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Money and Biased Technical Progress: A Further Test on 'Monetization as Technological Innovation' Hypothesis

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ABSTRAK

Kajian-kajian lalu telah menguji hipotesis 'pengewangan merupakan inovasi teknologi' untuk negara India. Oleh itu, tujuan artikel ini adalah untuk menguji hipotesis di atas terhadap data sektor estet getah di Malaysia, untuk tempoh masa 1962-89. Artikel ini juga ingin menentukan bias perubahan teknikal terhadap buruh dan modal di dalam sektor estet getah. Di dalam kajian ini, kaedah fungsi pengeluaran konvensional dan model pembetulan ralat (error correction model) digunakan untuk analisis. Keputusan kajian menyarankan bahawa jumlah bias di dalam perubahan teknikal adalah menuju ke arah penjimatan buruh. Juga, hasil kajian ini mendapati bahawa kegagalan untuk mengambilkira ketakpegunan sesuatu pembolehubah di dalam penganggaran akan menyebabkan kepada penganggaran yang tertakluk kepada bias-keatas yang agak besar.

ABSTRACT

Recent studies have tested the hypothesis of 'monetization as technological innovation' for the Indian economy. The objective of this paper is to test the above hypothesis on the the Malaysian rubber estate sector data over the period 1962-89. We seek to determine the bias in technical change on labor and capital in the rubber estate sector economy. In this study, we use both the conventional and the error correction model of production function. Results indicate that the total bias in technical change is labor saving. The study further points out that the failure to appropriately allow for non-stationary integrated variables in estimation has led to estimates which are subjected to substantial upward bias.

INTRODUCTION

Traditionally in production, output has been specified as a function of capital and labor. This technical relationship between output and input has been recognised by economists for over half a century. More recently, Sinai and Stokes (1972) provided empirical evidence which suggests that real money balances is a third factor input in the production function. However, the role of money as a factor input, has been recognised in earlier literature by Friedman (1959, 1969), Bailey (1971), Johnson (1969), Levhari and Patinkin (1968), Moroney (1972) and Nadiri (1969).

Despite the pioneering work done by Sinai and Stokes (1972), the consideration of real money balances as a production input has been criticised by Fischer (1974), Niccoli (1975), Prais (1975a, 1975b), Khan and Kouri (1975), Ben-Zion and Ruttan (1975) and Boyes and Kavanaugh (1979). They argue that incorporating real money balances in the production function is subjected to a specification bias.

Nevertheless, recent empirical evidence by Simos (1981), Apostolakis (1983), You (1981), Short (1979), Subrahmanyam (1980), Khan and Ahmad (1985), and Sarwar *et al.* (1989) have strongly supported the idea that real money balances act as a productive input in production. The reason for incorporating real money balances as a factor of production is that real money balances is a medium of exchange and facilitates the exchange between capital and labor for specialisation purposes, and tends to increase productivity. Also, it tends to reduce the transaction cost and therefore, increases the economic efficiency of the money market system. Thus, money acts as an input augmenting factor of production.

In two recent papers, Subrahmanyam and Cosimano (1979) (hereafter S-C) have tested the 'monetization as technological innovation' hypothesis, using data from the Indian economy by employing the CES production function framework. The study by S-C found that total technical change has been biased in the capital saving direction. In examining the bias due to time and the bias due to real money balances separately, S-C found that real money balances are biased toward labor saving, and that capital saving is biased toward time. On the other hand, Gupta (1985) using the translog cost function approach in testing the 'monetization as technological innovation' hypothesis for the Indian economy, found that his results contradict the earlier findings by S-C. Gupta (1985) points out that total technical change has been biased toward labor saving, and further, both time and real money balances lead to labor saving technological innovations.

The main objective of this paper is to test the 'monetization as technological innovation' hypothesis based on Malaysian rubber estate sector data for the period 1962-1989. The paper is divided into four sections. The model used in the study is discussed in Section 2. Empirical results are presented in Section 3, and the last Section contains our conclusion.

THE MODEL

The term 'monetization as a technological innovation' was coined by Crouch (1973) in his stimulating seminal paper (see also Moroney 1972). Crouch points out that on monetizing a barter economy, labor effort devoted in production that is, monetization of augmented labor input in production is eliminated. Therefore, he argues that in production function, monetization is equivalent to a one-shot labor augmenting technological innovation. With the introduction of money, the benefits are reaped all at once and that, the productive labor force is increased by a certain factor. The larger the benefits reaped from monetization, the larger will be that particular factor. Crouch further points that when we view 'monetization as a technological innovation,' it must lead unambiguously to higher income, wage rate and capital-labor ratio.

