# Theory and Evidence of the New Cambridge Private Expenditure Model: A Survey of Literature

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The aggregate private expenditure model that was constructed by the New Cambridge (NC) school first proved their hypothesized connection between the current account deficit and the government budget deficit. Then, it was found to produce erratic results. Critics discovered that in addition to specification error with the model, it was very much *ad hoc* in nature. The estimation technique employed by the NC school was also faulty. This paper argues that the basic hypothesis of the NC model is worth reexamining with new empirical evidence after modifying the model and the estimation technique.

## I. Introduction

In the early 1970s, the continuous decline in the British current account deficit prompted the Cambridge Economic Policy Group, popularly known an the New Cambridge (NC) school, to develop a theory which proposes an interdependence between government budget deficit and current account deficit. In the national income accounting framework, this proposition holds under the hypothesis that the private sector spends almost the entire amount of its disposable income with a short lag.

In verifying this hypothesis, the NC school constructed a unique aggregate private expenditure ($PX$) model, in which $PX$ is expressed as a function of current private sector disposable income ($PDI$), lagged disposable income ($PDI_{-1}$) and some non-income credit variables such as change in hire purchase debt outstanding to the personal sector ($HP$), change in bank loans outstanding to the personal sector ($BAP$) and stockbuilding ($ST$).

The present paper is an attempt to review the theoretical developments and empirical findings pertaining to the NC aggregate

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private expenditure model.

## II. Development of the Early NC Private Expenditure Model

The NC private expenditure model stems from its theory of balance of payments which is based on a direct link between the government budget deficit and the current account deficit. This link was proposed by Neild (1973), a member of the NC school. According to him, an open economy can be divided into three sectors: private sector, public sector and foreign sector. Any single sector of the economy, at a particular point in time, may demonstrate financial surplus or deficit. But all sectors taken together can never be in surplus nor in deficit. This is essentially derived from the identity:

$$(S - I) + (T - G) + (M - X) = 0 \tag{1}$$

where $S$ is domestic private sector savings;
$I$ is domestic private sector investment including changes in inventories;
$T$ is government tax revenue;
$G$ is government purchase of domestic goods and services;
$M$ is imports of goods and services;
$X$ is exports of goods and services.

From identity (1), it automatically follows that if the private sector surplus $(S - I)$ is zero or constant then government budget deficit would determine the balance of payments current account deficit and *vice versa*.

The implication of a "zero private sector balance" to the behavior of the private sector is that it spends virtually the entire amount of its disposable income with a short lag. In order to test this, the NC school initially constructed an aggregate private expenditure model as follows:

$$PX = bPDI + dPDI_{-1} + gHP + hBAP + qST + U \tag{2}$$
$$b,\ d,\ g,\ h,\ q > 0.$$

where $PX$ is aggregate private expenditure (composedof consumption, investment, and stockbuilding including the value of physical change in stocks);
$PDI$ is private sector disposable income (composed of personal disposable income and undistributed corporation

profits);
$PDI_{-1}$ is previous period's *PDI;*
*HP* is change in hire purchase debt outstanding;
*BAP* is change in bank loans outstanding to the personal sector;
*ST* is stockbuilding, including stock appreciation;
*U* is the disturbance term.

Before estimating this function, they took care of the simultaneity between *PX* and *PDI* by specifying another equation, i.e.:

$$PDI = nPX + XN \tag{3}$$

where $n$ is a coefficient that represents the extent to which private expenditure influences the magnitude of private income in the current year. Through an iterative process, the NC school estimated the *PX* model, with $n$ ranging from 0.0 to 1.0, and found that the value 0.42 for $n$ yields the best fit for the *PX* model. Thus, they select $n$ to be 0.42, which is known as the crude estimate of $n$.

*XN* is a variable representing other exogenous determinants of income on which no observation was taken.

