Efficiency wages, disinflation and labor mobility

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Abstract

The paper analyzes the role of labor market segmentation and relative wage rigidity in the transmission process of disinflation policies in an open economy facing imperfect capital markets. Wages are flexible in the nontradables sector, and based on efficiency factors in the tradables sector. With perfect labor mobility, a permanent reduction in the devaluation rate leads in the long run to a real appreciation, a lower ratio of output of tradables to nontradables, an increase in real wages measured in terms of tradables, and a fall in the product wage in the nontradables sector. Under imperfect labor mobility, unemployment temporarily rises.

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JEL classification: E24; J23; J42

1. Introduction

The nature and extent of labor market segmentation in developing countries has been the subject of much debate over the years, particularly in the context of discussions related to urbanization and migration between rural and urban areas. In a seminal paper, Harris and Todaro (1970) showed that the existence of a binding minimum wage in the urban sector leads, even if the rural labor market is competitive, to a persistent wage differential between the rural and urban sectors and to the emergence of unemployment in equilibrium. Expansion

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of labor demand in the urban sector, moreover, may raise urban unemployment by raising expected earnings relative to prevailing wages in rural areas.

More recent work has focused on the role of labor market segmentation in the context of trade and structural reforms. [1] By contrast, the implications of various types of labor market segmentation for the short-run determination of output and employment in small open developing countries have not received much attention in the existing analytical literature. [2] In particular, the role played by labor markets in disinflation programs in developing countries has been largely neglected – although numerous stabilization attempts were recorded in the past three decades, most notably in Latin America. Nevertheless, some recent studies have recognized that understanding the mechanisms through which labor markets operate in a developing country setting is essential for assessing the transmission process and the effectiveness – or the lack thereof – of stabilization and structural adjustment programs (Horton et al., 1994). In particular, the evidence available on the behavior of real wages and employment at the inception of exchange rate-based stabilization programs in Latin America in the 1970s and 1980s has led a number of economists to recognize the role of labor markets and the structure of the supply side in replicating some of the stylized facts. [3] However, the extent to which the output and employment effects of disinflation policies depend on the behavior of relative wages and the nature of labor market segmentation remains an open issue.

This paper analyzes the effects of a disinflation program based on a reduction in the nominal devaluation rate – the backbone of a number of stabilization plans adopted notably in Latin America in the past two decades, as documented by Rebelo and Végh (1995) – in a dynamic, two-sector general equilibrium model of a small open economy with a cash-in-advance constraint. Two key features of the model distinguish the analysis from previous research. First, labor markets are assumed to be segmented and the relative wage (defined as the ratio of wages in the traded to the nontraded goods sectors) turns out to be constant over time as a result of efficiency considerations. This assumption has important implications for the determination of the long-run unemployment rate under imperfect labor mobility across sectors. Second, as a result of capital market imperfections, the cost of foreign borrowing on world capital markets depends not only on domestic

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[1] Edwards (1988), for instance, examines the relationships between terms of trade disturbances, import tariffs, and the labor market, under alternative assumptions about wage formation and the degree of sectoral labor mobility.

[2] Demekas (1990) provides an early study attempting to examine the macroeconomic implications of labor market segmentation in an open economy. The issues he focuses on are, however, quite different from those considered here. A more recent study is by Agénor and Aizenman (1994), whose analysis is further discussed below.

[3] See Roldós (1995), Uribe (1995), and the survey by Rebelo and Végh (1995).

holdings of foreign assets but also on the long-run composition of domestic output.

Section 2 presents the basic framework, which assumes that labor is homogeneous and perfectly mobile across sectors. Section 2.3 examines the short- and long-run effects of a disinflation policy defined as a permanent, unanticipated reduction in the devaluation rate. It shows that such a policy leads on impact to a real exchange rate depreciation, a drop in real wages in all sectors, and a reallocation of labor from the nontraded goods sector to the traded goods sector. In the long run, the real exchange rate appreciates, the product wage rises in the traded goods sector and falls in the nontraded goods sector, output and employment expand in the nontraded goods sector and fall in the traded goods. Section 3 extends the basic model to account for the existence of gradual labor mobility across sectors. The results indicate that a permanent reduction in the devaluation rate leads to results that are qualitatively similar to those obtained under perfect labor mobility for some of the key macroeconomic variables. In addition, the unemployment rate falls in the short run. This fall is, however, only transitory and unemployment in the long run depends only on structural factors – in our framework, efficiency considerations. Finally, Section 4 summarizes the main implications of the analysis.

2. A basic framework

Consider a small open economy in which there are four types of agents: producers, households, the central bank, and the government. All firms and households are identical. The official nominal exchange rate is devalued at a predetermined rate by the central bank. The economy produces two goods, a nontraded good which is used only for final domestic consumption, and a traded good whose price is determined on world markets. The capital stock in each sector is fixed during the time frame of the analysis, whereas labor is homogeneous and assumed initially to be perfectly mobile across sectors. The labor market consists of two segments: a primary segment (corresponding to the traded goods sector), where wages and employment are determined by firms, and a secondary segment, corresponding to the nontraded goods sector. An above-equilibrium wage is set in the traded goods sector as a way to elicit effort and maintain productivity, whereas in the nontraded goods sector wages adjust flexibly to equilibrate supply and demand. [4] Firms in the primary (traded goods) sector make their employment

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[4] There is a voluminous literature in developed countries that views involuntary unemployment as the result of efficiency wages. See Akerlof and Yellen (1986), Haley (1990) and, for a more critical view, Carmichael (1990). Two-sector efficiency wage models have been developed by Agénor and Aizenman (1994), Bulow and Summers (1986), Brecher (1992), Copeland (1989), McDonald and Solow (1985), Wilson (1990) and van der Klundert (1989). In Brecher's model, unemployment emerges because wages in all sectors of the economy are set on the basis of efficiency considerations.

decisions first. The secondary (nontraded goods) sector absorbs all workers who are not hired in the primary segment of the market, preventing the emergence of unemployment.

Households consume both traded and nontraded goods, supply labor inelastically and hold two categories of financial assets in their portfolios: domestic money (which bears no interest) and a traded bond issued abroad, which bears a real rate of return determined on world markets. Domestic households and firms can borrow and lend freely at that rate, which varies inversely with the economy's total stock of foreign assets and the composition of domestic output. The government consumes only nontraded goods, collects lump-sum taxes and receives transfers from the central bank. It finances its budget deficit either by borrowing from the central bank, or by varying taxes on households. Finally, wage and employment expectations – which play a role only under imperfect labor mobility – are assumed to depend on prevailing conditions in the labor market.

2.1. Output and the labor market

Setting the world price of traded goods to unity, the domestic price of traded goods is given by $P_T(t) = E_t$, where E_t denotes the nominal exchange rate. The production technology in the traded goods sector is given by [5]

$$Q_T(t) = Q_T[e_t L_T(t)], \quad Q_T' > 0, \quad Q_T'' < 0, \tag{1}$$

where Q_T denotes output, L_T the level of employment, and e_t effort. Production takes place under decreasing returns to labor. The effort function takes the form

$$e_t = 1 - A \left\{ \frac{\omega_N(t)}{\omega_T(t)} \right\}^\gamma, \quad \gamma > 0 \tag{2}$$

where $\omega_T(t) \equiv w_T(t)/E_t$ denotes the product wage in the traded goods sector, $\omega_N(t) \equiv w_N(t)/E_t$ the real wage in the nontraded goods sector measured in terms of traded goods, w_T (respectively w_N) the nominal wage in the traded (respectively nontraded) goods sector and $0 < A \le 1$ a constant term. [6] Eq. (2) indicates that effort is negatively related to the real wage in the nontraded goods sector, which measures the opportunity cost of effort. The effort function is such that the minimal level of effort is $1 - A$ when real wages are equal in both production sectors. e_t is also homogeneous of degree zero in wages, and satisfies $\partial e/\partial \omega_T > 0$ and $\partial^2 e/\partial \omega_T^2 < 0$. The marginal effect of an increase in wages in the traded goods

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[5] Except otherwise indicated, partial derivatives are denoted by corresponding lower-case letters, while the total derivative of a function of a single argument is denoted by a prime.

