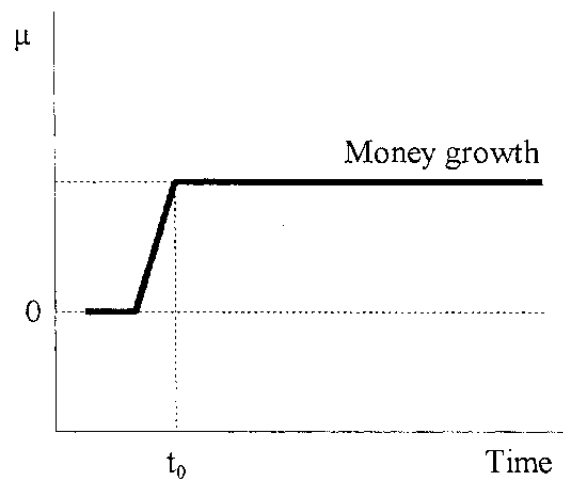
Larraín and Meller (1992) note about Allende's socialist-populist experiment in Chile:

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) 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.

Figure 6. Dynamic Effects of a Permanent Increase in Inflation.



A short-term boom and its painful reversal is exactly what the transition dynamics of the model imply. Figure 6 shows the trajectories of the main macro variables over time. By increasing transaction costs, 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 theorem.

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 seems to work against labor, and the initial boom leaves nothing but a bitter aftertaste. The long-run consequences were described above: in the new steady state, the levels of GDP and real wages are lower than before, making the attempt to redistribute income self-defeating. 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 rarely lasts long. The median duration of 23 high inflation episodes in my previous (2000) paper was around 7 years. Consider therefore an only 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.

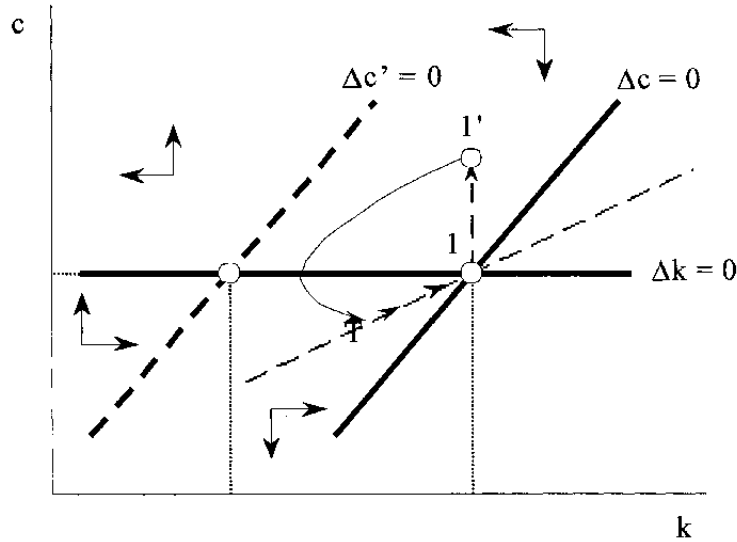
In contrast to before, the public anticipates that the government will return to stability after a certain time T . The dynamic behavior of the economy is illustrated in Figure 7 and 8. As inflation begins, the demarcation line for C shifts up to position $\Delta c'$ (broken line). From time 0 to T the 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 $T \rightarrow \infty$ – if stabilization is unlikely – the dynamics converge to the permanent case described before.

The trajectories of other macro 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) by re-labeling 'capital' as 'human capital'. In this case, one interprets real wages as salaries of low-skill workers, and real interest rates as salaries of high-skilled workers.

Figure 7. A Temporary Increase in Inflation.



An empirical illustration of relative price effects

One central mechanism in the model is a decline in the relative price of labor intensive goods. It ultimately causes the “overshooting” of real wages. How does the relative price effect fare 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 non-tradable over tradable prices). Non-tradables are generally more labor intensive than tradables. In Braumann (2000), I proxied tradables by the price of clothing and non-tradables by the price of housing services in the CPI. 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, which is implicit in the national accounts. Due to data restrictions, the sample was limited to 15 inflation crises. Figure 9 shows that the relative price of consumer goods declined by around 10 percent during high inflation. In a rough and preliminary way, the data seem to bear out the relative price effect of the model.