In this study, we employ the approach given by Subrahmanyam and Cosimano (1979) in order to test the 'monetization as a technological innovation' hypothesis. The S-C model is derived from the neo-classical production function, in the CES form as follows

$$Q_t = [\{1 - \emptyset\} \{aM_t^{\alpha} \exp(\Omega t)\, L_t\}^{-p} + \emptyset \{bM_t^{\beta} \exp\{\pi t\}\, K_t\}^{-p}]^{-1/p} \quad (1)$$

where Q, M, L and K are output, real money balances, labor and capital respectively. α and β are elasticities of efficiency of a and b with respect to M respectively. Ω and π are time rate of labor and capital augmenting technical change respectively. $\emptyset$, a, b and p are parameters, and t is the time period.

Assuming cost minimization, and equating the marginal products of the inputs to their respective prices, and after taking logarithms we arrive at the following relation

$$\log (K/L)_t = \log\{(a/b)^p [\emptyset/(1-\emptyset)]\} + \sigma \log (w/r)_t + [(1-\sigma)(\alpha - \beta)] \log M_t + [(1-\sigma)(\Omega - \pi)]t \quad (2)$$

where σ is the elasticity of capital-labor substitution. And defining Equation (2) in compact form and after adding a stochastic term we have Equation (3) which is ready for estimation.

$$\log (K/L)_t = \tau_0 + \tau_1 \log (w/r)_t + \tau_2 \log M_t + \tau_3 t + \epsilon_t \quad (3)$$

where β is the disturbance term, assumed to have mean zero and constant variance.

Our main focus is to measure the total bias in technical change, and separate biases due to real money balances and time. It has been shown that, using the results from Equation (3), the measurement of total bias in technical progress can be calculated as follows (see for example; Amano, 1964; Dandrakis and Phelps, 1966; David and Kundert, 1965; Subrahmanyam and Cosimano, 1979),

$$B = [(\beta - \alpha)\, m + (\pi - \Omega)]\, [\sigma - (1/\sigma)] \quad (4)$$

or calculated from the estimating Equation (3) as

$$B = \{-[\tau_2/(1-\tau_1)]m - [\tau_3/(1-\tau_1)]\}[(\tau_1 - 1)\tau_1] \quad (5)$$

where B is the measure of total bias in technical progress and m is the rate of growth of real money balances. If $B > 0$, we have total bias in labor saving. If $B < 0$, we have total bias in capital saving, and if $B = 0$, we have neutral technical progress.

The biases due to real money balances $(\alpha - \beta)$ and time $(\Omega - \pi)$ are shown by the terms

$[\tau_2/(1-\tau_1]$ and $[\tau_3/(1-\tau_1]$ respectively. If $[\tau_2/(1-\tau_1)] < 0$, we have bias in capital saving technological innovation due to real money balances. This means that monetization augments capital faster than labor. On the other hand, if $[\tau_3/(1-\tau_1)] > 0$, we have bias in labor saving due to time.

Sources of Data

In this study, we use the annual time series data from the Malaysian rubber estate sector for two reasons. Firstly, data on capital, labor, and their respective prices are readily available. And secondly, the rubber estate sector has experienced more technological innovations than the other sectors (including both agriculture and non-agriculture). This is not surprising as the rubber sector has been established in this country for nearly a century. Technological advances in this sector have been immense. Among others, some of the most important technological advancement in the rubber industry have been better high yielding clones, budgrafting techniques, the introduction of Standard Malaysian Rubber (SMR) commonly known as "block rubber", the use of yield stimulants and efficient tapping systems.

Data on capital, labor, wages and rentals are compiled from various issues of the Rubber Statistics Handbook published by the Department of Statistics Malaysia. However, the definition of capital K, poses a problem in studying production economy. Numerous definitions of capital appear in the literature. Capital expenditure in agriculture is commonly classified in several ways: modern versus traditional agriculture capital (Booth and Sundrum, 1984); durable versus non-durable capital (Desai, 1969); fixed versus variable capital (Ghosh, 1969); private versus public capital (Rajagopalan and Krishnamoorthy, 1969) and so on.