[6] The price of traded goods (that is, the nominal exchange rate) is used as the numéraire throughout.

sector on the level of effort is thus positive but decreasing. For simplicity, we set $\Lambda = 1$ in what follows. [7]

The representative firm in the traded goods sector maximizes its real profits, defined as $\Pi_T = Q_T(t) - \omega_T(t)L_T(t)$, with respect to ω_T and L_T, for $\omega_N(t)$ given. [8] The first-order conditions for this optimization problem are:

$$\omega_T/e[.] = Q_T', \tag{3a}$$

$$1/e_{\omega_T}[.] = Q_T', \tag{3b}$$

which imply:

$$e_{\omega_T}[.]\omega_T(t) = e[.]. \tag{4}$$

Eq. (4) indicates that in equilibrium the elasticity of effort with respect to the product wage is unity. It generalizes the 'Solow condition' (see Solow, 1979) to a two-sector economy and together with (2) can be solved for the efficiency wage in the traded goods sector, for a given value of the secondary sector wage:

$$\omega_T(t) = \delta\omega_N(t), \qquad \delta \equiv (1 + \gamma)^{1/\gamma} > 1, \tag{5}$$

which indicates that the efficiency wage is always higher than the opportunity cost of effort. A graphical determination of the efficiency wage is shown in Fig. 1.

Substituting the optimal value of $\omega_T(t)$ from Eq. (5) in Eq. (2) and the result in Eq. (3a) determines the equilibrium level of effort $\tilde{e}$ and the demand for labor in the traded goods sector, L_T^d:

$$L_T^d(t) = \frac{1}{\tilde{e}} Q_T'^{-1}\{\omega_T(t)/\tilde{e}\} \equiv L_T^d[\omega_N(t)], \qquad L_T^{d\prime} < 0, \tag{6}$$

where $\tilde{e} = \gamma/(1 + \gamma)$. It can be verified from Eq. (6) that the effect of an increase in the real wage in the nontraded goods sector on the demand for labor in the traded goods sector is negative. A rise in $\omega_N(t)$ increases the real efficiency wage in the traded goods sector sufficiently to keep effort constant in equilibrium and has a negative effect on labor demand.

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[7] The effort function (2) is derived from underlying microeconomic considerations by Agénor and Aizenman (1994), who explicitly model shirking behavior and monitoring costs. Appendix A shows that a relative wage equation similar to (5) would emerge in the presence of a trade union in the traded goods sector. Note that for tractability the decision regarding the level of effort is taken to be separable from consumption decisions, which are discussed below.

[8] Strictly speaking, firms in the traded goods sector set wages on the basis of the *expected* behavior of wages in the nontraded goods sector. However, assuming that firms have perfect foresight allows us to sidestep this issue.
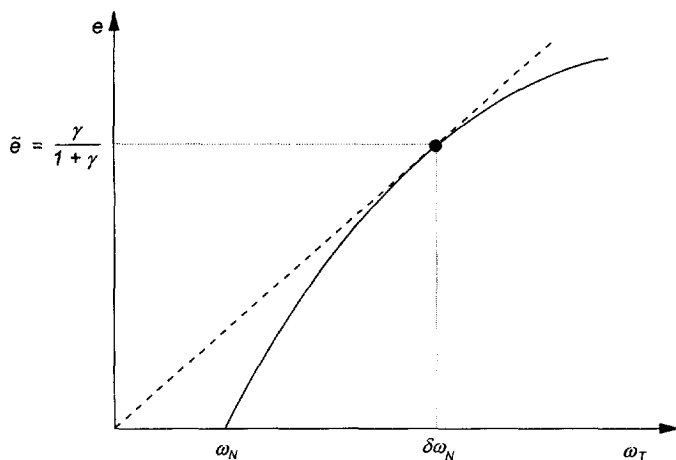
Fig. 1. Wages and effort in the traded goods sector.

Substituting Eqs. (2), (5) and (6) in (1) yields

$$Q_T(t) = Q_T^s[\omega_N(t)], \quad Q_T^{s'} < 0 \tag{7}$$

which indicates that an increase in the real wage in the nontraded goods sector also has a negative effect on output of traded goods.

Production in the nontraded goods sector is determined by

$$Q_N(t) = Q_N[L_N(t)], \quad Q_N' > 0, \quad Q_N'' < 0, \tag{8}$$

and real profits (in terms of the price of traded goods) are given by

$$\Pi_N = z_t^{-1} Q_N(t) - \omega_N(t) L_N(t), \tag{9}$$

where $z_t = E_t/P_N(t)$ denotes the real exchange rate, or the relative price of traded goods in terms of nontraded goods. Profit maximization yields the familiar equality between marginal revenue and marginal cost:

$$\omega_N(t) = z_t^{-1} Q_N'[L_N(t)], \tag{10}$$

from which labor demand can be derived as $L_N^d(t) = Q_N'^{-1}[z_t \omega_N(t)]$, where $z_t \omega_N(t)$ measures the product wage in the nontraded goods sector. Substituting this result in (8) implies

$$Q_N(t) = Q_N^s[z_t \omega_N(t)], \quad Q_N^{s'} < 0 \tag{11}$$

From Eqs. (7) and (11), net factor income – measured in terms of traded goods – is given by

$$q_t = z_t^{-1} Q_N^s[z_t \omega_N(t)] + Q_T^s[\omega_N(t)]. \tag{12}$$

The mechanism through which equilibrium of the labor market is reached in this economy is as follows. Available workers queue up first to seek employment in the primary segment (that is, the traded goods sector) of the labor market. Firms in the primary market set the efficiency wage and hire randomly from the queue – since labor is homogeneous, firms treat workers symmetrically – up to the point where their optimal demand for labor is satisfied. Workers who are unable to obtain employment in the primary sector become suppliers in the nontraded goods sector and, together with demand there, determine the wage that equilibrates the secondary market. Formally, let $\bar{L}$ be total labor supply in the economy. The equilibrium condition in the secondary labor market is given by

$$\bar{L} - L_T^d[\omega_N(t)] = L_N^d[z_t \omega_N(t)], \tag{13}$$

which, for a given value of the real exchange rate, can be solved for $\omega_N(t)$. The solution is such that $\omega_N(t)$ is inversely related to z_t and $\bar{L}$, with $|\partial \omega_N / \partial z| < 1$.

2.2. Consumption and the dynamics of wealth

Households supply a quantity of labor $\bar{L}$ inelastically and consume traded and nontraded goods. The representative household's lifetime discounted utility is given by

$$\int_0^\infty \ln[c_N(t)^\Phi c_T(t)^{1-\Phi}] e^{-\alpha t} \, dt, \quad \alpha > 0, \ 0 < \Phi < 1 \tag{14}$$

where α denotes the rate of time preference (assumed constant), $c_N(t)$ consumption of nontraded goods, and $c_T(t)$ consumption of traded goods. For tractability, the instantaneous utility function is taken to be of the logarithmic form.