The NC school encountered a problem with the disturbance term of the *PX* model:

> ... with income and expenditure growing over time it cannot realistically be assumed that the disturbances in the above formulation will have constant variance, so that some normalization is necessary. (Cripps, Godley and Fetherston 1974)

Accordingly, they took a logarithmic transformation of the model. Thus the early NC model takes the following form:

$$\begin{aligned} \text{Log } PX = \text{Log}[&bPDI + dPDI_{-1} + gHP \\ &+ hBAP + qST] + U \end{aligned} \tag{4}$$

$$PDI = nPX + XN \tag{5}$$

The NC school expressed all the variables in real terms. Given $n$ to be 0.42 and taking no observation on *XN*,[1] they jointly estimated

[1]The NC justification for the replacement of $n$ by 0.42 and having no observation on *XN*, in relation to the NC estimation method is discussed later in this chapter under the method of estimation.

the equations with annual British data for the period 1954–72, using maximum likelihood (ML) method.

The estimated results are as follows (Cripps, Godley and Fetherston 1974), with $t$ statistics in parentheses.

$$\begin{aligned} PX = {} & 0.533PDI + 0.416PDI_{-1} + 0.899HP \\ & (10.08) \quad (7.81) \quad (3.13) \\ & + 0.970BAP + 0.962ST \\ & (3.68) \quad (13.08) \end{aligned} \tag{6}$$

> The official figures for personal bank advances increase rapidly in 1971 and 1972 following the implementation of competition and credit decontrol in September 1971. The above equation was therefore first estimated for the period 1954–70 only; since the bank advances appear to be playing the role of a proxy monetary variable, the observed values of this series for 1971 and 1972 (which would obviously be misleading) were replaced by those obtained from a regression of bank advances of *HP* for 1954–70. (Cripps, Godley and Fetherston 1974)

The NC school did not report the $R^2$ of this fit in any source. As a result, it is not possible to ascertain the goodness of fit of this model. From $t$ statistics, it is clear that all the variables are significant[2] in explaining the variation in the dependent variable *PX*. Although the Durbin-Watson $d$ statistic is not reported, the NC school observed that there was no significant autocorrelation in the model.

The estimated coefficients of $PDI$ and $PDI_{-1}$ are calculated to be 0.533 and 0.415 respectively. The implication is that about 95 percent $(0.533 + 0.415)$ of the private sector disposable income is spent within two years, implying that the private sector is more or less in balance, which in turn leads to the conclusion that the deficit (or surplus) of the public sector would be more or less reflected on the deficit (or surplus) of the foreign sector and *vice versa*. Thus they proved their theory.

## III. Confirmation and Criticism of the Early Model

The British Treasury, as discussed in Mowl (1974), using the same NC method, verified their empirical findings with regard to

[2]5 percent level of significance will be consistently used in testing hypotheses throughout this research.

the sensitivity and stability of the parameter estimates over time and the justification for the exclusion of the constant term from the *PX* function and found the model unshakable.

Afterwards, Stamler and Grice, as discussed in Stamler (1975), had applied certain tests to this model to examine the validity and robustness of the *PX* model. They carried out the tests by introducing more lags on the income terms, inserting a constant term on the right-hand side of the function and varying the crude estimate of $n$, i.e. 0.42. These findings suggest that, under different circumstances, neither the sum of the estimated coefficients of the income terms nor the lag in adjustment were substantially different from what the NC school had postulated.

In order to test the consistency of the NC results, Stamler (1975) estimated the *PX* model with annual data in three different ways: first, ignoring simultaneity between *PX* and *PDI* and recognizing heteroscedastic error, he estimated the logarithmic form of the function as a single equation; second, he ignored both the simultaneity and heteroscedastic error and thus estimated the non-logarithmic form of the private expenditure function as a single equation with a constant term on the right-hand side; and third, the same equation as in the second case, but without a constant term. In all the cases he used OLS. The results are reported in Table 1.

