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Wage Indexation and the Real Exchange Rate in Small Economies Subject to Fluctuations in Export Earnings

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Summary

Many small countries that export primary commodities have often been subject to large and unpredictable fluctuations in their export earnings. Adjustment to these fluctuations in export earnings generally requires changes in relative prices such as the real wage rate and the real exchange rate; however, in many of these countries, such adjustments have not taken place because the real wage or the real exchange rate was fixed by indexation rules. The real wage rate has often been fixed because nominal wages were indexed on the general price level, and in some cases the real exchange rate was fixed because the authorities set the rate of depreciation of the nominal exchange rate equal to the difference between domestic and foreign inflation rates.

This paper argues that the necessary adjustments in wages and the exchange rate can take place even with the existence of indexation rules if the indexation rules are modified to take into account fluctuations in export earnings. While wages could still be adjusted to compensate for changes in the general price level, they should also be linked to permanent changes in export earnings. The link between changes in wages and fluctuations in export earnings that would minimize unemployment might differ across countries since it is shown to depend on the nature of the shocks that affect export earnings and the structure of the economy. For example, countries that export an exhaustible resource (e.g., copper in the case of Chile) should react more to changes in export earnings than countries that export a renewable resource (e.g., fish in the case of Iceland) since it can be expected that most shocks to the price of an exhaustible resource are permanent, whereas most shocks to the price or output of a renewable resource can often be expected to be transitory. Moreover, countries that are more open to trade should react more strongly to a given permanent change in export earnings than countries that are relatively closed.

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The analysis also examines the welfare and employment effects of different types of indexation rules. It is shown that a policy which indexes changes in the exchange rate to the difference between domestic and international inflation has a more adverse effect on employment when export earnings decline than a policy that fixes real wages by indexing nominal wages only on the domestic consumer price index. If fluctuations in export earnings are not taken into account in the adjustment of wages under indexation arrangements, then indexing wages only on the domestic component of the consumer price index (CPI) rather than on the full CPI can also help to minimize the unemployment effects associated with fluctuations in export earnings.

I. Introduction

This paper examines the consequences of indexation rules that link changes in wages or the exchange rate to changes in the price level in small countries with fluctuating export earnings. In countries with high and variable inflation rates, wage indexation rules are often implemented to protect workers from inflationary surprises, and the economy-wide use of this indexing minimizes the costs associated with the frequent renegotiations of wage contracts that would otherwise be necessary. The disadvantage of these rules is that they fix real wages and thereby impede adjustment to real shocks such as fluctuations in export earnings which can lead to high and variable unemployment rates. 1/ An exception to this experience has been provided by Iceland where real wages have always reacted strongly to sharp changes in export earnings, even falling by over 15 percent in a single year, and where the unemployment rate has always been below 2 percent. This experience suggests that the adverse effects associated with wage indexation can be minimized by indexing wages not only on consumer prices but also on export earnings. 2/ By indexing wages on prices and on export earnings, workers are still protected from inflationary surprises and, at the same time, the necessary adjustment to fluctuations in export earnings can take place without the need to renegotiate wages whenever export earnings change.

Our analysis shows that the exact nature of the link between wages and export earnings that minimizes unemployment and maintains protection from inflationary surprises depends on a variety of factors such as the

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1/ Export earnings can fluctuate both because supply is unstable or because the international price of the export commodity is unstable. For example, in Iceland, the fish catch (80 percent of exports) has at times fallen by 20 percent in a single year. In contrast, Chile has experienced a 30 percent fall in the price of its main export (copper) in a single year.

2/ In Iceland, real wages fall when the fish catch is bad and they rise when the fish catch is good; this amounts to an informal indexation system that takes into account not only prices, but also export earnings.

elasticity of labor supply with respect to real wages, the share of nontradables in consumption, and the nature of the shocks that affect export earnings. When labor supply is inelastic relative to the real wage, however, it is argued that wages should be adjusted by a fraction (equal to one minus the share of nontradables in consumption) of any change in permanent export earnings. But no additional adjustment would be necessary if wages were indexed only on the domestic component of the CPI.

Another indexation rule used in a number of countries is to fix the real exchange rate (i.e., the level of purchasing power parity (PPP)) by depreciating the nominal exchange rate in line with the difference between world and domestic inflation. The rationale for this policy is that the high and variable inflation rates prevailing in these countries require periodic adjustment of the nominal exchange rate. PPP rules have been proposed as an alternative to discretionary adjustments. 1/ Since the equilibrium real exchange rate is affected by export earnings, these PPP rules also impede the necessary adjustment to changes in export earnings and thus create unemployment if export earnings fall.

To examine the implications of indexation rules on small economies with fluctuating export earnings, three policies are considered: 2/ adjusting the exchange rate according to a PPP rule, and indexing wages on either CPI or on the domestic component of the CPI. The paper shows that a PPP rule for the exchange rate causes more problems with unemployment than full indexation of wages when there is a decline in export earnings. In this situation, indexation of wages on the full CPI basket creates more unemployment problems than partial indexation of wages on the domestic component of the CPI.

The remainder of the paper is organized as follows. Section II contains a description of the model and the equilibrium that would result with clearing labor markets, i.e., in the absence of fixed nominal contracts and inflationary surprises. Section III analyzes the degree of indexation of wages that would replicate this equilibrium. Section IV shows that the authorities could achieve the same outcome by indexing the real exchange rate. Section V calculates and compares the welfare losses that arise from fixed real exchange rates or real wages. If

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1/ By fixing the real exchange rate, exporters are presumably protected from inflationary surprises; however, it is difficult to see the need for this because exporters can change their prices (in domestic foreign currency) easily--whereas it is always more difficult to renegotiate wages. Floating exchange rates are often not considered because they are thought to lead to instability in the exchange rate market.

2/ Markets would no longer be able to clear if both the real exchange rate and real wages were to be fixed by indexation rules, eventually only one of the indexation rules could be implemented.

variable export earnings are the main source of uncertainty in the economy, then fixing the real exchange would lead to more unemployment than fixing real wages. Section VI contains some concluding remarks.