Nominal wealth of the representative household A_t is defined as

$$A_t = M_t + E_t b_t^p, \tag{15}$$

where M_t denotes nominal money holdings and b_t^p the foreign-currency value of the household's stock of traded bonds. The flow budget constraint of the household is given by

$$\dot{A}_t = E_t[q_t + \rho_t b_t^p - c_T(t) - \tau_t] - P_N(t)c_N(t) + \dot{E}_t b_t^p, \tag{16}$$

where τ_t denotes real lump-sum taxes, ρ_t the rate of return (or the cost of borrowing) on world capital markets, and the last term represents valuation effects. The interest rate facing domestic agents on world capital markets is assumed to vary

inversely with both the economy's total stock of foreign assets b_t and the long-run ratio of outputs of traded and nontraded goods, given by $\tilde{Q} \equiv \tilde{z}\tilde{Q}_T/\tilde{Q}_N$, which can be interpreted as a measure of the degree of openness on the production side:

$$\rho_t = \rho(b_t, \tilde{Q}), \quad \partial\rho/\partial b < 0, \quad \partial\rho/\partial\tilde{Q} < 0, \tag{17}$$

where a tilde is used to denote steady-state values. The first effect captures the existence of a 'country risk' associated with a small, developing economy, and is conceptually similar to the approach used in the literature on sovereign debt risk (see, for instance, Bhandari et al. 1990). The second effect has been introduced by Agénor and Aizenman (1994). It captures the idea that the cost of borrowing on world capital markets faced by a small country also depends inversely on its potential capacity to repay, which in turn depends on the economy's ability to produce traded goods (as opposed to nontraded goods) in the long run. We will assume below that this effect, although significant, is not too large.

Measuring real wealth in terms of traded goods as $a_t = A_t/E_t$ implies that, from (15) and (16):

$$\dot{a}_t = \rho_t a_t + q_t - z_t^{-1}c_N(t) - c_T(t) - \tau_t - i_t m_t, \tag{18}$$

where $m_t \equiv M_t/E_t$ denotes real money balances (measured in terms of traded goods) and $i_t = \rho_t + \varepsilon_t$ the domestic nominal interest rate, with $\varepsilon_t \equiv \dot{E}_t/E_t$ denoting the rate of devaluation of the exchange rate.

Households are subject to a cash-in-advance constraint on total purchases of home and foreign goods: [9]

$$vM_t \geq P_N(t)c_N(t) + P_T(t)c_T(t), \quad v > 0 \tag{19}$$

where v denotes the velocity of circulation, assumed constant. Eq. (19) can be written equivalently as

$$vm_t \geq z_t^{-1}c_N(t) + c_T(t). \tag{19'}$$

Households treat $\varepsilon_t, q_t, z_t, \rho_t$ and τ_t as given and maximize (14) subject to (18) and (19') – holding with equality – by choosing a sequence $\{c_N(t), c_T(t), m_t, b_t^p\}_{t=0}^{\infty}$. Straightforward calculations show that the solution to this program is characterized by the following conditions:

$$(1 - \Phi)/c_T(t) = \lambda_t(1 + v^{-1}i_t), \tag{20a}$$

$$c_T(t)/c_N(t) = (1 - \Phi)z_t^{-1}/\Phi, \tag{20b}$$

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[9] An alternative formulation would be to introduce money directly in the instantaneous utility function defined in (14), or to specify a transactions technology whereby holding money reduces transactions costs. Feenstra (1986) discusses the conditions under which these different approaches are functionally equivalent.

$$m_t = v^{-1}[z_t^{-1}c_N(t) + c_T(t)], \tag{20c}$$

$$\dot{\lambda}_t = (\alpha - \rho_t)\lambda_t, \tag{20d}$$

in addition to (18) and the transversality condition $\lim_{t \to \infty}(a_t e^{-\alpha t}) = 0$.

Eq. (20a) shows the familiar result according to which in equilibrium the marginal utility of consumption of traded goods is equal to the marginal utility of wealth λ_t times the 'effective' price of traded goods, which depends on the domestic interest rate. Eq. (20b) indicates that the ratio of consumption of traded and nontraded goods is inversely related to the real exchange rate in equilibrium. Eq. (20c) is the cash-in-advance constraint (holding with equality), which determines the demand for money. From Eqs. (20a)–(20c), the demand for real money balances can be shown to be inversely related to the domestic interest rate and thus inflation.[10] Finally, Eq. (20d) describes the dynamics of the marginal value of wealth as a function of the difference between the discount rate and the cost of borrowing on world capital markets.

2.3. Money, fiscal constraints, and the balance of payments

There are no commercial banks in the economy considered here, and credit only flows from the central bank to the government. The nominal money stock is therefore equal to

$$M_t = D_t + E_t R_t, \tag{21}$$

where D_t denotes the stock of domestic credit allocated by the central bank to the government, and R_t the stock of net foreign assets, measured in foreign currency terms.

The government's revenue sources consist of lump-sum taxes on households and transfers from the central bank resulting from interest receipts on net foreign assets and revaluation of foreign exchange reserves.[11] It consumes nontraded goods and finances its budget deficit by borrowing from the central bank or varying taxes. In nominal terms, the government's budget constraint can be written as

$$\dot{D}_t = P_N(t)g_N(t) - E_t\tau_t - (\rho_t E_t + \dot{E}_t)R_t,$$

or, in real terms,

$$\dot{d}_t = z_t^{-1}g_N(t) - \tau_t - \rho_t R_t - \varepsilon_t m_t, \tag{22}$$

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[10] There is a large literature showing a significant, negative effect of inflation on the demand for money in developing countries. See, for instance, Agénor and Montiel (1996, Chapter 3).

[11] This implies that the central bank does not offset capital gains or losses on its foreign assets by changing the stock of credit to the government or through adjustment in off-balance sheet items.

where d_t is the real credit stock which evolves as

$$\dot{d}_t = (\mu_t - \varepsilon_t)d_t, \tag{23}$$

where μ_t denotes the rate of growth of the nominal credit stock.

Suppose that the central bank sets the rate of growth of nominal credit so as to allow the government to monetize the loss in value of the real outstanding stock of credit resulting from inflation ($\mu_t = \varepsilon_t$). Given this credit rule – which implies that $\dot{d}_t = 0$ and thus $\dot{m}_t = \dot{R}_t$ – the government maintains spending on nontraded goods at a constant level in real terms (at g_N) and adjusts lump-sum taxes to balance the budget: [12]

$$\tau_t = z_t^{-1}g_N - \rho_t R_t - \varepsilon_t m_t. \tag{24}$$

Closing the model requires specifying the equilibrium condition for the non-traded goods market. Using Eq. (11) yields

$$Q_N^s[z_t\omega_N(t)] = g_N + c_N(t). \tag{25}$$

3. Disinflation, real wages and employment

Before examining the effects of disinflation policy in the previous model, it is convenient to re-write it in a more compact form. The labor market clearing Eq. (13) yields a solution in which $\omega_N(t)$ is inversely related to z_t and $\overline{L}$. Substituting this result in (7) yields

$$Q_T(t) = q_T^s(z_t), \quad q_T^{s'} > 0 \tag{26}$$

which shows that a depreciation of the real exchange rate has a positive effect on the supply of traded goods.