Figure 8. Dynamic Effects of a Temporary Increase in Inflation.

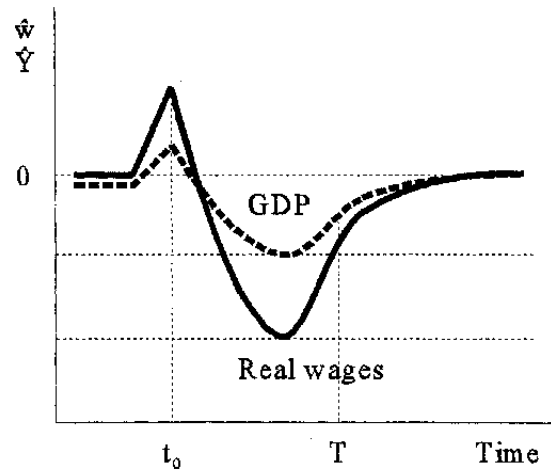
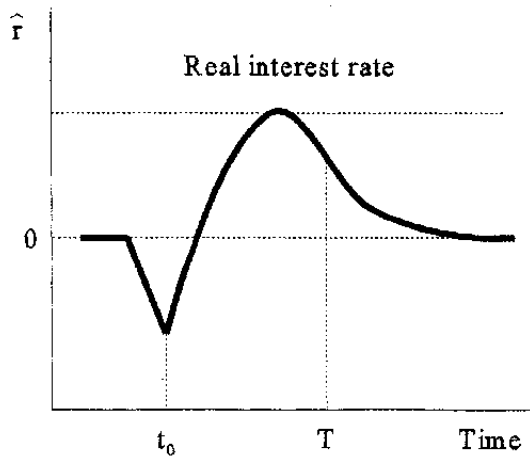
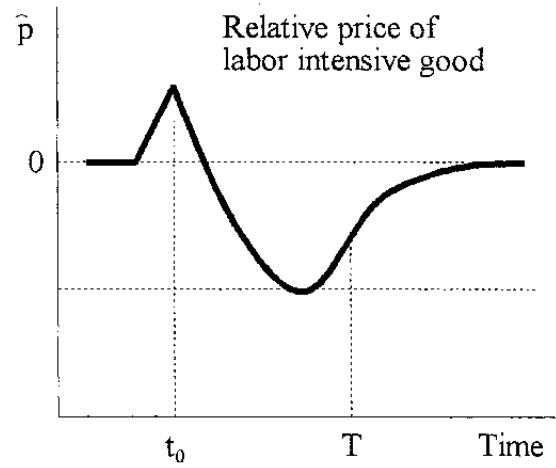