II. The Model

Consider a small economy with two sectors: an export sector whose export earnings are subject to stochastic fluctuations and a nontradable sector. The export sector produces a primary commodity whose exogenous international price is variable. The production process of that commodity is taken as highly capital intensive with fixed proportions of capital to labor. With a fixed capital stock, the demand of labor by the export sector, or at least its variability, is taken to be very small. 1/

Movements in the overall demand for labor therefore reflect changes in the level of employment in the nontradable goods sector. 2/ The production process for nontradables, n_t^s, in logarithmic form, is specified as:

$$(1) \qquad n_t^s = \beta \ell_t^d + v_t \qquad 0 < \beta < 1$$

where ℓ_t^d represents the logarithm of labor employed in the production of nontradables, β is the elasticity of the supply of nontradables with respect to labor input, and v_t represents a stochastic shock that is distributed independently over time with zero mean and a constant variance σ_v^2. Lower case Roman letters refer to deviations (in natural logarithms) from mean or expected values of the corresponding variables or shocks. 3/

1/ This assumption has been adopted by a number of authors, see Corden (1981), Neary and Purvis (1982); it is justified by the observation that unemployment usually does not arise in the export sector but in the rest of the economy. In Chile, for example, the copper sector which accounts for over half of total exports employs only 6 percent of the labor force.

2/ This excludes any effects that might come from another export sector such as manufacturing. This exclusion seems to be justified because there are a number of very small primary commodity exporters which are so small that almost the entire workforce that is not used in the primary export sector is used in the nontradables sector. In other cases, the country might be large enough to have a significant manufacturing sector but a restrictive commercial policy has effectively turned the output of this sector into nontradables.

3/ Equation (1) can be viewed as a shorthand notation for two equations. In levels, the Cobb-Douglas production function corresponding to equation (1) would be $\ln(N_t^s) = \ln(A) + \beta \ln(L_t^d) + \ln(e^{vt})$ where upper

Profit-maximizing producers will hire labor until the marginal product equals the wage rate. Since producers are assumed to know the value of v_t, this implies:

$$(2) \quad w_t - p_{n,t} = (\beta-1)\ell_t^d + v_t.$$

w_t represents the wage rate, l_t^d the labor demanded, and p_{ht} the price of nontradables; $w_t - p_{n,t}$ thus represents the logarithm of the product wage.

The supply of labor is assumed to be a function of the real wage rate:

$$(3) \quad \ell_t^s = \delta(w_t - p_t) \qquad \delta > 0.$$

Where p_t represents the CPI which is given by:

$$(4) \quad p_t \equiv \alpha p_{nt} + (1-\alpha)s_t \qquad 0 < \alpha < 1.$$

s_t is the nominal exchange rate, expressed as the domestic currency price of one unit of foreign currency. Since the international price of imports is normalized to one, s_t also represents the domestic price of importables. 1/

$$(5) \quad n_t^s = \{\beta\delta(1-\alpha)[s_t - p_{n,t}] - (1+\delta)v_t\}/\{(\beta-1)\delta - 1\}.$$

3/ (Footnote cont'd from page 4).
case letters indicate the levels of the respective variables, and A represents a productivity term. The nonstochastic supply of tradables is defined as the supply that would result if the stochastic shock, v, is equal to zero. The nonstochastic supply of nontradables is thus $\ln(N^s) = \ln(A) + \beta\ln(L^d)$. Subtracting this equation from the previous one yields

$$\ln(N_t^s) - \ln(N^s) = \beta[\ln(L_t^d) - \ln(L^d)] + \ln(e_t^v).$$

Defining $\ln(N_t^s) - \ln(N^s) \equiv n_t^s$, and $\ln(L_t^d) - \ln(L^d) \equiv \ell_t^d$, this is identical to equation (1). A similar procedure can be used to arrive at the other equations in the paper.

1/ This definition of the CPI is justified by the constant expenditure shares utility function that is used below.

These labor market relationships can be combined to give the supply of nontradables as a function of the real exchange rate. The real exchange rate is defined as the price of importables in terms of home goods ($s_t - p_{n,t}$). The supply of nontradables is thus a decreasing function of the real exchange rate.

In analyzing the consequences of fluctuating export earnings, it is important to note that these fluctuations would not represent a problem if they were purely temporary and if the country had access to an efficient international capital market or large reserves. With access to an efficient international capital market, the country could borrow to finance current account deficits in years with lower export earnings and add to its reserves or repay its debt in years with higher export earnings. In this situation, consumption would not react at all to temporary fluctuations in export earnings. A country that is integrated into world capital markets thus faces only an intertemporal budget constraint in that the expected present value of present and future export earnings has to be equal to the present value of present and future imports. Denoting the discount factor by B, the foreign currency value of export earnings and imports by Y_t and I_t respectively, this budget constraint can be written as: 1/

$$(6) \quad E_t\left(\sum_{j=0}^{\infty} B^j I_{t+j}\right) = E_t\left(\sum_{j=0}^{\infty} B^j Y_{t+j}\right) = Y_{pt}.$$

This equation defines the expected present value of export earnings, Y_{pt}, which also constrains the present value of imports.

In reality, however, export receipts are subject to fluctuations which are sometimes temporary and sometimes permanent. Since the nature of each shock is uncertain, the expected present value of future export receipts is often difficult to determine. One way to make this uncertainty tractable is to assume that export earnings have a permanent and a transitory component, but that only the sum can be observed: 2/

$$(7) \quad Y_t = Y_{Tt} + Y_{st}.$$

Y_{Tt} represents the transitory component which is assumed to be independently distributed over time with mean zero and a constant variance (σ_T^2). Y_{st} is the permanent component which is assumed to be distributed:

1/ The international price of imports is normalized to one for all time periods; B is thus a real discount rate.