Given the definition of the nominal interest rate, Eq. (20a) can be written as

$$c_T(t) = c_T(\overset{-}{\lambda_t}, \overset{+}{b_t}; \overset{-}{\varepsilon}, \overset{+}{\tilde{Q}}), \tag{27}$$

where the economy's total stock of foreign assets b_t is equal to $b_t^p + R_t$ and ε denotes the constant, initial rate of devaluation of the nominal exchange rate. Eq. (27) indicates that consumption of traded goods is inversely related to the marginal utility of wealth and positively related to the economy's stock of foreign assets and the long-run output ratio. Using Eqs. (20b) and (27), the equilibrium condition of the market for nontraded goods (Eq. (25)) can be written as

$$Q_N^s[z_t\omega_N(\overset{-}{z}_t)] \equiv q_N^s(z_t) = \frac{\Phi}{1 - \Phi}z_t c_T(\lambda_t, b_t; \varepsilon, \tilde{Q}) + g_N. \tag{28}$$

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[12] Equivalently, Eq. (24) can be interpreted as indicating that government spending on nontraded goods and net transfers to households minus interest income on reserves must be financed by the inflation tax.

It can be established, using the market-clearing condition (13), that the net effect of a real depreciation on output of nontraded goods is negative ($q_N^{s\prime} < 0$). A real depreciation raises directly the product wage in the nontraded goods sector. At the initial level of labor demand in the traded goods sector, this requires an offsetting fall in the real wage (measured in terms of traded goods) in the nontraded goods sector to maintain labor market equilibrium. This fall, in turn, lowers the real wage in the traded goods sector and reduces labor supply in the nontraded goods sector – thereby exerting upward pressure on the real wage there. This increase is however not sufficient to dominate the upward direct effect associated with a depreciation of the real exchange rate on the product wage, so that $\partial[z_t \omega_N(z_t)]/\partial z_t$ is positive.

Solving Eq. (28) yields the equilibrium solution for the real exchange rate: [13]

$$z_t = z(\overset{+}{\lambda_t}, \overset{-}{b_t}; \overset{+}{\varepsilon}, \overset{-}{g_N}, \overset{-}{\tilde{Q}}). \tag{29}$$

Substituting Eqs. (12) and (24) to (29) in Eq. (18) together with $\dot{d}_t = 0$ and a zero initial stock of credit yields

$$\dot{b}_t = \rho(b_t, \tilde{Q})b_t + q_T^s[z(\lambda_t, b_t; \varepsilon, g_N, \tilde{Q})] - c_T(\lambda_t, b_t; \varepsilon, \tilde{Q}), \tag{30}$$

which determines the rate of accumulation of foreign assets. Finally, using (17), Eq. (20d) can be re-written as

$$\dot{\lambda}_t/\lambda_t = \alpha - \rho(b_t, \tilde{Q}). \tag{31}$$

Eqs. (30) and (31) determine the behavior of foreign assets and the marginal utility of wealth over time, while Eq. (29) determines the equilibrium level of the real exchange rate, for given values of λ_t and b_t.

A linear approximation around the steady state to Eqs. (30) and (31) yields

$$\begin{bmatrix} \dot{\lambda}_t \\ \dot{b}_t \end{bmatrix} = \begin{bmatrix} 0 & -\tilde{\lambda}(\partial\rho/\partial b) \\ q_T^{s\prime}\left(\dfrac{\partial z}{\partial \lambda}\right) - \partial c_T/\partial \lambda & \Omega \end{bmatrix} \begin{bmatrix} \lambda_t & -\tilde{\lambda} \\ b_t & -\tilde{b} \end{bmatrix}, \tag{32}$$

where $\Omega = \rho(\tilde{b}, \tilde{Q}) + \tilde{b}(\partial\rho/\partial b) + q_T^{s\prime}(\partial z/\partial b) - \partial c_T/\partial b \lessgtr 0$. Assuming that the net effect of an increase in the economy's total stock of bonds is a reduction in interest income provides a sufficient (although not necessary) condition for $\Omega < 0$. [14] $\tilde{\lambda}$ and $\tilde{b}$ denote the steady-state solutions of the system.

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[13] Note that since the equilibrium values of wages in the traded and nontraded sectors have been substituted out, Eq. (29) imposes simultaneously equilibrium in the markets for labor and nontraded goods.

[14] Assuming that $\Omega > 0$ requires not only that the net effect of an increase in the stock of bonds yield a rise in interest income but also that this effect be large enough to compensate for the negative effect of an increase in b_t on output and consumption of traded goods.
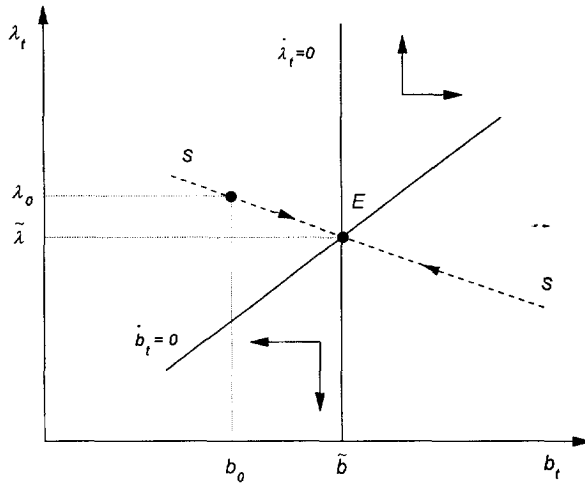
Fig. 2. Steady-state equilibrium.

Given that the stock of foreign assets is predetermined, the system described by (32) is locally saddle-point stable. [15] The steady-state equilibrium is depicted in Fig. 2, under the assumption that $\Omega < 0$. The locus $[\dot{\lambda}_t = 0]$ gives the combinations (λ_t, b_t) for which the marginal utility of wealth remains constant, while the locus $[\dot{b}_t = 0]$ depicts the combinations of λ_t and b_t for which the stock of foreign assets does not change over time. The saddle path, denoted SS in the figure, has a negative slope. Given an initial level of foreign bonds b_0, the equilibrium level of the shadow price of wealth is the unique level λ_0 that places the economy on the convergent trajectory SS leading to the steady-state equilibrium at point E. [16]

Consider now a disinflation program in which the central bank implements a permanent, unanticipated reduction at $t = 0$ in the devaluation rate, from its initial value ε with no change in the initial level of the nominal exchange rate. The long-run effects are summarized in the following proposition:

Proposition 1. In the long run, a permanent reduction in the nominal devaluation rate raises consumption, the marginal utility of wealth and holdings of foreign assets, appreciates the real exchange rate, lowers the ratio of output

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[15] The determinant of the coefficient matrix in Eq. (32) is equal to $\tilde{\lambda}(\partial\rho/\partial b)[q_T^{s\prime}(\partial z/\partial\lambda) - \partial c_T\partial/\partial\lambda] < 0$. Note that this condition holds irrespective of the value taken by Ω.