Based on these results, the only conclusion that can be drawn is that the sum of the coefficients of the income terms is less than, but fairly close to, unity in all cases. This supports the NC hypothesis that the private sector is more or less in balance. However, $R^2$s, Durbin-Watson $d$ statistic and Student's $t$ statistics are not available in any source for these models. Due to the absence of $R^2$, it is unknown how well the models fit the data. Since $t$ statistics are not reported, it is difficult to ascertain whether the independent variables are statistically significant in explaining the variation in dependent variable. The absence of $d$ statistics makes it impossible to judge if the models suffer from autocorrelation. Due to the missing summary statistics, $R^2$, $d$ and $t$, it is difficult to ascertain the quality and reliability of the estimates.[3]

Smith (1976) examined whether the NC model was sensitive to

[3]Stamler (1975) also estimated the *PX* function with quarterly data both ignoring and recognizing the simultaneity between *PDI* and $PDI_{-1}$, using a lag of 9 quarters. But the quarterly data displays somewhat different results, i.e. the sum of the coefficients of the income terms ranges from 0.77 to 0.87 in various cases.

TABLE 1
STAMLER'S SINGLE EQUATION OLS ESTIMATES OF THE AGGREGATE PRIVATE EXPENDITURE MODEL, 1954-72

| Regressors | Parameter estimates | | |
|---|---|---|---|
| | Logarithmic form with constant term | Non-logarithmic form without constant term | Non-logarithmic form with constant term |
| Private sector disposable income (*PDI*) | 0.562 | 0.560 | 0.566 |
| Lagged private sector disposable income ($PDI_{-1}$) | 0.388 | 0.389 | 0.387 |
| Change in bank loans outstanding to the personal sector (*BAP*) | 0.737 | 0.750 | 0.755 |
| Change in hire purchase debt outstanding (*HP*) | 0.869 | 0.860 | 0.872 |
| Stockbuilding (*ST*) | 0.944 | 0.970 | 0.959 |

Source: Stamler (1975).
Note: 1. Variables are expressed in constant prices.
2. All data are annual.

estimation techniques. For this purpose, he estimated it with two different methods other than the NC method.[4] They are the indirect least squares (ILS) method considering the simultaneity between *PX* and *PDI* assuming $n = 0.42$; and ordinary least squares (OLS) method assuming $n = 0$, which amounts to ignoring the simultaneity between *PX* and *PDI*. Smith's results have been compared with those of the original ML results obtained by the NC school in Table 2.

Smith did not provide any summary statistics of his estimates. However, from appropriate significance tests, he observed that parameter estimates obtained by ILS and OLS are not significantly different from those obtained by the original ML method. He also observed that the NC model does not suffer from simultaneity bias, because the relevant residual sum of squares was observed to be

[4]In doing so, he used the same set of data that the NC school had originally used.

TABLE 2
SMITH'S COMPARATIVE ESTIMATES OF THE AGGREGATE PRIVATE EXPENDITURE MODEL 1954-72

| Regressors | Parameter estimates | | |
|---|---|---|---|
| | Maximum likelihood method (ML) | Indirect least squares method (ILS) | Ordinary least squares method (OLS) |
| Private sector disposable income (*PDI*) | 0.533 | 0.545 | 0.573 |
| Lagged private sector disposable income ($PDI_{-1}$) | 0.416 | 0.404 | 0.375 |
| Change in bank loans outstanding to the personal sector (*BAP*) | 0.790 | 0.719 | 0.674 |
| Change in hire purchase debt outstanding (*HP*) | 0.899 | 0.992 | 0.924 |
| Stockbuilding (*ST*) | 0.962 | 0.971 | 0.958 |

Source: Smith (1976).
Note: 1. All the variables are expressed in constant price.
2. All data are annual.

small. From the heteroscedasticity test, he found that the model was free from this problem. He also found that the sum of the coefficients of *PDI* and $PDI_{-1}$ was close to 0.95. Smith did not report the Durbin-Watson *d* statistic, nor did he claim to have found the model free from autocorrelation.

On the basis of Smith's findings, apart from the possibility of autocorrelation, two conclusions can be drawn: first, the New Cambridge *PX* function is stable regardless of whether it is estimated with ML, ILS or OLS methods; and second, it supports the main NC hypothesis that the private sector spends virtually all of its disposable income with a short lag, thus confirming the NC theory of balance of payments.