2/ Export earnings in foreign currency are equal to the quantity of export production times export prices. A 1 percent change in either production or export prices would thus have the same effect in this framework.

$$(8) \quad Y_{st} = Y_{st-1} + W_t.$$

W_t represents innovations in the permanent component and is distributed independently over time with a constant variance (σ_w^2). As indicated by Sargent (1979), the rational forecast of the present value of future export receipts when only Y_t, and not its components, are observable is based on a distributed lag of past export earnings according to:

$$(9) \quad E \sum_{j=0}^{\infty} (B^j Y_{t+j}) = \left[\frac{1-\lambda}{1-B}\right] \sum_{i=0}^{\infty} \lambda^i Y_{t+i}.$$

In this formulation, the weight of each observed value of actual past export earnings is a declining function of time. How rapidly the weights decline depends on the coefficient λ, which is a function of the relative variances of the transitory and permanent components. 1/ If all shocks are permanent, λ is equal to zero, and only current observed export earnings should be used to forecast future export earnings. However, if all shocks are transitory, λ is equal to one and the average of all current and past observed export earnings should be used to forecast future export earnings. To simplify our analysis, y_{pt}, is defined to equal the percentage change in the expected present value of future export earnings. Using equation (9), it can then be shown that changes in the present value of export earnings are related to shocks in actual export earnings by: 2/

$$(10) \quad y_{pt} = \ln \{\lambda + (1-\lambda)[Y_t/E_{t-1}(Y_t)]\}.$$

The demand for imports, which consists only of consumables, comes from consumers who maximize intertemporal utility, U_t, which is given by:

$$(11) \quad U_t = E_t\left[\sum_{j=0}^{\infty} \left(\frac{1}{1-\zeta} C_{t+j}^{1-\zeta}\right) R^j\right], \qquad \zeta > 0$$

where R is the subjective intertemporal discount factor, which is assumed to be equal to B, the market discount factor. This utility function has

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1/ $\lambda = 1 + 1/2(\sigma_w^2/\sigma_T^2) - [\sigma_w^2/\sigma_T^2 + (\sigma_w^2/\sigma_T^2)^2/4]^{1/2}$.

2/ Where E_{t-1} refers to an expectation formed at time t-1. In this analysis there is no specific information available about the nature of the shock in each period. However, if this economy is subject to a shock that is clearly temporary it should be financed, and if the shock is clearly permanent it should be reflected in y_{pt}.

constant relative risk aversion and a constant intertemporal elasticity of substitution equal to $1/\zeta$. The index C_t depends on consumption of two goods, nontradables, N_t, and importables, I_t, according to:

$$(12) \quad C_t = N_t^{\alpha} I_t^{1-\alpha} \qquad 0 < \alpha < 1.$$

The demand function for nontradables depends on permanent income and the relative price of nontradables (i.e., the real exchange rate): 1/

$$(13) \quad n_t^d = y_{pt} + \rho(s_t - p_{n,t}) + u_t, \quad \infty > \rho > \alpha,$$

where ρ is the elasticity of demand for nontradables with respect to the real exchange rate. ρ is a composite parameter whose value depends on the discount factor and the parameters of the utility function, $\alpha < \rho < \infty$. 2/ The unitary elasticity of the demand for nontradables with respect to the permanent income from export earnings, y_{pt}, is a consequence of the intertemporal budget constraint which implies that, imports can rise by 1 percent if the present value of export earnings rises by 1 percent. It is assumed that the demand for nontradables is subject to shocks, u_t, that are distributed independently over time with zero mean and variance σ_u^2.

When the supply of nontradables (equation (5)) is equal to the demand for nontradables (equation (13)), the percentage change in the real exchange rate can be expressed in terms of the change in export earnings (y_{pt}) and the shocks v_t and u_t. 3/

$$(14) \quad s - p_n = \{(1+\delta)v - (\delta(1-\beta) + 1)(y_p+u)\}/\omega$$

where

$$(14') \quad \omega \equiv \rho[1 + \delta(1-\beta)] + \beta\delta(1-\alpha).$$

1/ All variables in equation (13) are again specified in terms of logarithmic deviations from nonstochastic values.

2/ See Appendix; this consumption plan is time consistent given the constant rate of discount R. For the time consistency of consumption plans with a constant rate of time preference see Strotz (1956).

3/ Because all variables are measured at the same point in time, the subscript t will henceforth be suppressed.

Positive shocks to permanent export earnings lead to a real appreciation (i.e., a fall in $s-p_n$). In this formulation, shocks to export earnings and shocks to the demand for nontradables have similar effects on the real exchange rate. Inspection of equations (14) and (14') also reveals that if labor supply is completely inelastic, i.e., if $\delta = 0$, the elasticity of the real exchange rate with respect to export earnings is equal to $1/\rho$. Moreover, if consumers have a unitary intertemporal elasticity of substitutions ρ is equal to one, which implies that a 1 percent increase in permanent export earnings would lead to a 1 percent real appreciation. 1/

Finally, a shock that raises the supply of nontradables would lead to a real depreciation. Thus, in our analysis, the real exchange rate is determined by the supply of and demand for nontradables. Any change in a factor that has an effect on either the supply of or demand for nontradables would thus lead to a change in the equilibrium real exchange rate; this suggests immediately that, in general, it is not advisable to fix the real exchange rate with a PPP rule.

The supply of and demand for home goods (equations (5) and (13)) can also be used to show that changes in consumption of home goods is an increasing function of changes in export earnings and the supply shock, v:

$$(15) \qquad n^d = n^s = \{\beta\delta(1-\alpha)(y_p+u) + \rho(1+\delta)v\}/\omega.$$

Since the equilibrium supply of nontradables depends on labor inputs (equation (1)), changes in employment also depends on changes in export earnings and shocks, u and v:

$$(16) \qquad \ell^s = \ell^d = \{(1-\alpha)(y_p+u) + \alpha v\}\delta/\omega.$$

Not surprisingly, increases in export earnings raise the demand for home goods and employment, and positive shocks to the productivity of labor, v, also raise employment. If labor supply is rigid (i.e., $\delta = 0$), employment does not react to changes in export earnings.

1/ The real exchange rate in practice is often defined in terms of the CPI as $s - p$ (instead of $s-p_n$ as done here). However, the two are closely related as manipulation of the definition of the CPI yields $s - p = \alpha(s-p_n)$. Using the CPI definition of the real exchange rate, the elasticity of the real exchange rate with respect to export earnings (in this special case) would be equal to α, the share of nontradables in consumption.

However, since labor supply is a function only of the real wage rate, w - p (equation (3)), the real wage rate is also a function of export earnings which is identical to equation (16) except for the factor δ:

$$(17) \qquad w - p = \{(1-\alpha)(y_p+u) + \alpha v\}/\omega.$$

This implies that, in equilibrium, positive shocks to export earnings, the demand for nontradables, and labor productivity all lead to higher real wages.