[16] Note that if $\Omega > 0$, the slope of the $[\dot{b}_t = 0]$ would be negative. But since the slope of the saddlepath is independent of Ω, the dynamic effects discussed below are qualitatively similar under the assumption that $\Omega > 0$.
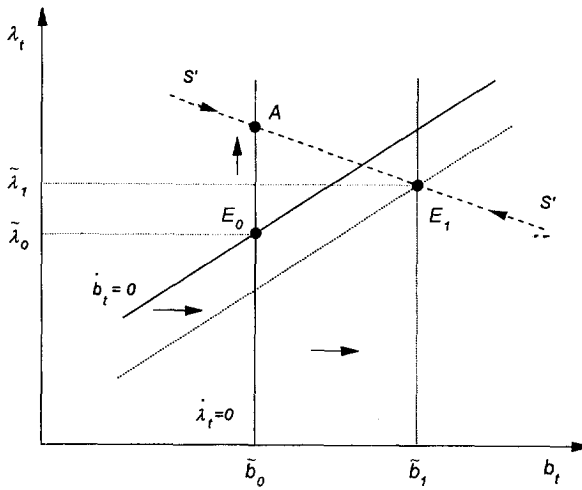
Fig. 3. Reduction in the devaluation rate.

of traded to nontraded goods, and has no effect on the cost of borrowing on world capital markets. Real wages measured in terms of traded goods increase in both sectors, but the product wage in the nontraded goods sector falls.

The key to understanding these results is to note that from Eq. (31) the cost of borrowing on world capital markets must be equal in the steady state to the rate of time preference. Given the definition of ρ, this implies that any long-run change in the stock of net foreign assets (in this case, a rise in $\tilde{b}$) must be offset by a movement in the opposite direction in the relative share of traded goods in total output (a fall in $\tilde{Q}$), which in turn requires an appreciation of the real exchange rate. A formal proof of this proposition – which is derived under the assumption that $\partial\rho/\partial\tilde{Q}$ is sufficiently small – is provided in Appendix B.

The dynamics of adjustment towards the new steady state are illustrated in Fig. 3. Suppose that the economy is initially located at the equilibrium point E_0. The reduction in the devaluation rate shifts the $[\dot{b}_t = 0]$ curve to the right. The $[\dot{\lambda}_t = 0]$ curve also shifts to the right as a result of the change in the long-run composition of output discussed above. On impact, the shadow value of wealth jumps upwards, from point E_0 to point A on the new saddle path $S'S'$. From then on, the economy begins increasing its holdings of foreign assets until the new steady-state equilibrium, characterized by a higher marginal value of wealth, is reached at point E_1.

Intuitively, the transmission mechanism of this policy shock can be described as follows. On impact, the reduction in the devaluation rate tends to reduce the

domestic nominal interest rate. This reduces the opportunity cost of money hold-
ings (as a result of the cash-in-advance constraint), which raises real money bal-
ances and validates an increase in consumption expenditure. However, there are
two offsetting effects also at play on impact. First, the reduction in the domestic
nominal interest rate $(\rho_0 + \varepsilon)$ is mitigated by the increase in the cost of borrowing
on world capital markets induced by the reduction in the long-run ratio of output
of tradables relative to nontradables, as discussed above. Second, the upward jump
in the marginal value of wealth exerts a downward effect on spending. The net
overall effect is a reduction in consumption of traded goods and a depreciation of
the real exchange rate (which helps maintain equilibrium in the nontraded goods
market) on impact. Output of traded goods rises on impact, whereas production in
the nontraded goods sector falls. [17] The resulting fall in labor demand in the sec-
ondary segment of the labor market exerts downward pressure on the real wage in
that sector, and is associated with a fall in the product wage in the traded goods
sector – which brings about the expansion of output of tradables. Employment
rises in the traded goods sector, and falls in the nontraded goods sector. This
reallocation occurs instantly, since there are no barriers to labor mobility across
sectors.

During the transition to the new steady-state equilibrium, the marginal value
of wealth falls (thereby lowering the effective price of consumption) and the
economy increases its holdings of foreign assets (thereby lowering the cost of
borrowing on world capital markets and thus the effective price of consump-
tion). As a result of both effects, consumption of traded and nontraded goods
rise over time, leading to a gradual appreciation of the real exchange rate. The
fall in the relative price of traded goods lowers output and the demand for la-
bor in that sector. The flow of labor away from the traded goods sector exerts
downward pressure on the real wage (measured in terms of traded goods) in
the nontraded goods sector. The net effect of the real appreciation is a reduc-
tion in the product wage in the nontraded goods sector, which has a positive
effect on output and raises the demand for labor there. Although consumption
of traded goods rises and output falls over time, the rate of accumulation of
foreign assets remains positive throughout the transition. In the long run, the
real exchange rate appreciates, output of traded goods falls, and output of non-
traded goods rises – implying that the output ratio falls in such a way that
it leaves the cost of foreign borrowing equal to the rate of time preference in
the steady state. Employment in the traded goods sector falls below its ini-
tial steady-state level, whereas employment in the nontraded goods sector is
higher.

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[17] As assumed above, the direct effect of a change in the real exchange rate dominates the indirect
effect, so that the net impact of a real depreciation on output of nontraded goods and the demand for
labor in that sector is negative.

4. Labor mobility and adjustment

The foregoing analysis was based on the assumption that workers who cannot find a job in the traded goods sector can immediately obtain one at the going wage in the nontraded goods sector, implying the absence of involuntary unemployment in the economy. However, the assumption of perfect mobility across sectors is not very appealing, particularly in a short-run context.[18] In migrating across sectors, workers typically incur a variety of costs (such as training costs and relocation expenses) that may prevent instant reallocation of the labor force. We now assume that adjustment across sectors takes place gradually, so that the allocation of labor to each sector is predetermined at any moment in time.

Let $L_T^s(t)$ denote the available pool of workers in the traded goods sector at any given period t, and let $L_N^s(t) = \bar{L} - L_T^s(t)$. Real wages and employment in the traded goods sector are determined, as assumed previously, on the basis of efficiency considerations. However, workers who are unable to obtain a job offer in the traded goods sector cannot shift instantaneously to the secondary sector, as assumed before. Short-run constraints on labor mobility thus introduce the possibility of unemployment in the traded goods sector. Wages in the secondary sector remain perfectly flexible and maintain full employment of the secondary sector labor force. The equilibrium condition of the secondary labor market is now given by

$$\bar{L} - L_T^s(t) = L_N^d[z_t \omega_N(t)], \tag{33}$$

which can again be solved for the real wage:

$$\omega_N(t) = \omega_N[\overset{-}{z}_t, \overset{+}{L_T^s}(t)], \quad \partial \omega_N / \partial z = -1. \tag{34}$$

Substituting Eq. (34) in (11) and solving Eq. (25) yields the equilibrium real exchange rate:[19]

$$z_t = z(\overset{+}{\lambda_t}, \overset{-}{b_t}, \overset{\sim}{L_T^s}(t); \overset{+}{\varepsilon}, \overset{-}{g_N}, \overset{-}{\tilde{Q}}). \tag{29'}$$

Substituting this equation, together with (34), in Eq. (7) yields the supply function of traded goods:

$$Q_T(t) = q_T^s[\omega_N\{z(\lambda_t, b_t, L_T^s(t); \varepsilon, g_N, \tilde{Q}), L_T^s(t)\}], \tag{35}$$

---

[18] Trade models with imperfect factor mobility have been developed by a number of authors, including Beladi and Parai (1993), Casas (1984), and Hill and Mendez (1983). Note that in the model developed here, perfect mobility of labor in the long run is not sufficient to establish equality between sectoral wage rates.

[19] Using Eqs. (11) and (34), it can be established that the partial equilibrium effect of a change in the real exchange on labor demand and output in the nontraded goods sector is now zero.

where the sign of the partial derivatives with respect to all the arguments of $q_T^s[.]$ is opposite to those appearing in (29').