However, the NC theory of balance of payments was strongly criticized by Bispham (1975). Based on the facts presented by the NC school, Bispham observed that the variable bank advances to the personal sector (*BAP*) rose rapidly in 1971 and 1972 following the

introduction of competition and credit decontrol policies. As such, the actual observations of the variable *BAP* for the period 1971-72 were replaced by the calculated values based on a regression of *BAP* on *HP* for the period 1954-70. This, according to Bispham, is equivalent to an admission that the initial specification of the model did not fit the data well with the changed monetary situation. This raises doubt about the model's usefulness, should monetary conditions change again.

In addition, from the British Blue Book[5] data (constant price), according to the NC method, Bispham showed how the model predicted the aggregate expenditure of the private sector for the period of 1972-74. This data, shown in Table 3, suggested that the NC model overpredicted the private expenditure by more than 10 percent during 1973-74. Thus he concluded that the NC model "has broken down massively."

TABLE 3
BISPHAM'S PREDICTION RESULTS BASED ON THE AGGREGATE PRIVATE EXPENDITURE MODEL: 1972-74

| Variables | Observed values | | | Predicted values | | Residuals | |
|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1973 | 1974 | 1973 | 1974 |
| Aggregate private expenditure (*PX*) | 40,249 | 43,151 | 42,937 | 44,914 | 46,761 | −1,763 | −4,824 |
| Private sector disposable income (*PDI*) | 42,406 | 44,989 | 45,136 | | | | |
| Change in bank loans outstanding to the personal sector (*BAP*) | 239 | 163 | −63 | | | | |
| Change in hire purchase debt outstanding (*HP*) | 218 | 144 | −45 | | | | |
| Stockbuilding (*ST*) | 1,094 | 2,156 | 4,239 | | | | |

Source: Bispham (1975).

Note: 1. All variables are expressed in constant price.
2. All data are annual.
3. Data for 1972, 1973 and 1974 have been deflated by the deflators 1.1597, 1.2715 and 1.4689 respectively.

[5]The United Kingdom National Accounts books are popularly known as Blue Books.

## IV. The Revised New Cambridge Model

The empirical breakdown of the NC model during the post-1972 period prompted Cripps, Godley and Fetherston (1976) to revise their model. In doing so, they dropped the variable BAP, incorporated a constant term on the right-hand side of the equation and expressed all the variables in nominal rather than in real terms. Other assumptions remained the same. Thus the revised two-equation model becomes:

$$\text{Log } PX = \text{Log}[a + bPDI + dPDI_{-1} + gHP + qST] + U \quad (7)$$

$$PDI = nPX + XN \quad (8)$$

where: $a$ is the intercept;
all other variables and coefficients are defined as before.

With these changes in the model, they estimated the revised model with their ML method for the original period (1954–72) and for an extended period (1954–74) separately, in order to test whether their model did in fact break down during the post-1972 period as claimed by Bispham in 1975. The results with $t$ statistics in parentheses are as follows:

$$\begin{aligned} 1954\text{-}72:\ PX = &-208.6 + 0.624PDI + 0.345PDI_{-1} \\ &(-2.70)\quad (13.18)\qquad (6.74) \\ &+ 1.062HP + 0.874ST \\ &(3.70)\qquad (10.61) \end{aligned} \quad (9)$$

$$\begin{aligned} 1954\text{-}74:\ PX = &-156.5 + 0.616PDI + 0.360PDI_{-1} \\ &(1.14)\quad (7.60)\qquad (4.09) \\ &+ 1.173HP + 0.472ST \\ &(2.26)\qquad (4.99) \end{aligned} \quad (10)$$

Again, $R^2$s are not reported anywhere for these models, and so it is not known how well the models fitted the data. The $t$ statistics suggest that all the explanatory variables are statistically significant. The intercept in the case of extended data period is not significant. Due to the absence of Durbin-Watson $d$ statistics, it is hard to know whether or not there is autocorrelation in the model.