Capital expenditure in the agriculture sector generally includes expenditures on land reclamation, land clearing, land improvement, irrigation, construction of dams, farm buildings, dwellings, storage and warehouses, cost of agricultural machinery and equipment (harvestors, ploughs, tractors, harrows), livestock, factor inputs (seeds, fertilizer, manure, insecticides, hired human labor), investment on research, education, skills and health for the development of human capital (see Kumar, 1969; Bansil, 1969; Panikar, 1969; Sisodia, 1969; Kurian, 1969: Singh, 1969; Nurkse, 1952; Booth and Sundrum, 1984). Therefore, in this study, the definition of capital expenditure includes expenditure on agricultural and plant machinery, and equipment, land improvement, transport equipment, new construction on residential dwellings, non-residential buildings, etc. The same definition of capital has been used by Habibullah in several of his research studies on Malaysian rubber estate sector (see for example; Habibullah 1988, 1989a, 1989b, 1992). Variable L, is the number of hired labor in estate, w is the average wage rate per labor, and r is rent paid on plant, equipment and buildings.

EMPIRICAL RESULTS

Equation (3) was estimated with correction for first-order autocorrelation. However, the results reported in Table 1 are somewhat disappointing. Firstly, variable 't' is not significant in Equation (1a). And, secondly, low Durbin-Watson (DW) statistics indicate the presence of serial correlations in the equations. This suggests that the model is misspecified.

Following Chow (1966), we theorize that this may be the result of incomplete adjustment of the capital-labor ratio to equilibrium between one period to the next. We assume that the rubber estate sector takes time to adjust to its level of capital-labor ratio from desired $(K/L)^*$, to the actual (K/L) level. Thus, we apply a partial equilibrium mechanism of the following form

$$[(K/L_t)/(K/L)_{t-1}] = [(K/L)^*_t/(K/L)_{t-1})^{\theta}; \; 0 < \theta \leq 1 \quad (6)$$

where $(K/L)^*$ is the desired or equilibrium capital-labor ratio and θ is the coefficient of adjustment. Thus, we get the following regression equation

$$\log (K/L)_t = \delta_0 + \delta_1 \log (w/r) + \delta_2 \log M_t + \delta_3 t + \delta_4 \log (K/L)_{t-1} + n_t \quad (7)$$

where $\delta_0 = \theta \log A$, $\delta_1 = \theta\sigma$, $\delta_2 = \theta(1-\sigma)(\alpha - \text{ß})$, $\delta_3 = \theta(1-\sigma)(\Omega - \pi)$, $\delta_4 = (1-\theta)$, and n_t is the disturbance term.

From the estimated Equation (7), total biases are calculated as follows

$$B = \{-[\delta_2/(1-\delta_1)]m - [\delta_3/(1-\delta_1-\delta_4)]\}\{[(\delta_1/(1-\delta_4)) - 1]/[\delta_1/(1-\delta_4)]\} \quad (8)$$

TABLE 1
Regression results for the Static Model

Independent Variables	Eq. No. 1a	Eq .No. 1b	Eq. No. 1c
Constant	–7.0988 (–3.9504)***	–15.858 (–10.289)***	–15.258 (–7.6280)***
$\log (w/r)_t$	0.31360 (2.2187)**	0.43200 (5.1777)***	0.42072 (4.1627)***
$\log (M1)_t$	1.6386 (2.5107)**		
$\log (M2)_t$		4.1946 (8.4892)***	
$\log (M3)_t$			4.0785 (6.2422)***
t	–0.03437 (–0.73314)	–0.38249 (–7.1963)***	–0.41179 (–5.3422)***
R^2	0.917	0.954	0.941
D.W.	1.109	2.174	1.574
rho	0.223	–0.383	–0.246
SER	0.300	0.223	0.252

Notes: *** Statistically significant at one percent level
** Statistically significant at five percent level
* Statistically significant at ten percent level
Figures in parentheses are t-statistics.

Since one of the regressors in Equation (7) is a lagged dependent variable, ordinary least squares will yield inconsistent estimates. As such, we employ the maximum likelihood estimation procedure of Beach and MacKinnon (1978) to correct for autocorrelation assuming a first-order autocorrelation. The final results are shown in Table 2.

These results are a much improved set over those of the static form. The results imply that the presence of the lagged dependent variable appears to remove the misspecification error which occurred in the static model, as shown by the h-statistics which is calculated as follows (see Pindyck and Rubinfeld, 1981)

$$h = (1 - DW/2) \sqrt{(T/(1 - T.(\mathrm{var}\ \beta)))} \qquad (9)$$

where var(ß) is the square of the standard error of the coefficient of the lagged dependent variable, and T is the number of observations. At the five percent level, the critical value of the normal distribution is 1.645. Since the calculated h-statistics in all equations are less than 1.645, we cannot reject the null hypothesis of there being no serial correlation.

