

The Phillips Curve and Minimum Wage Rates in LDC's:

The Brazilian Experience

David E. Hojman*

I. Introduction

Macedo (1977) and Morley (1982) have argued that LDC's labour supply schedules are not linear, but highly elastic at low wage levels and increasingly rigid as the wage increases. The condition for the equilibrium intersection to move from the elastic to the rigid zone is that labour demand should grow consistently faster than population. This, together with high GDP growth rates, seems an accurate description of Brazilian developments in the late 1960's and 1970's. In this fast growing environment, stagnant real levels of the government-determined minimum wage rate would not affect average real earnings. Unfortunately, no definitive empirical test of this proposition has been offered, and alternative hypotheses have been advanced (Taylor, et al., 1980; *Bacha*, 1982). Here, we use a model introduced by McCallum (1974) and previously applied by Holden and Peel (1979) and Hojman (1983) to estimate a Phillips curve, and transform this model to explain real wage changes as a function of excess labour demand, expected inflation, and the minimum wage rate. The conclusions seem to confirm Macedo's and Morley's views and further, the minimum wage coefficient appears to be always negative (both when assumed constant and when assumed time-dependent), though never statistically significant.

* Department of Economics, University of Liverpool, England.

II. The labour market

Let LD: labour demand

S: labour supply

W/P: real wage

m_1, m_2, n_1, n_2 : structural demand and supply parameters

X: relative excess labour demand

w: rate of money wage increases, percent

Then

$$LD = m_1 + n_1 (W/P); \quad m_1 > 0, n_1 < 0$$

$$S = m_2 \exp (n_2 (W/P)), \quad m_2 > 0, n_2 > 0$$

$$X = (LD - S) / S$$

Under equilibrium ($X = 0$):

$$m_1 + n_1 (W/P) = m_2 \exp (n_2 (W/P))$$

The Phillips curve is based on the notion that excess labour demand can be represented by the rate of money wage increases.

If $X \neq 0$:

$$w = \frac{m_1 + n_1 (W/P) - m_2 \exp (n_2 (W/P))}{m_2 \exp (n_2 (W/P))}$$

There are not sufficient independent equations to solve them as a simultaneous system for the structural parameters m_1, m_2, n_1 , and n_2 , but the Holden and Peel semi-logarithmic specification of the McCallum framework adequately conveys the notion that at low real wage levels a marginal real wage movement will provoke a substantial impact on the absolute excess demand position ($LD - S$), while at high wage levels the effect of a marginal wage movement on excess demand will be relatively lower. The empirical work by Holden and Peel and by Hojman suggests that adjustment is not instantaneous. If \hat{p} stands for the expected inflation rate (percent) and a time trend T is introduced to account

for other exogenous influences such as capital stock and technical progress, then:

$$(1) \quad w_t = a_1 + b_1 \ln(W/P)_{t-1} + c_1 \hat{p}_t + d_1 T,$$

$$b_1 < 0 \quad c_1 > 0$$

To assess the impact of the minimum wage rate (MIN/P), Equation (1) can be solved for $\ln(W/P)$, and $\ln(MIN/P)$ can be introduced as an additional right-hand variable.

$$(2) \quad \ln(W/P)_{t-1} = a + b T + c w_t + d \hat{p}_t + e \ln(MIN/P)_{t-1},$$

$$c < 0, \quad d > 0$$

If coefficient e is assumed to be time-dependent, so that the influence of the minimum rate on the average wage declines gradually over time ($e = E/T$):

$$(3) \quad \ln(W/P)_{t-1} = a + b T + c w_t + d \hat{p}_t$$

$$+ E \ln(MIN/P)_{t-1} / (T-1)$$

III. Partial adjustment

A more general model is obtained by introducing the twice lagged left-hand variable on the right-hand side, and expressing the regressors in first differences $D, D\hat{p}_t = \hat{p}_t - \hat{p}_{t-1}$

$$(4) \quad \ln(W/P)_{t-1} = A \ln(W/P)_{t-2} - b + c Dw_t + d D\hat{p}_t$$

$$+ e D\ln(MIN/P)_{t-1}, \quad 0 < A < 1$$

Equations (2) and (3) are special cases of the above, for which $A = 1$. A special version of Equation (4) where A is constrained to be equal to unity can be obtained by lagging Equation (2) a fur-

ther period and subtracting this new equation from Equation (2). The model represented by Equation (4) has the double advantage that it makes it possible to estimate short and long-run impacts, and it minimizes the danger of spurious correlation between W/P and MIN/P . An alternative model can be generated by lagging Equation (2) and multiplying this new equation by A ($0 < A < 1$) before subtracting it from Equation (2), but the potential advantages of this framework are jeopardized by possible collinearity problems (Hojman, 1984).