However, it is observed that the coefficients of disposable income ($PDI$ and $PDI_{-1}$) and changes in hire purchase debt outstand-

ing (*HP*) have been altered slightly when the period is extended up to 1974, but at the 5 percent level their statistical significance did not change at all. The sum of the coefficients of the income terms remains stable at less than but close to unity, i.e. 0.96 and 0.97 for the original and extended periods respectively, implying that the private sector maintains a small and stable surplus. Thus the overall estimated results remain quite consistent with the original NC hypothesis and therefore, the new version of the NC aggregate private expenditure function has survived this empirical test.[6]

## V. A Critique of the Revised Model

Both the model specification and the estimation method employed by the NC school have been subject to bitter criticism. Model Specification:

The NC shcool's aggregated private expenditure function is quite uncommon and new in macroeconomic literature. Although initially critics objected in principle to the aggregation of personal consumption and corporate investment, during the recent past, applied economists have been increasingly accepting it for the purpose of forecasting and public policy analysis of government deficit and balance of payments deficit. Blinder (1978) said that since the aggregate private expenditure function was so central to the NC theory, it would need a more careful examination and theoretical justification.

Another characteristic of the NC model is its *ad hoc* nature. From the very beginning, the NC school manipulates varibles to get a better fit. They confessed that they replaced *BAP* by regressing it on *HP* to get a better fit in their first attempt to estimate the model for 1954-72. This might have caused a systematic bias in the estimates of the parameter coefficients. Over and above, they dropped the same variable from the revised model (Cripps, Godley and Fetherston 1976), with a plea that it was not consistent with the data. Thus both the inclusion and exclusion of this variable were done on an *ad hoc* basis.

*ST* is another *ad hoc* variable. About its inclusion as an explanatory variable, Cripps, Godley and Fetherston (1974) have argued that "... firms treat stocks as liquid liabilities and tend automatically

[6]It should, however, be noted that again the NC School did not perform an $F$ test to verify whether or not the sum of the coefficients of $PDI$ and $PDI_{-1}$ is jointly significantly different from zero and unity.

to borrow additional sums from banks to finance them." Thus, basically they have used it as a proxy variable for change in bank advances to the company sector (*BAB*).

But the problem of using *ST* as a proxy variable for *BAB* is three-fold: first, since the data on the original variable *BAB* are available, there is no valid reason to use a proxy variable for it; second, if the changes in stockbuilding are planned, then it can be considered as liquid liabilities as claimed by the NC school. But if they are unplanned, then their assumption would not be valid; third, and more important, a part of *ST* (i.e., the value of physical change in stocks (inventories)) is a component part of the dependent variable (*PX*), making *PX* a linear combination of *ST*. Therefore, the presence of *ST* as an explanatory variable is not econometrically justifiable.

The revised model inserted a constant term on the right-hand side of the equation without any theoretical explanation. Inclusion of a constant term implies that the average and marginal propensities to spend out of disposable income are different. According to Chrystal and Darnell:

> On the question of constant term, it is better included than excluded in such an equation, for not only does it aid the linear approximation, but its erroneous exclusion could seriously bias the estimates.

The NC school used the logarithmic transformation of their private expenditure function on the assumption that the error term displays heteroscedasticity. They are not known to have performed any statistical test for the presence of heteroscedasticity.

The second equation in the NC model can be considered as an auxiliary equation for the purpose of facilitating the estimation process of the function.

In this equation, the variable private sector disposable income (*PDI*) is expressed as a function of *PX* and *XN* where *PX* represents aggregate private expenditure and *XN* represents all exogenous determinants of income other than *PX*. In estimating the model, the NC school replaced *n* by its crude estimate (0.42) which was obtained through an iterative process discussed earlier. The selection of the value for *n* was not done on any standard statistical basis. They also did not take any observation on the variable *XN;* hence it is clearly vague and undefined and does not add any new information to the model.