It is important to recall that the shocks to permanent export earnings, y_p, that determine the real exchange rate, employment, and real wages in equations (14)-(17) represent shocks to the present value of future export earnings which are not directly observable. The relationship between the present value of future export earnings and observed changes in earnings as described in equation (10) implies that the link between actual changes in export earnings and changes in the real exchange rate (or employment or real wages) depend on the parameter λ which determines whether actual changes in export earnings are regarded as mostly temporary or mostly permanent. 1/

1/ Future export earnings can influence current consumption only if the country has access to a world capital market. The discussion so far is based on the assumption of a perfect international capital market but the model can equally be applied to the other extreme case of no access to an international capital market. The only difference would be in the demand for nontradables (equation (13)). Given Cobb-Douglas preferences, the demand for nontradables would then be proportional to actual export earnings, i.e., actual export earnings instead of the permanent income from exports would determine current demand for nontradables. Cobb-Douglas preferences also imply unitary price elasticity, i.e., ρ should be set equal to one. In this case, the link between actual export earnings and the real exchange rate would therefore be given directly by the parameters shown in equation (14), where ρ is equal to one and ω is equal to $1 + \delta(1-\alpha\beta)$. Although the domestic interest rate does not appear in any of the equations in this paper, it would have to vary if the country does not have access to international capital markets. The real interest rate that would clear the domestic capital market under these conditions can be calculated from the ratio of expected marginal utilities of consumption between two periods.

III. Optimal Wage Indexation Rules

The preceding section has shown that in general real wages should vary with export earnings and other shocks. This suggests that it may be impossible to maintain full employment in economies with fluctuating export earnings that have wage indexation schemes that fix real wages. However, in a number of countries with high and variable inflation rates, wage indexation schemes have been used to protect workers against inflationary surprises. This raises the question of whether it is possible to obtain the protection against inflationary surprises that is offered by wage indexation without incurring unemployment as a result of shocks to export earnings. The purpose of this section is to show first that simple wage indexation schemes purchase inflation protection at the cost of unemployment and second that these indexation schemes can be improved by adjusting nominal wages not only for changes in the price level but also for changes in export earnings.

A simple wage indexation rule by which wages rise equiproportionally with the CPI can be written as:

$$(18) \quad w = p.$$

With such a rule, employment is determined by the demand for labor. Given the demand for labor (equation (2)) and the demand for nontradables (equation (13)), 1/ the level of employment equals:

$$(19) \quad \ell = \{(1-\alpha)(y_p+u) + (\rho-(1-\alpha))v\}\delta/\{\omega - \rho\}.$$

A comparison of equations (16) and (19) shows that, with fixed real wages, employment reacts more to variations in export earnings. This implies that whenever export earnings fall there will be unemployment because the demand for labor falls with the demand for nontradables and the supply of labor is constant because the wage indexation scheme keeps the real wage constant. 2/ A 1 percent fall in export earnings under these circumstances would lead to an unemployment rate of $\rho(1-\alpha)/\omega[(1-\beta)\rho + \beta(1-\alpha)]$ percent.

1/ Equation (18) can be rewritten as $w - p_n = (1-\alpha)(s-p_n)$, i.e., in terms of the product wage and the real exchange rate. These two variables determine the demand for labor and the demand for nontradables.

2/ Of course, whenever export earnings rise the opposite would happen, but in this case wage drift might alleviate the problem. Section V contains a more rigorous analysis of the exact economic loss caused by this wage indexation scheme.

While a simple wage indexation rule like equation (18) leads to unemployment problems, it is possible to construct a wage indexation scheme that does not lead to unemployment by taking proper account of fluctuations in export earnings. An indexation scheme that duplicates the path of the equilibrium real wage as described in equation (17) would clearly solve the unemployment problems that arise from the simple indexation rule (equation (18)) because equation (17) gives the real wage that would preserve full employment whatever the shocks to export earnings. But an indexation scheme that duplicates the path of the full employment real wage would also continue to offer worker protection against inflationary surprises. Real wages would follow the path of the full employment real wage described in equation (17) if the wage indexation takes the form:

$$(20) \qquad w = p + \nu_1(y_p+u) + \nu_2 v,$$

with

$$(20') \qquad \nu_1^* = (1-\alpha)/\omega \quad \text{and} \quad \nu_2^* = \alpha/\omega .$$

For the special case of an inelastic labor supply and a unitary intertemporal elasticity of substitution (i.e., $\delta = 0$ and $\rho = 1$; thus $\omega = 1$), real wages should always be adjusted by a fraction $(1-\alpha)$ of any change in the permanent income from export earnings. Since changes in permanent export earnings are a function of only a fraction, λ, of actual changes in export earnings (equation (10)), this implies that the link between real wages and actual export earnings is given by the product of two fractions, $1 - \alpha$ and λ, where $(1-\alpha)$ is equal to the share of imports in consumption and λ is related to the variances of the permanent and transitory shocks that affect export earnings. 1/

It has also often been suggested that the import component of the CPI should not be included in the basket used to index wages. This implies that real wages would be indexed only on home goods prices. The indexation rule could then be written as:

$$(21) \qquad w = p_n.$$

1/ The optimal wage indexation rule (equation (20)) also implies that export earnings influence real wages through their effect on the demand for nontradables. Any change in the demand for nontradables should have the same effect on real wages whether caused by a change in export earnings, y_p, or by a temporary shock, u.

However, $w - p_n$ is the product wage that determines labor demand (equation (2)). Indexing wages only on nontradables prices would thus lead to a constant level of labor demand and employment if there were no productivity shocks. But this constant level of labor demand does not guarantee full employment if labor supply varies with the real CPI wage. Labor supply is given by equation (16), whereas the labor demand resulting from this indexation scheme can be calculated from equations (21) and (2). The potential unemployment caused by indexing wages only on home goods prices can then be calculated as the difference between labor supply and labor demand:

$$(22) \qquad \ell^s - \ell_d\Big|_{w=p_n} = \delta\{\frac{(1-\alpha)}{\omega}\}(y_p+u) + [\frac{\alpha\delta}{\omega} - \frac{1}{(\beta-1)}]v.$$