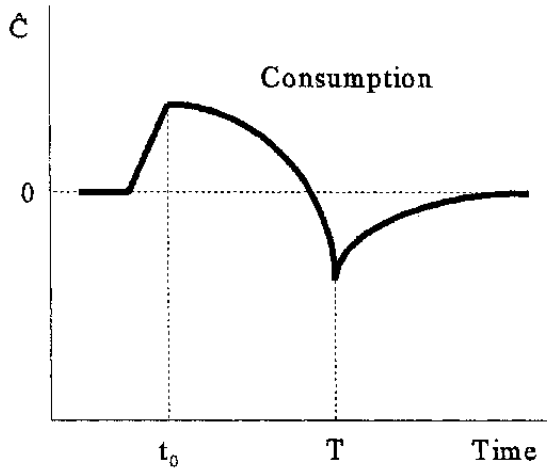
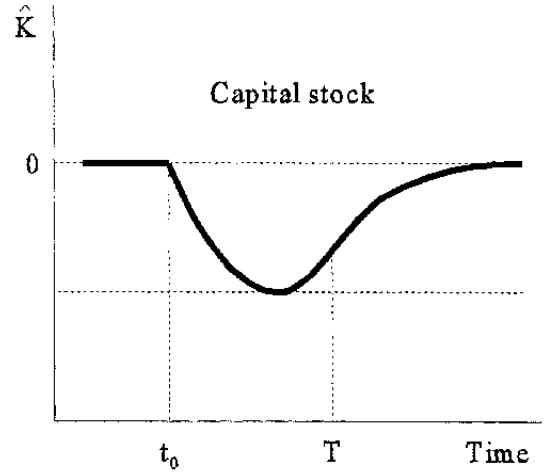
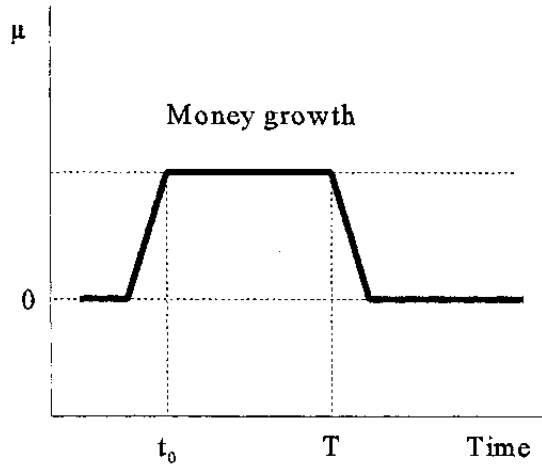
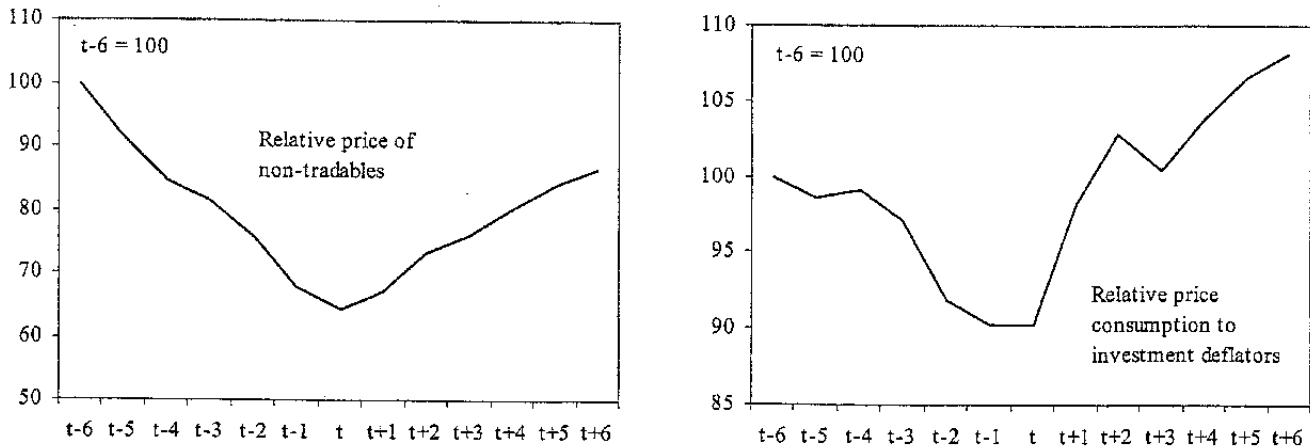