Workers migrate across sectors in response to the perceived degree of labor market tightness in the two segments of the market. Wage expectations and the probability of finding a job are assumed to depend on prevailing labor market conditions. [20] The expected payoff from queueing in the primary market is equal to the primary sector wage weighted by the probability of being hired in the traded goods sector. Assuming that hiring is random, this probability can be approximated by the number of primary sector jobs over the number of workers seeking employment, that is, the prevailing employment ratio. The expected payoff in the secondary market is simply the going wage rate, since the employment probability is unity. Over time, labor moves across sectors in response to the discrepancy between the payoffs available in the two sectors: [21]

$$\dot{L}_T^s(t) = \kappa \left\{ \frac{\omega_T(t) L_T^d(t)}{L_T^s(t)} - \omega_N(t) \right\}, \quad \kappa > 0, \tag{36}$$

where κ denotes the speed of adjustment. [22] Using the equilibrium solutions for wages as a function of the real exchange rate, and substituting out the equilibrium condition (29') in (36) yields

$$\dot{L}_T^s(t) = \kappa L[\lambda_t, b_t, L_T^s(t); \varepsilon, g_N, \tilde{Q}]. \tag{37}$$

In general, the signs of the partial derivatives appearing in Eq. (37) are ambiguous since they all depend on $\partial L / \partial z$, which is itself ambiguous (see Appendix B). In what follows, we will assume that $\partial L / \partial z > 0$. This condition requires that a reduction in the payoff associated with working in the nontraded goods sector is large enough to dominate the ambiguous effect of a real exchange rate depreciation on the payoff associated with working in the traded goods sector. As a result, the gap between the two expected payoffs widens and workers migrate to the traded goods sector. Assuming thus that $\partial L / \partial z > 0$ implies that the sign of the partial derivatives appearing in Eq. (37) are identical to those appearing in Eq. (29'). This assumption implies, in particular, that $\partial L / \partial L_T^s < 0$.

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[20] The absence of a forward-looking component in wage expectations may be justified by the existence of large costs associated with search, and by the lack of sophistication of the labor force.

[21] Note that, since $\bar{L}$ is constant, $\dot{L}_N^s(t) = -\dot{L}_T^s(t)$. A conceptually similar migration mechanism across sectors is used by Djajic and Purvis (1987). Eq. (36) can be interpreted as a dynamic extension of the Harris-Todaro labor allocation process.

[22] The specification given in Eq. (36) does not explicitly account for reallocation costs to the traded goods sector. A simple way of introducing these costs would be to assume that they are proportional – at the rate, say, $0 < \eta < 1$ – to the going wage in that sector. In that case, the first term in brackets in Eq. (36) would be multiplied by $1 - \eta$, and the equilibrium unemployment rate (derived below) would also depend on η. However, other qualitative features of our results would not be affected.

The dynamic system driving the economy consists now of Eqs. (30) – after substitution of Eq. (35) for q_T – (31), and (37). A linear approximation around the steady state to this system can be written as

$$
\begin{bmatrix} \dot{\lambda}_t \\ \dot{b}_t \\ \dot{L}_T^s(t) \end{bmatrix} = \begin{bmatrix} 0 & -\tilde{\lambda}(\partial\rho/\partial b) & 0 \\ q_T^{s\prime}\left(\dfrac{\partial z}{\partial\lambda}\right) - \partial c_T/\partial\lambda & \Omega & \partial q_T^s/\partial L_T^s \\ \kappa(\partial L/\partial\lambda) & \kappa(\partial L/\partial b) & \kappa(\partial L/\partial L_T^s) \end{bmatrix}
$$

$$
\begin{bmatrix} \lambda_t & -\tilde{\lambda} \\ b_t & -\tilde{b} \\ L_T^s(t) & -\tilde{L}_T^s \end{bmatrix}, \tag{38}
$$

where we assume that $\tilde{L}_T^s < \overline{L}$.

The system now has two predetermined variables and one jump variable, and therefore requires two negative roots and one positive root to ensure saddle-path stability. Sufficient conditions are therefore that the determinant of the coefficients matrix in (38) be positive and that the trace of the matrix of coefficients be negative. Under the above assumptions on Ω and $\partial L/\partial L_T^s$, the trace condition is always satisfied. We assume, in what follows, that the condition on the determinant of the system holds.

As can be shown by extending the procedure used in Appendix B, the steady-state solution of the model with imperfect labor mobility possesses similar properties to those summarized in Proposition 1. The cost of foreign borrowing must be equal to the rate of time preference in the long run. The real exchange rate appreciates, the marginal utility of wealth rises, and real wages measured in terms of traded goods increase in all sectors. In addition, the following result holds:

Proposition 2. A permanent reduction in the devaluation rate lowers unemployment in the traded goods sector on impact but has no long-run effect, because the supply of labor in the traded goods sector falls in the same proportion as the demand for labor. The steady-state unemployment rate depends only on efficiency factors.

To prove this proposition, note that the long-run unemployment $\tilde{u}_T$ is given by

$$
\tilde{u}_T \equiv 1 - \tilde{L}_T^d/\tilde{L}_T^s = \delta^{-1}(\delta - 1), \quad \delta > 1, \tag{39}
$$

which indicates that the 'natural' rate of unemployment in the traded goods sector is positive in equilibrium ($0 < \tilde{u}_T < 1$) and depends only on the sensitivity of effort

with respect to relative wages.[23] The constancy of the unemployment rate in the long run implies that the supply of labor in the traded goods sector must change in exactly the same proportion as the change in labor demand in that sector. Since the product wage rises in the traded goods sector, the demand for labor – and therefore labor supply – must fall in that sector.

Suppose that the economy is initially in a steady-state equilibrium and consider, as before, a disinflation program that takes the form of a permanent, unanticipated reduction in the devaluation rate. The behavior of the 'jump' variables (the marginal value of wealth and the real exchange rate) as well as holdings of foreign assets is qualitatively similar to what was obtained in the case of perfect labor mobility examined previously.[24] However, now labor supply in the traded goods sector cannot rise on impact. Since employment cannot change in the nontraded goods sector, it must be that the product wage in that sector $z_0\omega_N(0)$ remains constant on impact. Thus, as shown by Agénor and Aizenman (1994) in a somewhat similar context, the depreciation of the real exchange rate (which results from the fall in consumption) must be fully offset by a fall in the real wage (measured in terms of traded goods) in the nontraded goods sector. As before, the real depreciation raises output and employment on impact in the traded goods sector, thereby temporarily lowering unemployment there, both in absolute terms (as measured by $L_T^s(0) - L_T^d(0)$) and relative terms (as measured by $1 - L_T^d(0)/L_T^s(0)$).

The initial increase in the employment ratio in the traded goods sector raises the probability of finding a job and income prospects in that sector relative to the nontraded goods sector. As a result labor supply in the traded goods begins rising.[25] Over time, however, the appreciation of the real exchange rate and the outflow of workers from the nontraded goods sector tend to increase real wages (measured in terms of traded goods) there – as implied by Eq. (34). In turn, this increase tends to raise wages in the traded goods sector and to lower the demand for labor in that sector – thereby gradually reducing the probability of employment. The flow of workers entering the traded goods sector falls over

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[23] The effect of an increase in the efficiency parameter γ on the steady-state rate of unemployment is given by

$$d\tilde{u}_T/d\gamma = (1 + \gamma)^{-1/\gamma} \left\{ \frac{1}{\gamma(1 + \gamma)} - \frac{\ln(1 + \gamma)}{\gamma^2} \right\},$$

which is, in general, ambiguous.

[24] Of course, since the model possesses now two negative roots, cyclical movements cannot be excluded.