Equation (22) shows that fluctuations in export earnings would cause unemployment unless the labor supply were rigid ($\delta = 0$). Equation (22) also shows that negative shocks to productivity would lead to unemployment because this wage indexation rule makes the appropriate fall in the product wage impossible. Indexing wages only on home goods prices can therefore still lead to unemployment problems. The general form of the indexation rule that would avoid unemployment problems would be:

$$(23) \qquad w = p_n + \nu_1'(y_p+u) + \nu_2'v.$$

Employment would then be given by:

$$(24) \qquad \ell^d = \nu_1'/(\beta-1)(y_p+u) + (\nu_2'-1)/(\beta-1)v.$$

Actual employment as described in equation (24) would be identical to full employment, as described in equation (16), only if the coefficients in equations (24) and (16) were the same, i.e., if:

$$(25) \qquad {}^*\nu_1' = (\beta-1)\delta(1-\alpha)/\omega \quad \text{and} \quad {}^*\nu_2' = 1 + (\beta-1)\delta\alpha/\omega .$$

Inspection of equation (25) reveals that wages should be negatively related to export earnings if they are fully adjusted for changes in home goods prices ($0 < \beta < 1$). This seemingly counter-intuitive result is explained by noting that an increase in export earnings that increases the demand for home goods should lead to more employment. But a higher level of employment implies a lower marginal productivity of labor as capacity becomes a constraint; employers will then hire more labor only if wages rise by less than output prices, i.e., if the product wage falls.

This section thus not only argues that it is inappropriate to fix real wages by letting wages rise in line with prices 1/ but also that the appropriate adjustment to wages in response to changes in export earnings depends on the price index to which wages are linked. If wages are indexed on the full CPI basket they should be positively related to export earnings, but if wages are indexed only on the domestic component of the CPI they should be negatively related to export earnings. 2/

IV. Exchange Rate Policy and Export Earnings

As an alternative to indexing wages, some countries have adopted real exchange rate rules that involve adjusting the nominal rate according to the difference between world and domestic inflation. 3/ Such rules are often referred to as PPP (purchasing power parity) rules, because they fix the real exchange rate. Since it has been shown that the real exchange rate should vary in response to fluctuations in export earnings and other shocks, these PPP rules can lead to unemployment problems. Indeed, a policy that fixes the real exchange rate by setting s=p would lead to a labor supply (taking into account only y_p) of $\ell^s = y_p(\beta-1)/\beta$,

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1/ In the sense that this would lead to unemployment problems.

2/ It is important to recall that the optimal coefficients that link wages to export earnings implicitly represent a link between wages and the permanent income from exports. The link between the permanent income from exports and actual export earnings (more specifically what fraction of any actual change in export earnings can be regarded as temporary or permanent) is described by equation (10). Only the permanent income from exports is relevant if the country has access to an international capital market. However, the model can also accommodate the opposite extreme of no access to an international capital market. In this case, the optimal coefficient would link wages directly to actual changes in export earnings and ω would be equal to $1 + \delta(1-\alpha\beta)$. The optimal indexation coefficient that links wages to actual export earnings thus depends not only on the parameters describing the structure of the economy, but also on whether or not the country has access to an international capital market.

3/ In an economy with both wage indexation and a real exchange rate rule two relative prices would be fixed. This implies that shocks to the economy would lead to disequilibrium not only in the labor market but also in other markets. It is difficult to see how markets could continue to function in this situation. This paper is concerned only with the real aspects of indexation rules. Real exchange rate rules, however, also have monetary implications in that the monetary authorities can no longer control inflation if they follow a real exchange rate rule. This aspect is discussed in Adams and Gros (1985).

and a labor demand of $\ell^d = y_p/\beta$. 1/ This implies that under such a policy, a 1 percent fall in export earnings would lead to an unemployment rate of $[(\beta-1)\delta]/\beta$ percent. The question therefore arises whether it is possible to formulate a rule that would adjust the nominal exchange rate automatically for domestic price developments and, at the same time, avoid the unemployment problems associated with simple PPP rules. The discussion in Section II suggests a rule of the form:

$$(26) \quad s = p + \mu_1(y_p+u) + \mu_2 v.$$

The values for the coefficients μ_1 and μ_2 that would always preserve full employment can be calculated from equation (14). However, the rule in equation (26) is specified in terms of the CPI whereas the full-employment solution for the real exchange rate in equation (14) is defined in terms of the relative price of nontradables. This discrepancy can be bridged by noting that $\alpha(s-p_n) = s - p$; the full-employment solution for the real exchange rate in equation (14) can then be rewritten in terms of the CPI as:

$$(27) \quad s = p - [(\delta(1-\beta)+1)\alpha/\omega](y_p+u) + [\alpha(1+\delta)/\omega]v.$$

The indexation coefficients that would prevent unemployment in response to export earnings and productivity are equal to:

$$(28) \quad \mu_1^* = -[\delta(1-\beta) + 1]\alpha/\omega \quad \text{and} \quad \mu_2^* = (1+\delta)\alpha/\omega.$$

For the special case of rigid labor supply and unitary intertemporal elasticity of substitution this implies that a 1 percent change in (permanent) export earnings should lead to a α percent change in the real, CPI, exchange rate.

1/ The definition of the CPI implies $p - s = (1-\alpha)(p_n-s)$ and thus if the exchange rate rule sets $s = p$, it follows that $p_n = s$ and $p_n = p$. Using this in the supply and demand for nontradables equation yields an expression for employment: $\ell^d = [(y_p+u) - v]/\beta$. Substituting this into the labor demand equation (2) yields: $w-p = [(\beta-1)(y_p+u) + v]/\beta$.

V. A Welfare Comparison of Simple Wage Indexation Schemes and PPP Exchange Rate Rules

A number of countries have indexation schemes that fix real wages or the real exchange rate without taking into account shocks that affect the economy. This raises the question as to which of these policies leads to more serious unemployment problems. This section investigates this problem, using a social loss function which provides a criterion according to which these suboptimal policies can be ranked. 1/ The theoretical justification for the specific form chosen is explained in detail in Aizenman and Frenkel (1984, 1985), but the economic rationale for the loss function can be explained in terms of the familiar "triangle" analysis of welfare loss. The loss function is given by:

$$(29) \quad L = [\ell^* - \ell][(w-p) - (w-p)^*]$$

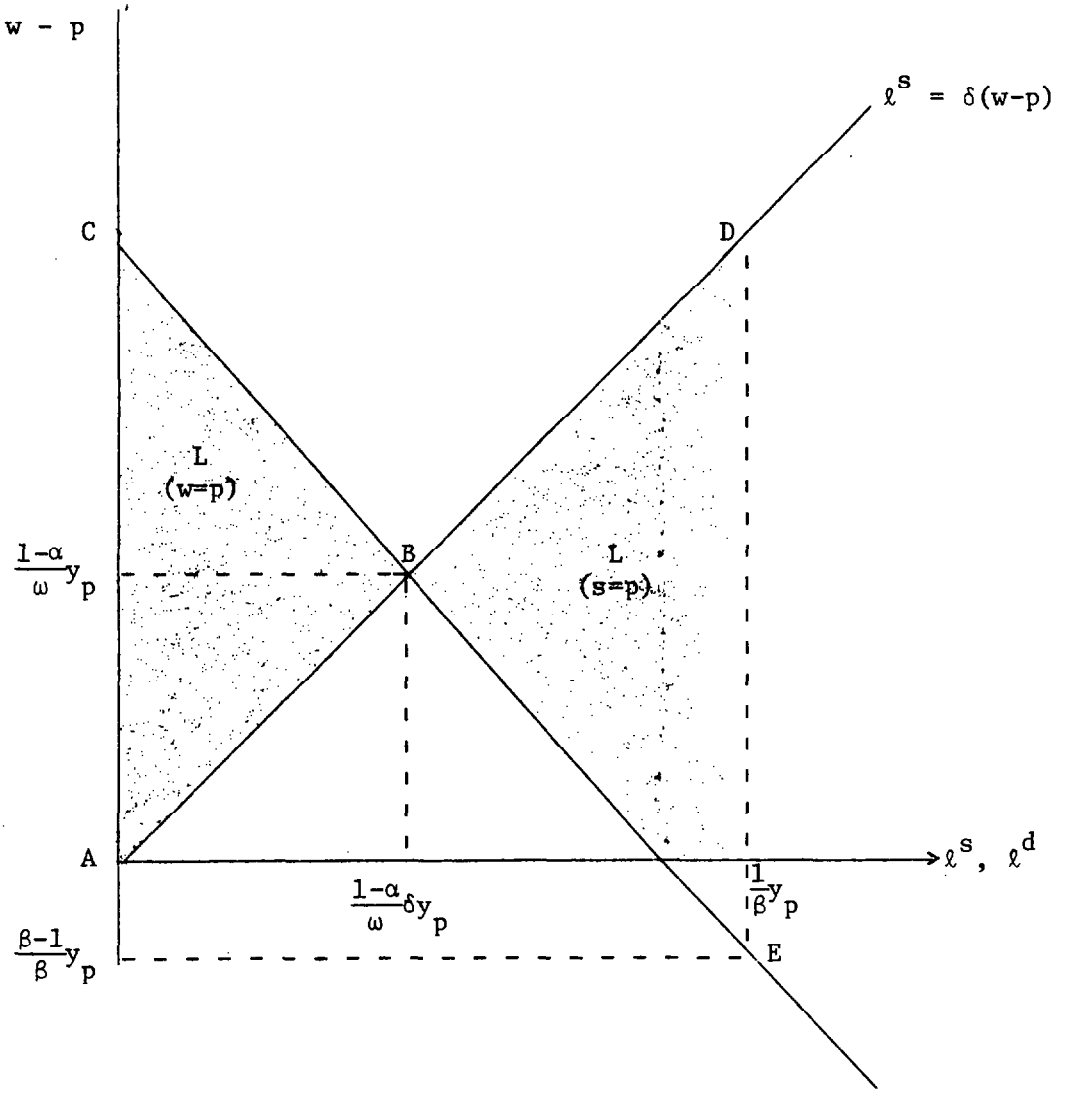
where ℓ^* and $(w-p)^*$ represent the market-clearing levels of employment and the real wage. The value of the loss function is equal to two times the area of the triangle under the labor demand function (Figure 1). The area of the triangle ABC measures the sum of the lost producers' and consumers' surplus, its area is proportional to $[\ell^*-\ell][(w-p) - (w-p)^*]$. The welfare loss caused by a wage rule that fixes real wages can be determined by calculating first the equilibrium values of employment and the real wage, ℓ^* and $(w-p)^*$, which are determined by equations (16) and (17). The actual real wage is determined by the policy rule (equation (18)) which implies $w-p = 0$ and the employment level caused by this rule is determined by equation (19). These relationships can be substituted into the formula for the loss function (equation (29)). Concentrating only on the loss caused by fluctuations in export earnings, this yields the following expression for the expected loss, E(L):

$$(30) \quad \underset{(w=p)}{E(L)} = \left(\frac{1-\alpha}{\omega}\right)^2 \left[\frac{\rho}{\rho(1-\beta) + \beta(1-\alpha)}\right] \sigma_y^2.$$

Because the welfare loss is due to the stochastic shocks to export earnings, it is proportional to the variance of (the permanent income from) export earnings.

1/ The rationale for simple wage indexation schemes and PPP exchange rate rules have been discussed in the previous section. This section implicitly assumes that the market clearing, full-employment equilibrium is the optimum or benchmark case.

Figure 1


w - p
$\ell^s = \delta(w-p)$
C
D
L
(w=p)
$\frac{1-\alpha}{\omega}y_p$
B
L
(s=p)
A
ℓ^s, ℓ^d
$\frac{1-\alpha}{\omega}\delta y_p$
$\frac{1}{\beta}y_p$
$\frac{\beta-1}{\beta}y_p$
E

The expected loss that would be caused by a PPP exchange rate rule, i.e., a rule that sets s = p, can be calculated in a similar fashion. The actual employment levels and real wage rates that would result from such a policy can be calculated by using the fact that s = p implies $s = p_n$ and $p = p_n$; 1/ changing the exchange rate in line with domestic inflation (international inflation is assumed here to be zero) thus fixes all relative prices. The value of the loss function under this policy is proportional to the area of the triangle BDE in Figure 1. The expected loss (or more precisely, that component of the loss deriving from variations in export earnings) under such an exchange rate policy is therefore: 2/

$$(31) \quad \underset{(s=p)}{E(L)} = [\beta\omega]^{-2}\rho[1 + \delta(1-\beta)]^2[(1-\alpha)\beta + (1-\beta)\rho]\sigma_y^2.$$

Having derived the exact welfare consequences of the two alternative, suboptimal, policies, it is now possible to compare them by considering

$$(32) \quad \underset{(s=p)}{E(L)} - \underset{(w=p)}{E(L)} = \left\{\frac{\rho\sigma_y^2}{\omega^2\beta^2[\rho(1-\beta) + \beta(1-\alpha)]}\right\}$$

$$\{[1 + \delta(1-\beta)]^2[(1-\alpha)\beta + (1-\beta)\rho]^2 - \beta^2(1-\alpha)^2\}.$$

Inspection of equation (32) reveals that the expression in the curled brackets is always positive and thus:

$$(33) \quad \underset{(s=p)}{E(L)} - \underset{(w=p)}{E(L)} > 0,$$

1/ See footnote 1, page 15.