The NC school, in their revised model, expressed both the *PX* and *PDI* functions in nominal rather than in real variables. In favor of this alteration, Cripps, Godley and Fetherston (1976) attempted to provide a theoretical explanation. According to them:

> A constant price expenditure function implies, since the equation involves lags, that a given level of money disposable income in the current period will generate the same amount of real expenditure in the following period, regardless of the rate of inflation between the two periods. However, since this period's expenditure is being financed by the money disposable income of the current and preceding periods, the real expenditure of the current period is more likely to be financed by current and lagged money income, both deflated by the prices prevailing in the current period. But this is the same as denominating the whole thing in money terms.

Chrystal and Darnell (date n.a.) are not convinced with the NC school's justification for current price formulation of the model. They counterargued that the current and lagged *PDI* expressed in nominal terms are likely to be very highly correlated, giving rise to multicollinearity in the model.

With regard to the NC estimation method, Chrystal (1981a) raised a question as to the status of the *PDI* equation because, according to him, *PDI* is neither a behavioral equation nor a reduced form. He argued that if this equation were considered as an equation and $n$ were set to zero, then the NC technique being correctly applied could produce the same parameter estimates as 2SLS. But in reality, the NC school used this equation as an identity rather than an equation. The NC method of estimation has been criticized on two major points: the undefined nature of the variable *XN* and the use of the crude estimate of $n$.

Fetherston (1975) tried to justify the undefined nature of *XN* in the following manner. In his own words:

> The procedure to be described here, which will be denoted FAML (feedback adjusted maximum likelihood) attempts to allow for this feedback effect in a way which, unlike 2SLS, does not require specifications of any additional predetermined variables, but merely requires an *a priori* value for the magnitude of the feedback effect (i.e., a value for $n$). This eliminates the danger of misspecifying predetermined variables of the system, but of course, introduces the possibility of misspecifying the value of $n$. However, as long as the feedback parameters are correctly specified, then the estimates obtained will

> be valid and so compatible with a great number of possible alternative specifications of other equations. (Fetherston 1975)

Since no observation has been taken on *XN*, therefore the *PDI* equation does not represent a complete behavioral relationship; hence, its inclusion is in fact not taking care of simultaneity between *PX* and *PDI* as was originally intended. Chrystal (1981a) criticized the addition of this equation as making the parameter coefficients of *PDI*s biased downward.

Imputation of 0.42 to the parameter $n$ as its crude estimate has been an *ad hoc* phenomenon, not found in any established statistical procedure. Apart from this, the parameter estimates of the *PX* model are found to be quite sensitive to the value of $n$. Putting the value of $n$ from 0.0 to 1.0, Mowl (1974) found that the estimated co efficients of *PDI*, $PDI_{-1}$, *HP*, *BAP* and *ST* vary from 0.562 to 0.445, 0.388 to 0.505, 0.869 to 1.045, 0.737 to 0.936 and 0.944 to 0.014 respectively.

Chrystal (1981a) was most critical about the crude estimate of $n$. He accused the NC school of simply trying various values and settling on the value they liked the best.

## VI. Further Testing of the Revised Model

With a view to testing the goodness of fit of the NC model, Chrystal (1981b) ran a regression on the revised private expenditure function with more recent British data (1962-80). In this estimation process, he ignored simultaneity between *PX* and *PDI* and possible heteroscedasticity with the error term of the *PX* model. Thus he estimated the non-logarithmic form of the single equation *PX* model using OLS. In his estimation process, he suspected that there was no lag in the adjustment between income and expenditure. Thus, in order to test this, he estimated the *PX* model both with and without $PDI_{-1}$. The results are show in Table 4.