[25] From Eqs. (5) and (36), it can be verified that $\dot{L}_T^s(t)$ is positive as long as δ times the employment ratio is greater than unity.

time, eventually turning negative. In the long run, as indicated in Proposition 2, labor supply in the traded goods sector must fall (in the same proportion as labor demand) since the wage ratio is constant and output and employment in that sector fall. After falling initially, the unemployment rate returns to its natural level which, as shown in (39), depends only on efficiency factors.

Although the impact and long-run effects of a disinflation program under imperfect labor mobility do not depend on whether the speed of adjustment of labor supply in the traded goods sector to changes in expected payoffs (coefficient κ) is small or large, the transitional dynamics do. When κ is large, the temporary fall in unemployment in the traded goods sector will be eliminated more rapidly, forcing the economy to return faster to the natural rate equilibrium. When, by contrast, the speed of adjustment is small, changes in the flow of labor supplied in the two segments of the labor market will have a more limited effect on movements in wages in both sectors, and will dampen fluctuations in employment and output.

5. Summary and Conclusions

The purpose of this paper has been to examine the implications of efficiency considerations, labor market segmentation, and imperfect labor mobility for the short-run dynamics associated with disinflation programs. The analysis is motivated by some recent studies showing that large movements in wages and employment have often taken place during such episodes (Horton et al., 1994; Roldós, 1995). The analysis was based on a two-sector optimizing model of a small open economy with segmented labor markets. While firms in the traded goods sector were assumed to determine both wages and employment, wages in the nontraded goods sector were taken to be determined by market forces. Labor productivity in the traded goods sector was assumed to depend on relative wages. In equilibrium firms in the traded goods sector set the real wage above the level that prevails in the nontraded goods sector; they do not reduce wages in the face of persistent unemployment, because to do so would reduce productivity. In contrast to some existing macroeconomic models, sectoral wage rigidity is thus derived endogenously. Moreover, as noted in Appendix A, a wage equation formally identical to the one obtained under the assumption of efficiency wage determination can be derived in a simple bargaining framework, if trade unions operate in the traded goods sector. Two additional, and equally important, features of the model are that the cost of foreign borrowing (as a result of capital market imperfections) depends on domestic holdings of foreign assets as well as the steady-state ratio of output of traded and nontraded goods, and that agents are subject to a cash-in-advance constraint on consumption expenditure.

We first considered the case where labor is homogeneous and perfectly mobile across sectors. The analysis showed that a permanent, unanticipated reduction in the devaluation rate leads on impact to a depreciation of the real exchange rate, a drop in real wages in all sectors (but an increase in the product wage in the nontraded goods sector), an increase in output in the traded goods sector, and an instantaneous reallocation of labor away from the nontraded goods sector. In the long run, the real exchange rate appreciates, output of traded goods falls, and output of nontraded goods increases. Domestic agents also increase their holdings of foreign assets and real money balances, as the opportunity cost of holding such balances falls. A key feature in deriving these results is the long-run equality between the cost of borrowing on world capital markets and the rate of time preference, which implies an inverse relationship between the economy's stock of foreign assets and the composition of domestic output in the steady state. Qualitatively similar results to those obtained here with efficiency factors in the traded goods sector could be derived with a perfectly competitive labor market, although some of the quantitative implications of the two assumptions could differ substantially.

We then considered the case where the movement of workers across sectors occurred gradually as a result of barriers to mobility – such as relocation or congestion costs. The qualitative behavior of some of the key variables of the model (such as the marginal utility of wealth, the real exchange rate, and holdings of foreign assets) was shown to be similar to what we obtained under perfect labor mobility. However, unemployment was shown to be positive in equilibrium. Two features of the model account for this result: the existence of a Harris–Todaro migration mechanism, and the markup relationship between wages in the traded and nontraded goods sectors. A deflationary policy leads to a reduction in unemployment in the short run. In the long run, the unemployment rate depends only on supply-side factors, namely, the importance of efficiency considerations in the traded goods sector.

Although the analytical framework developed here is already quite complex, it can be extended in a variety of directions. Possible extensions would be to endogenize the rate of time preference, to introduce imperfect domestic capital markets, and to analyze empirically the effect of the composition of output (as emphasized here) on the risk premium faced by developing countries on world capital markets. Other fruitful areas of investigation might be to introduce labor heterogeneity and a government-funded unemployment benefit scheme – as for instance in Agénor and Aizenman (1994). These extensions would add another dimension to the sources of labor market segmentation and would allow an analysis of the effect of unemployment insurance on the opportunity cost of labor – as well as (through the efficiency wage-setting mechanism) the effect of labor market policies on relative wage rigidity across sectors and their implications for stabilization policy. A final avenue of research could be to investigate the quantitative effects of the

labor market imperfections described here in the context of actual disinflation episodes.

Appendix A

This appendix shows that a wage equation similar to Eq. (5) in the text can be derived by introducing a bargaining game between firms in the traded goods sector and trade unions.

Specifically, suppose that there exists in the traded goods sector a centralized trade union that bargains with firms for the setting of the wage. Whatever the wage set in the bargain, firms always choose $L_T(t)$ so as to maximize profits, so that employment always lies on the demand curve. Assume also that the trade union is risk-neutral and maximizes the net expected income of the representative worker employed in the traded goods sector. Since a worker who is not hired in the traded goods sector can always be employed in the nontraded goods sector at the wage $\omega_N(t)$, expected income ω_t is

$$\omega_t = \rho\omega_T(t) + (1 - \rho)\omega_N(t), \tag{A.1}$$

where $0 < \rho < 1$ denotes the probability of being hired in the traded sector, which is assumed constant (see below). The union guarantees to all employed workers in the traded goods sector, if they go on strike, a revenue equal to the opportunity cost of unemployment – the market-clearing wage in the nontraded goods sector. The union's objective is thus to maximize 'excess' income

$$\omega_t - \omega_N(t) = \rho[\omega_T(t) - \omega_N(t)]. \tag{A.2}$$

Assume that the production function in the traded goods sector is of the Cobb–Douglas form, that is, $Q_T(t) = L_T(t)^{\alpha_T}$, where $0 < \alpha_T < 1$. Let Π_T^* denote the maximized value of real profits. Under a Nash bargaining framework, the solution for $\omega_N(t)$ is such that it maximizes the outcome

$$\Omega = \rho^\sigma[\omega_T(t) - \omega_N(t)]^\sigma \Pi_T^*, \quad \sigma > 0, \tag{A.3}$$

where σ measures the degree of union power.[26] Letting L_T^* denote the profit-maximizing level of employment, the bargained wage satisfies

$$\frac{\partial \ln \Omega}{\partial \omega_T(t)} = \frac{\sigma}{\omega_T(t) - \omega_N(t)} - \frac{L_T^*}{(L_T^*)^\alpha - \omega_T(t)L_T^*} = 0,$$

---

[26] See Layard et al. (1991, Chapter 2). For reasons discussed at length by Layard et al., we assume that the union does not bargain over employment but only over the level of real wages.

since $\partial \Pi_T^*/\partial \omega_T(t) = -L_T^*$ by the envelope theorem. This equation yields [27]

$$\omega_T(t) = \frac{1}{1+\sigma}\omega_N(t) + \frac{\sigma}{1+\sigma}(L_T^*)^{\alpha_T-1}. \qquad (A.4)$$

The profit-maximizing level of employment is determined by solving the first-order condition $\alpha_T(L_T^*)^{\alpha_T-1} = \omega_T(t)$. Substituting this result in Eq. (A.4) yields

$$\omega_T(t) = \delta\omega_N(t), \quad \delta \equiv 1 \bigg/ \left\{1 + \sigma\left(1 - \frac{1}{\alpha_T}\right)\right\} > 1, \qquad (A.5)$$

which indicates that, as long as union power is not zero, the negotiated real wage in the traded goods sector is always set at a higher level than the market-clearing wage, in a manner similar to Eq. (5) in the text.