2/ The optimal values, ℓ^* and $(w-p)^*$, are still given by equations (16) and (17); *the actual values are given in the previous footnote.* Plugging them into the formula for the loss function yields:

$$\underset{s=p}{E(L)} = \left[\frac{\delta(1-\alpha)}{\omega} - \frac{1}{b}\right]\left[\frac{\beta-1}{b} - \frac{1-\alpha}{\omega}\right]\sigma_y^2,$$

which can be transformed into equation (31) in the text.

i.e., fixing the real exchange rate will lead to a larger welfare loss (for a given change in export earnings) than fixing real wages. 1/ This result is a consequence of the fact that the direct impact of changes in export earnings should have a direct impact on the real exchange rate and only an indirect impact on real wages. An exchange rate rule that fixes the real exchange rate by adjusting the nominal rate according to inflation differentials fixes the real exchange rate and thus does not allow the direct adjustment mechanism to work. In this context, fixing the real exchange rate will thus be worse than fixing real wages by indexing nominal wages on the full CPI basket.

Another policy that has often been proposed is to index wages only on domestic good prices, i.e., to set $w = p_n$ (equation (21)). This policy would keep employment stable except for shocks to the production function, which affect the marginal productivity of labor. As mentioned above, such a policy would be optimal if the supply of labor were completely inelastic so that, at least in this limiting case, indexing wages on the domestic component of the CPI would be superior to indexing wages on the entire CPI. It is not clear, however, whether this is still true if labor supply is not completely inelastic. To resolve this, it is necessary to compute the welfare loss that is caused by this policy and compare it to the loss that is caused by indexing wages on the entire CPI (equation (30)).

To calculate the welfare loss from the policy that indexes wages on home goods only, it is first necessary to calculate the actual employment and real wages resulting from this policy. This implies that the loss function is: 2/

$$(34) \quad \underset{(w=p_n)}{E(L)} = \left(\frac{1-\alpha}{\omega}\right)^2 \frac{\delta^2}{\rho}[\rho(1-\beta) + \beta(1-\alpha)]\,\sigma_y^2.$$

1/ If there are constant returns to scale in the production of nontradables, i.e., if $\beta = 1$, then equation (40) holds with equality sign, i.e., the two policies lead to the same welfare loss. This is due to the fact that, if $\beta = 1$, it follows that $\omega = p_n$. Setting $\delta = p = p_n$ via the exchange rate rule or $\omega = p$ via full wage indexation is thus completely equivalent.

2/ The labor demand function (equation (2)) and the policy $w = p_n$ imply immediately: $\ell = v/(1-\beta)$. Writing $w - p_n \equiv w-p+p-p_n$ shows that with this policy $w-p = -(1-\alpha)(s-p_n)$ which can be substituted into the demand for nontradables equation to yield: $w-p = \{(1-\alpha)/\rho\}[(y_p+u) + v/(\beta-1)]/$. The expected loss is thus equal to:

$$\underset{(w=p_n)}{E(L)} = \left[\frac{\delta(1-\alpha)}{\omega}\right]\left[\frac{1-\alpha}{\rho} - \frac{1-\alpha}{\omega}\right]\sigma_y^2.$$

Given the definition of ω, this is equivalent to equation (34).

This can now be compared to the expression that determines the welfare loss resulting from indexing wages on the entire CPI (i.e., setting w=p) in equation (35). The difference between the two equations is equal to:

$$(35) \quad \underset{(w=p)}{E(L)} - \underset{(w=p_n)}{E(L)} =$$

$$\left(\frac{1-\alpha}{\omega}\right)^2 \frac{1}{\rho} \left[\rho(1-\beta) + \beta(1-\alpha)\right]^{-1} \left\{\rho^2 - \delta^2\left[\rho(1-\beta) + \beta(1-\alpha)\right]^2\right\}\sigma_y^2.$$

Inspection of equation (35) reveals that the entire expression is positive if $\delta < \rho/[\rho(1-\beta) + \beta(1-\alpha)]$, i.e., if the elasticity of labor supply (with respect to the real wage rate) is below a critical value, it is better to eliminate imported goods prices from the basket on which wages are indexed because this gives a lower welfare loss. For $\rho \geq 1$, this critical value would be greater than one which implies that if the elasticity of labor supply is lower than one, it would be preferable to index wages only on home goods. Because it is usually assumed that labor supply is inelastic, it follows that it is preferable, although not optimal, to index wages only on the domestic component of the CPI. The optimal policy would be to take into account fluctuations in export earnings directly in the indexation formula as shown above.

This section has considered three policies: fixing the real exchange rate (s=p); fixing real wages (w=p); and fixing the product wage ($w=p_n$). In general, the worst policy would be fixing the real exchange rate since this would always lead to a higher social cost than fixing real wages. 1/ There is also a presumption that it would be better to take imported goods out of the index to which wages are linked. This would at least stabilize employment, although it does not avoid unemployment when labor supply responds to real wages.

1/ These statements are based only on the effects of the variability in export earnings. As shocks to the demand for nontradables, u, have the same effect, the results continue to hold if these shocks are taken into account. Shocks to the production of nontradables, v, however, have different effects. But, it can be shown that as long as $\alpha < 0.5$, it is still better (in terms of a smaller loss) to fix real wages than to fix the real exchange rate, even if productivity shocks are important. However, the existence of these shocks would affect any welfare comparison between wage indexation based on the CPI and wage indexation based on nontraded goods prices only.

VI. Concluding Remarks

Small open economies have to sustain profound adjustments in response to fluctuations in export earnings. The required adjustment to these fluctuations generally includes changes in real wages and the real exchange rate. But at the same time there exist a number of countries with highly variable export receipts in which real wage rates are fixed because nominal wages are indexed on the general price level or the real exchange rate is fixed because the nominal exchange rate is depreciated in line with the difference between domestic and foreign inflation rates.