As shown in Table 2, in all cases, results of the estimated regressions of the dynamic model are clearly superior than those in the static model estimated earlier. The goodness of fit shows an improvement of an average of 4 percent, and a reduction of the standard error of regression (SER) to an average of 33 percent compared to the static model. Furthermore, all variables are at least significant at the five percent level.

The coefficient of the lagged dependent variable is in accordance with economic theory and less than one. Thus, the speed of adjustment (desired to actual level) ranges from 0.45 to 0.58 years.

Using the estimated coefficients in Table 2, we can calculate the Hicksian biases as presented in Table 3. We find that the bias in technical change due to real money balances for all of the three definitions of money stocks are consistent, and trend in the direction of labor saving. Thus, monetization seems to increase the efficiency of labor faster than that of capital in the Malaysian

TABLE 2
Regression results for the Dynamic Model

Independent Variables	Eq. No. 2a	Eq. No. 2b	Eq. No 2c
Constant	–5.0840 (–3.9515)***	–8.1167 (–3.3675)***	–6.4817 (–2.7717)***
$\log (w/r)_t$	0.27693 (3.5827)***	0.39628 (6.0441)***	0.38667 (5.4620)***
$\log (M1)_t$	1.3147 (3.0395)***		
$\log (M2)_t$		2.0046 (2.8672)***	
$\log (M3)_t$			1.5760 (2.2506)**
t	–0.06656 (–2.7767)***	–0.18436 (–2.8088)***	–0.16369 (–2.1829)**
$\log (K/L)_{t-1}$	0.54313 (6.2882)***	0.41817 (3.4128)***	0.50957 (4.4604)***
R^2	0.976	0.975	0.974
D.W.	1.904	2.148	1.714
rho	–0.334	–0.327	–0.231
h–statistic	0.277	–0.468	0.871
SER	0.166	0.169	0.175

Note: As per Table 1

rubber estate sector. But, the exogenous technical change appears to increase the efficiency of capital faster than that of labor. However, total bias in technical change due to monetization and time shows positive values for all definitions of money stocks. This suggests that the bias in technical change for the Malaysian rubber estate sector for the period 1962 to 1989 has been labor saving in nature.

Further Analysis: Testing for Unit Roots and Cointegration

It is recognised that the estimates presented in Tables 1 and 2, from the conventional model of Equations (1) and (3) are subjected to spurious regressions. Granger and Newbold (1977) have pointed out that it is important to check for the stationarity of the variables in question before estimation. A stationary series is defined as one whose parameters that describe the series namely the mean, variance and covariance are independent of time, or rather exhibit constant mean and variance and have covariances that are invariant to the displacement in time. Once the non-stationary status of the variables is determined, the presence of long-run equilibrium relationships between variables can be tested. In other words, we test whether the variables are cointegrated.

TABLE 3
Calculated Hicksian Biases

	For M1	For M2	For M3
1. Biases due to real balances ($\alpha - \beta$)	7.306	10.80	15.19
2. Biases due to time ($\Omega - \pi$)	–0.369	–0.993	–1.577
3. Total Bias (B)	35.04	52.50	46.77

To determine whether a variable is stationary, we employ a useful test provided by Dickey-Fuller (1979). The Dickey-Fuller (DF) test on unit root is based on the following equation

$$\Delta X_t = a + pX_{t-1} + e_t \tag{10}$$

where $\Delta X_t = X_t - X_{t-1}$. The DF tests the null hypothesis of a unit root, Ho: $X_t \approx I(1)$, which is equivalent to the null hypothesis that p is zero. and will be negatively and significantly different from zero if X is stationary and hence I(0). The test statistic is simply the t-statistic; however, under the null hypothesis it does not follow the usual Student's t-distribution, but this ratio can be compared with critical values tabulated in Fuller (1976).