Appendix B

Slope of the $[\dot{b}_t = 0]$ *curve.* From Eq. (30), the equation of the $[\dot{b}_t = 0]$ curve shown in Fig. 2 can be linearly approximated by

$$\Omega b_t = \left[\frac{\partial c_T}{\partial \lambda} - q_T^{s\prime}\left(\frac{\partial z}{\partial \lambda}\right)\right]\lambda_t \qquad (B.1)$$

$$+ \left\{\frac{\partial c_T}{\partial \varepsilon} - q_T^{s\prime}\left(\frac{\partial z}{\partial \varepsilon}\right) - \left[\tilde{b}\left(\frac{\partial \rho}{\partial \tilde{Q}}\right) + \frac{\partial c_T}{\partial \tilde{Q}} - q_T^{s\prime}\left(\frac{\partial z}{\partial \tilde{Q}}\right)\right]\left(\frac{\mathrm{d}\tilde{Q}}{\mathrm{d}\varepsilon}\right)\right\}\varepsilon,$$

where Ω (defined in the text) is negative. Establishing the direction in which the $[\dot{b}_t = 0]$ curve shifts following a reduction in the rate of devaluation requires therefore determining the sign of $\mathrm{d}\tilde{Q}/\mathrm{d}\varepsilon$.

Proof of Proposition 1.   To characterize the steady-state solution in the basic model of Section 3, a key result is that from Eq. (31) we have

$$\alpha = \rho(\bar{\tilde{b}}, \bar{\tilde{Q}}), \qquad (B.2)$$

---

[27] In general, the employment probability in the traded goods sector will depend negatively on the product wage in that sector. In Eq. (A.4), the coefficient σ would then be replaced by

$$\Sigma = \sigma\left\{\left(\frac{\partial \ln \rho}{\partial \omega_E}\right)\left(\frac{\omega_T - \omega_N}{\omega_E}\right) + 1\right\},$$

which is lower than σ if the elasticity $\partial \ln \rho/\partial \ln \omega_T$ is negative. The result is thus a higher weight on the first term of Eq. (A.4), and correspondingly a lower weight on the second term.

which implies that $\tilde{b}$ and $\tilde{Q}$ must move in exactly opposite directions following any given shock. A linear approximation to Eq. (B.2) thus implies that

$$\tilde{b} = \left[\alpha - \left(\frac{\partial \rho}{\partial \tilde{Q}} \right) \tilde{Q} \right] \Big/ \left(\frac{\partial \rho}{\partial b} \right) \equiv b(\tilde{Q}), \quad b' < 0 \tag{B.3}$$

From Eq. (28) we have $q_N^s(\tilde{z}) = [\Phi/(1 - \Phi)]\tilde{z}\tilde{c}_T + g_N$, which can be solved to give

$$\tilde{z} = z(\tilde{c}_T), \quad z' < 0. \tag{B.4}$$

Combining this result with Eqs. (30) with $\dot{b}_t = 0$ and (B.2) yields

$$\alpha\tilde{b} = \tilde{c}_T - q_T^s[z(\tilde{c}_T)] \equiv H(\tilde{c}_T), \quad H' > 0 \tag{B.5}$$

which establishes that $\tilde{c}_T$ and $\tilde{b}$ move in the same direction.

To determine the effect of ε on $\tilde{c}_T$ note that Eqs. (20a), (29) and (B.2) yield

$$\tilde{c}_T = (1 - \Phi)/\tilde{\lambda}[1 + v^{-1}(\alpha + \varepsilon)] \equiv c_T(\overset{-}{\tilde{\lambda}}, \overset{-}{\varepsilon}), \tag{B.6}$$

which implies, from (B.4), $\tilde{z} = z(\overset{+}{\tilde{\lambda}}, \overset{+}{\varepsilon})$. Thus, $\tilde{c}_T$ and $\tilde{z}$ are both independent of $\tilde{Q}$ and $\tilde{b}$. From the definition given in the text, $\tilde{Q}$ is a positive function of $\tilde{z}$. We therefore have $\tilde{Q} = Q(\overset{+}{\tilde{\lambda}}, \overset{+}{\varepsilon})$. Substituting this result in (B.3) implies that

$$\tilde{b} = F(\overset{-}{\tilde{\lambda}}, \overset{-}{\varepsilon}). \tag{B.7}$$

From (B.2) and (B.4)–(B.6) we have

$$\alpha\tilde{b} = c_T(\overset{-}{\tilde{\lambda}}, \overset{-}{\varepsilon}) - q_T^s[z(\overset{+}{\tilde{\lambda}}, \overset{+}{\varepsilon})]. \tag{B.8}$$

Substituting (B.7) in (B.8) and solving yields

$$d\tilde{\lambda}/d\varepsilon = \left[\alpha \left(\frac{\partial F}{\partial \lambda} \right) - \left(\frac{\partial c_T}{\partial \lambda} \right) + q_T^{s'} \left(\frac{\partial z}{\partial \lambda} \right) \right]^{-1}$$
$$\times \left[-\alpha \left(\frac{\partial F}{\partial \varepsilon} \right) + \left(\frac{\partial c_T}{\partial \varepsilon} \right) - q_T^{s'} \left(\frac{\partial z}{\partial \varepsilon} \right) \right], \tag{B.9}$$

which is in general ambiguous. It can be established that if the direct effect of $\tilde{Q}$ on the cost of foreign borrowing is not too large (that is, if $\partial\rho/\partial\tilde{Q}$ is sufficiently small), then $d\tilde{\lambda}/d\varepsilon < 0$. It can also be verified from (20a) and (B.6) that $\partial c_T/\partial\tilde{Q}$ is positively related to $\partial\rho/\partial\tilde{Q}$, so that a small value of $\partial\rho/\partial\tilde{Q}$ also implies that

the $[\dot{b}_t = 0]$ shifts to the right following a reduction in the devaluation rate, as shown in Fig. 3.

Eq. (B.5) implies that $\tilde{c}_T$ must increase since $\tilde{b}$ rises. [28] $\tilde{z}$ must therefore fall from (B.4), and from (B.3) $\tilde{Q}$ must also fall. Proposition 1 follows.   □

Derivation of $\partial L/\partial z$.   The exact expression of $L()$ in Eq. (37) is given by

$$L() = \left\{ \omega_T[\omega_N(z_t)]L_T^d[\omega_N(z_t)] \right\} / L_T^s(t) - \omega_N(z_t),$$

so that

$$\partial L/\partial z = \left\{ L_T^d\left(\frac{\partial \omega_T}{\partial \omega_N} \right) + \omega_T\left(\frac{\partial L_T^d}{\partial \omega_N} \right) \right\} \left(\frac{\partial \omega_N}{\partial z} \right) \Big/ \tilde{L}_T^s - \left(\frac{\partial \omega_N}{\partial z} \right),$$

which is in general ambiguous. Assuming that the expression in brackets is negative ensures that $\partial L/\partial z$ is positive.

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[28] Since $\tilde{\lambda}$ rises and ε falls, it can be inferred from Eq. (B.6) that the effect of the latter on $\tilde{c}_T$ dominates.

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