Figure 9. Relative Price of Labor Intensive Goods During High Inflation.
Median behavior of two empirical proxies. Source: see data appendix.



5. 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.⁵

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 level of poverty, as e.g. Cardoso (1992) argues. Therefore, it seems more likely that not adjustment, but the previous bout of high inflation caused the rise in poverty. Inflation led to a sharp decline in real wages, forcing 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 per day. Despite some gaps in the data record, a clear pattern emerges that contradicts the view that stabilization increased poverty. Poverty peaked roughly at the inflation maximum. After the end of inflation, real wages rebounded and poverty decreased. This picture continues to hold in a wider sample of observations. Figure 11 shows the median poverty rate of 6 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 could have been instrumental in increasing poverty.

⁵ For an explicit and quite thorough presentation of this argument see Morley (1995).

Figure 10. Poverty and Inflation in Selected Countries.

Source: see data appendix.

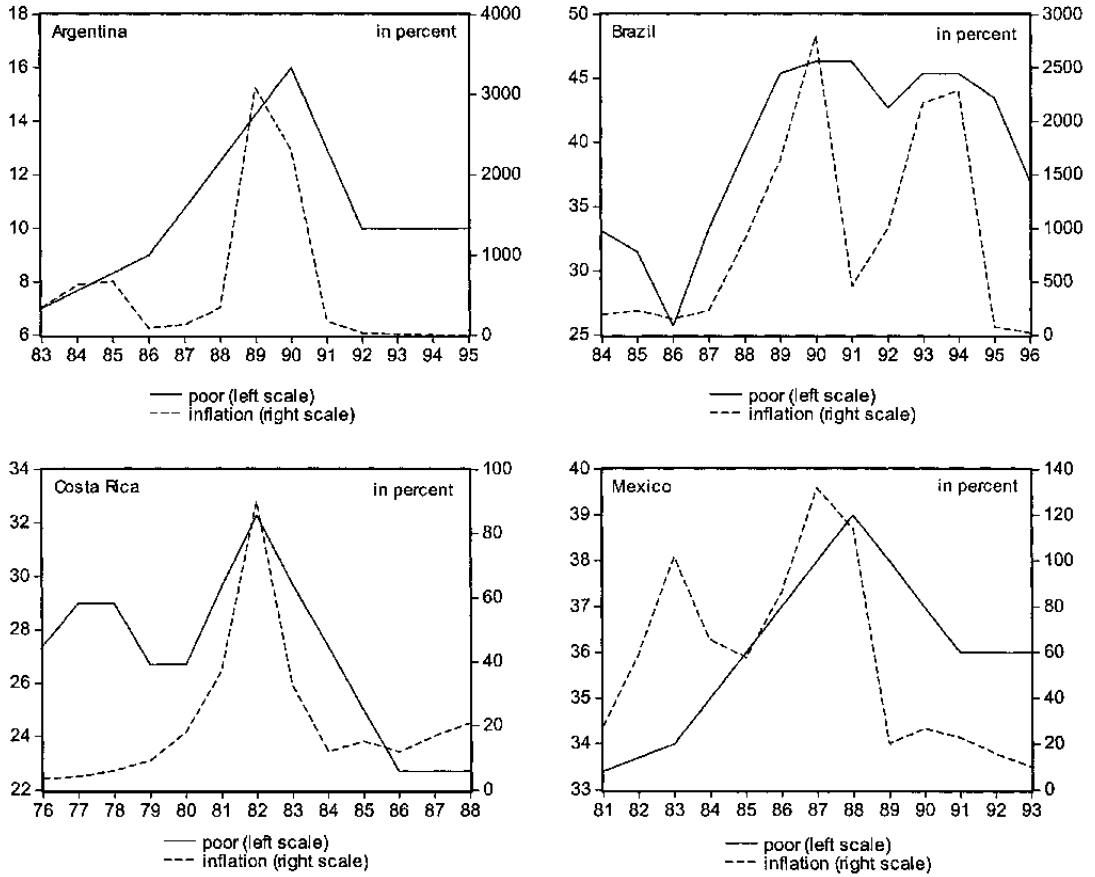


Figure 11. Median Poverty.



6. 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 not received much attention in the literature. The often heard argument that this is a result of incomplete indexation is theoretically not convincing and poses some empirical problems. I explore 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 money is introduced through a cash-in-advance constraint. 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 a potent force in driving down real wages.

For reasons of tractability, this paper has focused on a closed economy. A natural extension would be to open up the model for trade and capital flows. The main results can still be expected to hold. Investment goods might be equated to tradables, and consumption goods to non-tradables. The relative price of non-tradables would become the real exchange rate. In a previous paper, I found that real depreciations (falling non-tradable prices) and trade surpluses are common empirical patterns during inflation periods. This observation can be interpreted in light of the model above. When inflation makes investing at home more expensive, trade surpluses could 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. It thus appears unlikely that stabilization and market-oriented reforms were the main culprits for rising poverty. Populist and inflationary policies, which often promised to raise the living standards of the poor, may have resulted in eroding them. Fighting inflation could be a first step towards reducing poverty.