To test against a higher-order autoregression, the following augmented Dickey-Fuller (ADF) test is employed

$$\Delta X_t = a + pX_{t-1} + \sum_{j=1}^{N} c_j \Delta X_{t-j} + v_t \qquad (11)$$

where N, the number of lagged differences, is chosen so as to eliminate any autocorrelation in the residual, v. The ADF test statistic is again the ratio of the estimate of p to its estimated standard error; and again, large negative values lead to the rejection of the null hypothesis that X is a random walk in favor of the alternative that it is stationary and I(0). The test was also applied to the first difference of the variables. That is,

$$\Delta^2 X_t = a' + p'\Delta X_{t-1} + \sum_{i=o}^{N} c'_j \Delta^2 X_{t-i} + u_t \qquad (12)$$

where the null hypothesis is the H_o: X_t is I(2), which is rejected (in favor of I(1)) if p' is found to be negative and statistically significant.

Having established that the variables are non-stationary, we test for cointegration. Only variables that are of the same order of integration may constitute a potential cointegrating relationship. Cointegration is defined as follows. Consider a pair of variables X and Y each of which is integrated of order d. The linear combination

$$z_t = Y_t - AX_t \qquad (13)$$

will generally be I(d). However, if there is a constant A, such that z_t is I(d–b), where b > 0, X and Y are said to be cointegrated of order d,b; and the vector (1, –A) is called the cointegrating regression and the relation $Y_t = AX_t$ may be considered as the long-run or equilibrium relation (Engle and Granger, 1987); z_t, the error correction term, is the deviation from the long-run equilibrium. When X_t and Y_t are cointegrated, the long-run relationship $Y_t - AX_t = 0$ will tend to be reestablished after a disequilibrium shock.

Testing whether variables are cointegrated is merely another unit root test on residual z_t in Equation (13), using the critical value reported in Engle and Yoo (1987). If the two series are cointegrated, then, as shown by Engle and Granger (1987), there exists an error correction model (ECM) of the form

$$\Delta Y_t = f + \sum_i g_i \Delta Y_{t-i} + \sum_j r_j \Delta X_{t-j} + sECM_{t-1} + w_t \qquad (14)$$

where ECM_{t-1} equals lagged one period residual z_t in Equation (13). The ECM embodies both short-run dynamics and the long-run equilibrium condition of the series. When the system is at rest, all differences vanish, and the long-run equilibrium condition holds.

TABLE 4
Unit root tests for non-stationarity

Variables	Level Form		First Difference	
	DF	ADF	DF	ADF
log(K/L)	–0.38	–	–4.62	–
log(w/r)	–	–1.03a	–9.48	–
log(M1)	–0.03	–	–	–4.70b
log(M2)	–0.24	–	–4.81	–
log(M3)	–0.26	–	–4.43	–

Notes: Critical values for DF and ADF; –2.6310%, –3.005%, and –3.751%. See Fuller 1976 For ADF, the lagged dependent variable was constraint to one, in order to save degree of freedom.

a

Lagged dependent variable was statistically significant at five percent level.

b

Lagged dependent variable was statistically significant at ten percent level.

The DF and ADF statistics for all the variables in Equation (1) above, in their level form, and first-difference are reported in Table 4. It appears that all the variables are I(1), and that the null hypothesis that ΔX_t is stationary is rejected.

Given that the variables; log(K/L), log(w/r), log(M1), log(M2) and log(M3) are of the same order of integration, we then proceed to test for cointegration. The results of the cointegrating regressions are given in Table 5. The critical values for the DF statistics for testing the null hypothesis that the following equation

$$\log(K/L)_t = f\,[\log(w/r)_t, \log(Mk)_t]\quad k = 1, 2, 3 \quad (15)$$

are not cointegrated is rejected in favor of the hypothesis that they are cointegrated for all three definitions of money stocks.

Given that Equation (15) are cointegrated, we estimate an error correction model for log(K/L) with each money stock M1, M2 and M3. The results are presented in Table 6. The appropriateness of the error correction version of Equation (1) is shown by the significance of variable ECM_{t-1}. In each of the equations for M1,

TABLE 5
Cointegration tests for equation 1

Models	CRDW	DF	ADF
1. With M1	1.06	–3.28	–
2. With M2	1.81	–4.74	–
3. With M3	1.52	–4.03	–

Notes: Critical values for CRDW at the one percent level of significance, for three variable case is 0.488. (see Hall, 1986).
Critical values for DF and ADF are –3.2010%, 3.605%, and –4.401% for a three variable case. (see Engle and Yoo, 1987).