IV. Empirical estimation

The empirical estimation used Brazilian annual data for 1952-1977 (Bacha, 1982, except for the minimum wage rate, which was taken from Lemgruber, 1977, Taylor, et al., 1980, and World Bank, 1979). Tests were run with both a naive series of expected inflation (expected inflation being equal to the previous period actual rate), and a series generated by a rational expectations model (for a theoretical presentation see Sargent, 1973, 1976, and McCallum, 1975; the actual Brazilian regression is in Hojman, 1984). Estimates of the augmented Phillips curve are (t statistics in parentheses):

Naive expectations (OLSQ; \bar{R}^2 : 0.507; DW: 2.292)

$$w_t = 23.52 - 12.67 \ln(W/P)_{t-1} + 0.697 \hat{p}_t + 0.0465 T$$

(0.933) (0.511) (5.111) (0.132)

Rational expectations (ARI;

$$\bar{R}^2 : 0.883 ; DW: 2.517 ; \text{Rho: } -0.574$$

(3.280))

$$w_t = 27.71 - 24.35 \ln(W/P)_{t-1} + 0.929 \hat{p}_t - 0.00798 T$$

(2.421) (2.108) (13.08) (0.0518)

ARI stands for the Beach and McKinnon (1978) maximum likelihood estimation method for first order error autocorrelation. Clearly the latter equation should be preferred. Not only is it a better fit in terms of \bar{R}^2 and t statistics, but the hypothesis of the expected inflation coefficient being equal to one cannot be re-

jected at the usual significance levels (this is consistent with an absence of money illusion). According to this equation, the equilibrium wage for $\hat{p}_t = 0$ fell slightly from 312 to 310 during the estimation period. The actual real wage rose from 241 to 297 (all values in Cruzeiros per month at 1970 prices). Since, despite its increasing during the period, the actual real wage stayed below equilibrium, a dramatic increase in formal sector employment was possible.

V. The real wage equation

The best estimates for Equation (2) are:

Naive expectations

$$(IV, AR1 ; SER: 0.0651 ; DW: 1.607 ; Rho: 0.706(5.010))$$

$$\begin{aligned} \ln(W/P)_{t-1} = & 0.1399 + 0.00402 T - 0.00381 w_t \\ & (0.337) \quad (0.999) \quad (2.998) \\ & + 0.00279 \hat{p}_t + 0.1917 \ln (MIN/P)_{t-2} \\ & (1.916) \quad (1.901) \end{aligned}$$

Rational expectations

$$(IV, AR1 ; SER: 0.0594 ; DW: 1.609 ; Rho: 0.678(4.564))$$

$$\begin{aligned} \ln(W/P)_{t-1} = & 0.3014 + 0.00444 T - 0.00388 w_t + 0.00287 \hat{p}_t \\ & (0.820) \quad (1.291) \quad (3.483) \quad (1.989) \\ & + 0.1525 \ln (MIN/P)_{t-2} \\ & (1.680) \end{aligned}$$

According to the above estimates of Equation (2), the best regressor is the rate of money wage increases (which represents structural labour market forces). Both expected inflation and the minimum wage rate are statistically significant only at the ten percent level. There are no substantive differences between the

naive and the rational expectations models.

The best estimates for Equation (4), both with constant and time-dependent coefficients for the minimum wage variable, are presented in Table 1. The empirical results obtained for Equation (4) are much better than those presented previously for Equation (2), in terms of standard error of the regressions and *t* statistics. In all the fits presented in Table 1, both the rate of money wage increases and expected inflation are statistically significant. By contrast, the minimum wage rate is never significantly different from zero, and the sign of the respective estimated coefficient is always negative. Equation (4), which does not include a minimum wage variable in the right-hand side, is as good a fit as any. The real wage is fully explained by market forces and expected inflation, and the government-determined minimum wage rate makes no difference to it. There is no evidence in Table 1 that the rationally formed expected inflation series performs better than the naive one. Since the right-hand side variables of Equation (4) are expressed in first differences, naive expectations are "less naive" here than in Equation (2). (In Equation (4) naive expectations are formed by looking at two periods, while in Equation (2) they are formed by looking at one period only).

VI. Conclusions

If, following Linneman (1982), the Brazilian formal sector labour force is divided in a sub-minimum and an above-minimum wage sections, the first one represents a substantial share of the total (Morley, 1982). The informal sector is also sizeable (Merrick, 1976). However, despite these differences with labour markets of developed countries, the Brazilian labour market seems to be reasonably efficient, and the Phillips curve is well behaved and determined. Price expectations seem to be formed rationally and there is no evidence of money illusion. The Phillips curve estimates confirm that during the period 1952-1977 actual wages always stayed below equilibrium, allowing for an important increase in formal sector employment. Solving the Phillips curve equation for the real wage, in order to assess the relative impact on the left-hand variable of market forces, expected inflation, and minimum wage rates, suggests that only the

first two right-hand variables play a significant role, but the latter does not, thus confirming Macedo's and Morley's views on the irrelevance of minimum rates. However, the fact that equilibrium wages stagnated despite fast GDP growth possibly reflects both a very high rate of urban population growth, and a capital bias in the industrialization process.