It is argued here that such indexation schemes, which might be useful in the face of high and variable inflation rates, should be "augmented" by rules that index either the real exchange rate or real wages on export earnings. By choosing the appropriate indexation coefficients, the authorities could replicate the equilibrium that would obtain under clearing labor markets and in the absence of inflationary surprises, this means that fluctuations in export earnings need no longer cause large unemployment problems. Linking wages to prices without taking into account fluctuations in export earnings would be appropriate only if labor supply is completely inelastic and if the index used to adjust nominal wages does not contain any imported goods prices.

The optimal indexation coefficients obtained with this model might seem complicated at first. However, if it is assumed that labor supply is inelastic, they all depend only on two parameters; the share of non-tradables in consumption and the intertemporal elasticity of substitution.

The main policy implication of the paper is thus that in small open economies with fluctuating export earnings, it is important not to fix either the real exchange rate or real wages. Given an inflationary environment that requires some form of wage indexation, the best policy would be to link wages not only to changes in the general price level but also to changes in export earnings. Such a policy would protect workers from inflationary surprises and would foster, at the same time, the necessary real adjustment to changes in export earnings.

Appendix

The intertemporal utility function (equation (5)), the consumption index (equation (6)), and the equality of the market rate of interest and the rate of time preference imply:

$$\text{(A1)} \quad \frac{\partial C_t / \partial N_t}{\partial C_{t+1} / \partial N_{t+1}} = \frac{C_t^{-\zeta} I_t^{\alpha} N_t^{-\alpha}}{C_{t+1}^{-\zeta} I_{t+1}^{\alpha} N_{t+1}^{-\alpha}} = \frac{P_{Nt}}{P_{Nt+1}}.$$

The Cobb-Douglas specification of the consumption index also implies constant expenditure shares:

$$\text{(A2)} \quad (1-\alpha) I_t P_{It} = \alpha N_t P_{Nt}; \quad \text{all } t.$$

Setting $P_{It} = 1$ and substituting into equation (A1) yields:

$$\text{(A3)} \quad \left(\frac{N_t}{N_{t+1}}\right)^{-\zeta} = \left(\frac{P_{Nt}}{P_{Nt+1}}\right)^{1-\alpha(1-\zeta)}$$

or solving for I_t:

$$\text{(A4)} \quad \left(\frac{I_t}{I_{t+1}}\right)^{-\zeta} = \left(\frac{P_t}{P_{t+1}}\right)^{(1-\zeta)(1-\alpha)}.$$

For the special case of a logarithmic intertemporal utility function, i.e., $\zeta = 1$, it is apparent from equation (A4) that

$$\text{(A5)} \quad I_t = I_{t+1}.$$

Given the budget constraint (equation (7)) and the constancy of interest rates, this then implies:

$$\text{(A6)} \quad I_t = rY_{pt}$$

and therefore using again (equation (A2)):

$$\text{(A7)} \quad N_t = \frac{rY_{pt}(1-\alpha)}{P_{Nt}\alpha} .$$

Equation (A7) clearly implies a unitary price and income elasticity of the demand for nontradables.

In the general case, $\zeta \neq 1$, the demand for nontradables is somewhat more complicated. A solution can still be obtained if it is taken into account that for time t+1 and thereafter all shocks are expected to be zero. Hence, all relative prices should be expected not to change and the consumption profile should be expected to be flat. This implies that for time t+1 and thereafter the consumption of importables should be equal to permanent income available at time t+1 which is linked to current permanent income by:

$$\text{(A8)} \quad r[(1+r)(Y_{pt}-I_t)] = I_{t+1} = P_{Nt+1}N_{t+1}\alpha/(1-\alpha).$$

Equation (A3) can be written as:

$$\text{(A9)} \quad N_t = N_{t+1}\left(\frac{P_{Nt}}{P_{Nt+1}}\right)^{\frac{1-\alpha(1-\zeta)}{-\zeta}} .$$

Substituting equation (A8) into equation (A9) yields:

$$\text{(A10)} \quad N_t = \frac{r(1+r)(Y_{pt} - I_t)(1-\alpha)}{P_{Nt+1}\alpha}\left(\frac{P_{Nt}}{P_{Nt+1}}\right)^{\frac{1-\alpha(1-\zeta)}{-\zeta}} .$$

In equation (A10) I_t can be substituted by again using equation (A2), simplifying yields finally:

$$\text{(A11)} \quad N_t = \frac{r(1+r)Y_{pt}\left(\frac{P_{Nt}}{P_{Nt+1}}\right)^{\frac{(1-\zeta)(1-\alpha)}{-\zeta}}(1-\alpha)}{P_{Nt}\left[1 + (1+r)r\left(\frac{P_{Nt}}{P_{Nt+1}}\right)^{\frac{(1-\zeta)(1-\alpha)}{-\zeta}}\right]\alpha} .$$

If it is assumed that a change in P_{Nt} does not affect expectations about P_{Nt+1}, the elasticity of N_t with respect to P_{Nt} is equal to:

$$\text{(A12)} \quad \left.\frac{\partial \ln N_t}{\partial \ln P_{Nt}}\right|_{P_{Nt+1}} \equiv \rho =$$

$$-\left[1 + \frac{(1-\zeta)(1-\alpha)}{\zeta}\left(\frac{P_{Nt}/P_{Nt+1}^{\frac{(1-\zeta)(1-\alpha)}{\zeta}}}{(P_{Nt}/P_{Nt+1})^{\frac{(1-\zeta)(1-\alpha)}{\zeta}} + (1+r)r}\right)\right].$$

For small shocks, P_{Nt}/P_{Nt+1} would be close to one and hence ρ could be approximated by:

$$\rho \equiv \frac{[(1+r)r + 1]\zeta + (1-\zeta)(1-\alpha)}{[(1+r)r + 1]\zeta}.$$

ρ is a monotonic, increasing function of the intertemporal elasticity of substitution, $1/\zeta$, it tends to ∞ as the elasticity of substitution goes to infinity and it goes to $1 - (1-\alpha)/[(1+r)r + 1] > \alpha$ as the elasticity of substitution goes to zero.

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