TABLE 6
Error correction model of equation (1)

1. With M1

$$\underset{}{\Delta\log(K/L)_t} = \underset{(-1.3279)}{-0.09655} + \underset{(3.6323)^{***}}{0.3166\,\Delta\log K/L_{t-2}} - \underset{(-1.4806)}{0.14820\,\Delta\log K/L_{t-4}} + \underset{(5.2702)^{***}}{0.18858\,\Delta\log w/r)_t}$$

$$+ \underset{(1.9995)^{*}}{0.60902\,\Delta\log M1_{t-2}} + \underset{(1.7688)^{*}}{0.00625\,t} - \underset{(-6.3684)^{***}}{0.62871\,ECM_{t-1}}$$

$R^2 = 0.88$ DW = 1.811 SER = 0.099

2. With M2

$$\Delta\log(K/L)_t = \underset{(-0.99898)}{-0.12215} + \underset{(2.5890)^{**}}{0.33087\,\Delta\log(K/L)_{t-1}} + \underset{(1.8911)^{*}}{0.22572\,\Delta\log(K/L)_{t-2}} + \underset{(6.1142)^{***}}{0.29858\,\Delta\log(w/r)_t}$$

$$+ \underset{(1.1819)}{0.72163\,\Delta\log(M2)_t} + \underset{(0.69503)}{0.00309_t} - \underset{(-4.9166)^{***}}{0.79614\,ECM_{t-1}}$$

$R^2 = 0.80$ DW = 1.914 SER = 0.131

3. With M3

$$\Delta\log(K/L)_t = \underset{(-0.55983)}{-0.08313} + \underset{(2.2244)^{**}}{0.34009\,\Delta\log(K/L)_{t-1}} + \underset{(5.2928)^{***}}{0.30349\,\Delta\log(w/r)_t} + \underset{1.1855}{0.80595\,\Delta\log(M3)_t}$$

$$+ \underset{(0.23334)}{0.00124t} - \underset{(-3.3077)^{***}}{0.53038\,ECM_{t-1}}$$

$R^2 = 0.69$ DW = 1.967 SER = 0.159

Notes: *** Statistically significant at one percent level
** Statistically significant at five percent level
* Statistically significant at ten percent level
Figures within brackets are t-statistics.

M2 and M3, the ECM_{t-1} variable is highly significant and shows the correct negative sign. The goodness of fit is quite satisfactory with 0.88 for M1, 0.80 for M2 and 0.69 for M3. Furthermore, the standard errors of regressions are much smaller than the earlier estimates in Tables 1 and 2.

The variables of interest; log(w/r), log(Mk) and 't', are significantly different from zero in equation M1. However, for M2 and M3, the later two variables are not significantly different from zero. Nevertheless, this will not hinder us from calculating the Hicksian biases which is our ultimate objective in this study.

The Hicksian biases from the error correction model of Equation (1) are presented in Table 7. Results in Table 7 clearly show that monetization tends to increase the efficiency of labor faster than it does the capital. On the other hand, the exogenous technical change appears to show the opposite effect compared to the earlier results reported in Table 3. Total bias in technical change due to monetization and time is computed to be positive and thus indicates that the bias in technical change for the Malaysian rubber estate sector economy over the period 1962-89 has been labor saving in nature.

Finally, it is interesting to note that the estimates of the Hicksian biases obtained from the conventional model reported in Table 3 are substantially different from those derived from the cointegrating regressions in Table 7. We observe that the Hicksian biases obtained from estimates of the conventional model always tend to be greater than those obtained from estimates based on the cointegration method. The magnitude of this effect is particularly pronounced for the biases due to real balances and time. It would appear from our results that the failure in previous studies to allow for non-stationary integrated variables in estimation has led to estimates of the Hicksian biases to be sometimes substantially biased upwards.

TABLE 7
Calculated Hicksian biases from the error correction model

	For M1	For M2	For M3
1. Biases due to real balances ($\alpha - \beta$)	0.750	1.027	1.15
2. Biases due to time ($\Omega - \pi$)	0.0076	0.0044	0.0018
3. Total Bias (B)	24.11	25.30	30.55

CONCLUSION

In this study we tested the 'monetization as technological innovation' hypothesis on the Malaysian rubber estate sector data for the period 1962-89. The models used were the conventional and the error correction approaches. Our regression analyses indicate that the error correction model is more appropriate in representing the Malaysian rubber estate sector data, taking into account the non-stationary integrated variables in question.

Our results suggest that the technical bias in the Malaysian rubber estate sector economy over the period 1962-89 is not neutral. The total technical change has been biased in the labor saving direction. Coincidently, our results are consistent with the Indian study by Gupta. The most important contribution this study offers is that the endogenous technical change attributable to increased monetization is the high significance of labor saving.

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