Table 1

ESTIMATED COEFFICIENTS AND t STATISTICS OF THE REAL WAGE EQUATION (EQUATION (4)), 1952-1977

$$\ln(W/P)_{t-1} = A\ln(W/P)_{t-2} - b + cDw_t + dD\hat{p}_t + eD\ln(MIN/P)_{t-1}$$

Coefficient	Eq.(4.1)	Ea.(4.2)	Eq.(4.3)	Eq.(4.4)	Eq.(4.5)
A	0.5473 (4.605)	0.6285 (3.417)	0.6382 (4.727)	0.6369 (4.755)	0.6419 (4.869)
-b	0.4550 (3.708)	0.3830 (2.062)	0.3682 (2.680)	0.3743 (2.760)	0.3646 (2.726)
c	-0.00332 (10.00)	-0.00305 (5.166)	-0.00364 (9.640)	-0.00382 (9.638)	-0.00364 (10.41)
d	0.00213 * (4.214)	0.00039** (0.327)	0.00256* (3.346)	0.00257* (3.312)	0.00255* (3.392)
e	-0.0183 (0.759)	-0.0513 (1.163)	-0.0088*** (0.0883)	-0.0476 (1.424)	
Estimation method	AR1	IV,AR1	IV,AR1	IV,AR1	IV,AR1
SER	0.0337	0.0478	0.0357	0.0363	0.0349
\bar{R}^2	0.881				
DW	1.399	1.827	1.636	1.929	1.637
Rho	0.811	0.661	0.723	0.708	0.717
t for Rho	(6.604)	(3.998)	(4.833)	(4.535)	(4.870)
Durbin's h	1.92	1.27	1.28	0.25	1.25

* Naive expectations

** Rational expectations

*** Time-dependent coefficient (see Equation (3))

References

- Bacha, E. L., "Economic Growth, Rural and Urban Wages: the Case of Brazil, in M. Syrquin and S. Teitel," eds., *Trade, Stability, Technology and Equity in Latin America*, Academic Press, London, 1982.
- Beach, C. M. and J. G. McKinnon, "A Maximum Likelihood Procedure for Regression with Auto-correlated Errors," *Econometrica*, 46, 1978.
- Hojman, D. E., "Wages, Unemployment and Expectations in Developing Countries: the Labour Market and The Augmented Phillips Curve for Chile," *Journal of Economic Studies*, 10, 1983.
- Hojman, D. E., *Legal Minimum Wages and the Brazilian Labour Market*, manuscript, University of Liverpool, 1984.
- Holden, K. and D. A. Peel, "The Augmented Phillips Curve: Some Empirical Results for Italy, Japan and the U.K.," *Economic Studies Quarterly*, 30, 1979.
- Lemgruber, A. C., "Inflation in Brazil, in LB Krause and WS Salant," eds., *Worldside Inflation: Theory and Recent Experience*, Washington DC, Brookings Institution, 1977.
- Linneman, P., "The Economic Impacts of Minimum Wage Laws: a New Look at an Old Question," *Journal of Political Economy*, 90, 1982.
- Macedo, R.B.M., "A Critical Review of the Relation Between the Post-1964 Wage Policy and the Worsening of Brazil's Size Income Distribution in the Sixties," *Explorations in Economic Research*, 4, 1977.
- McCallum, B. T., "Wage Rate Changes and the Excess Demand for Labour: an Alternative Formulation," *Economica*, 41, 1974.
- McCallum, B. T., *Rational Expectations and the Natural Rate Hypothesis: Some Evidence for the U.K.*, The Manchester School, 1975.
- Merrick, T. W., "Employment and Earnings in the Informal Sector in Brazil; the Case of Belo Horizonte," *Journal of Developing Areas*, 10, 1976.
- Morley, S. A., *Labour Markets and Inequitable Growth: The Case of Authoritarian Capitalism in Brazil*, Cambridge, Cambridge University Press, 1982.
- Sargent, T. J., "Rational Expectations, the Real Rate of Interest, and the Natural Rate of Unemployment," *Brookings Papers on Economic Activity*, 1973.
- Sargent, T. J., "A Classical Macroeconomic Model for the United States," *Journal of Political Economy*, 84, 1976.
- Taylor, L., Bacha, E. L., Cardoso, E. A., and Lysy, F. J., *Models of Growth and Distribution for Bra-*

zil, Oxford, Oxford University
Press, 1980.

World Bank, *Brazil: Human Re-
sources Special Report*, 1979.