DATA SOURCES

Ratio of poor: Londoño and Székely (1997) for Brazil, Costa Rica, ECLAC (1999) for Argentina, Mexico, Peru, Uruguay.

Inflation rates: 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.

REFERENCES

- Abel, A. (1985): Dynamic Behavior of Capital Accumulation in a Cash-in-Advance Model. *Journal of Monetary Economics*, 16, 55-71.
- Braumann, B., Shah, S. (1999): Suriname: A Case Study of High Inflation. *IMF Working Paper 99/157*.
- Braumann, B. (2000): Real Effects of High Inflation. *IMF Working Paper 00/85*.
- Bruno, M., Easterly, W. (1995): Inflation Crises and Long-Run Growth. *NBER Working Paper # 5209*.
- Calvo, G. (1986): Temporary Stabilization: Predetermined Exchange Rates. *Journal of Political Economy*, 94, 1319-1329.
- Calvo, G., Végh, C. (1993): Exchange Rate Based Stabilization under Imperfect Credibility. In: *Open Economy Macroeconomics*, Frisch, H., Worgotter, A. (eds.). London: McMillan.
- Cardoso, E. (1992): Inflation and Poverty. *NBER Working Paper # 4006*.
- Dornbusch, R., Edwards, S., (1992) (eds.): *The Macroeconomics of Populism in Latin America*. Chicago: University Press of Chicago.
- ECLAC (1999): *Panorama Social de America Latina. Anexo Estadístico*. Santiago de Chile.
- Helpman, E., Leiderman, L. (1989): Real Wages, Monetary Accommodation, and Inflation. *NBER Working Paper #3146*.
- Lago, R. (1992): The Illusion of Pursuing Redistribution through Macro Policy: Peru's Heterodox Experience 1985-1990. In: Dornbusch, R., Edwards, S., (1992) (eds.): *The Macroeconomics of Populism in Latin America*. Chicago: University Press of Chicago.
- Larraín, F., Meller, P. (1992): The Socialist-Populist Chilean Experience: 1970-1973. In: Dornbusch, R., Edwards, S., (1992) (eds.): *The Macroeconomics of Populism in Latin America*. Chicago: University Press of Chicago.
- Londoño, J., Székely, M. (1997): Persistent Poverty and Excess Inequality: Latin America, 1970-1995. *Inter-American Development Bank, Working Paper # 357*.
- Menendez, A. (1998): The Effects of Inflation on Relative Wages: Argentina 1974-1993. *Mimeo*, Princeton University.

- Morley, S. (1995): Poverty and Inequality in Latin America. Baltimore: *Johns Hopkins University Press*.
- Rebelo, S., Végh, C. (1996): Real Effects of Exchanger-Rate Based Stabilization: An Analysis of Competing Theories. *NBER Macroeconomics Annual*, 125-174.
- Roldós, J. (1995): Supply-Side Effects of Disinflation Programs. *IMF Staff Papers*, 42, 158-183.
- Stockman, A. (1981): Anticipated Inflation and the Capital Stock in a Cash-in-Advance Economy. *Journal of Monetary Economics*, 8, 387-393.
- Stockman, A. (1985): Effects of Inflation on the Pattern of International Trade. *Canadian Journal of Economics*, 18, 587-601.
- Sturzenegger, F. (1992): Description of a Populist Experience: Argetina, 1973-1976. In: Dornbusch, R., Edwards, S., (1992) (eds.): *The Macroeconomics of Populism in Latin America*. Chicago: University Press of Chicago.
- Uribe, M. (1998): Exchange-Rate-Based Inflation Stabilization: The Initial Real Effects of Credible Plans. *Journal of Monetary Economics*, 39(2), 197-221.