$R^2$s in this Table indicate that all the equations have a very high goodness of fit. For the current price formulation of the equation with $PDI_{-1}$, the $t$ tests suggest that all the variables are statistically significant. However, when $PDI_{-1}$ is dropped, then *HP* becomes statistically insignificant. In the case of constant price formulation of the model with $PDI_{-1}$, the $t$ test demonstrates that all the variables except *PDI* are statistically insignificant. The results of the $t$ test are basically the same when it is performed on the same function without $PDI_{-1}$. Thus the overall fit in real terms is worse than

TABLE 4
CHRYSTAL'S OLS ESTIMATES OF THE REVISED AGGREGATE PRIVATE EXPENDITURE MODEL: 1962-80

| Regressors | Parameter estimates | | | |
|---|---|---|---|---|
| | Nominal | | Real | |
| Private sector disposable income (*PDI*) | 0.40<br>(4.5) | 0.92<br>(74.0) | 1.1<br>(5.4) | 0.96<br>(76.0) |
| Lagged private sector disposable income ($PDI_{-1}$) | 0.59<br>(5.8) | —<br>— | −0.21<br>(−0.97) | —<br>— |
| Change in hire purchase debt outstanding (*HP*) | 0.9<br>(3.2) | 3.8<br>(1.4) | −1.8<br>(−0.64) | −0.38<br>(0.16) |
| Stockbuilding (*ST*) | 0.38<br>(4.0) | 0.46<br>(2.8) | 0.31<br>(1.4) | 0.26<br>(1.2) |
| $R^2$ | 0.999 | 0.999 | 0.999 | 0.999 |
| Durbin-Watson *d* statistics | 1.40 | 0.73 | 1.00 | 0.75 |

Source: Chrystal (1981b)
Note: 1. Current price data are deflated by the retail price index.
2. Values in parentheses represent *t* statistics.

what is obtained in nominal terms.

The sum of the coefficients of the income terms are stable and less than but close to unity in all cases. But Chrystal and Darnell (date n.a.) did not test the joint significance of the variables *PDI* and $PDI_{-1}$ using an *F* test.

The problem with the models is autocorrelation. Both in nominal and in real terms, for the model with $PDI_{-1}$, the Durbin-Watson *d* statistics are in the inconclusive range, implying that the presence of first-order correlation cannot be rejected conclusively. With $PDI_{-1}$ dropped from the model, *d* indicates conclusive evidence of autocorrelation, making the parameter estimates inefficient and significance tests imprecise.

Chrystal (1981b) also argued that the NC model exhibited structural instability during the mid-1970s. In order to examine this, he conducted a test for the constancy of regression relationships over time, by using a moving regression method advanced by Brown, Durbin and Evans, as found in Chrystal (1981b).

According to this method, he estimated the revised NC model as a single equation, first with 10 observations and moved the regression through the data (1962-80) by successively dropping the first and

adding the next observation. He carried out this test in both real and nominal terms, and his findings suggest that the estimation results in real terms are highly unstable. The estimated coefficients of *PDI* vary from 0.42 to 2.40, and that of $PDI_{-1}$ from −1.50 to 0.54, and that of *HP* from −10.90 to 10.10. Chrystal (1981b) has not reported the range of the parameter estimate of *ST* but mentioned that it had not demonstrated the slightest hint of stability.

Again the results of the moving regressions, using current price data, were found to be more consistent with the NC hypothesis than those obtained from the constant price data. The range of the coefficients in nominal and real terms are in Table 5.

Based on these estimted results, it has been observed that the coefficient of the variable *HP* is extremely sensitive. The variation of the coefficients of other variables are also relatively large. Therefore, Chrystal (1981b) again concluded that the NC aggregate private expenditure function did not seem to be stable at all.

TABLE 5
CHRYSTAL'S CONSTANCY TEST FOR THE PARAMETERS OF THE AGGREGATE PRIVATE EXPENDITURE MODEL, 1962–80

| Regressors | Range of parameter estimates in current price | Range of parameter estimates in current price |
|---|---|---|
| Private sector disposable income (*PDI*) | 0.81 to 0.36 | 0.42 to 2.40 |
| Lagged private sector disposable income ($PDI_{-1}$) | 0.13 to 0.65 | −1.50 to 0.54 |
| Change in bank loans outstanding to the personal sector (*BAP*) | −0.85 to 5.59 | −10.90 to 10.10 |
| Stockbuilding (*ST*) | 1.10 to 0.27 | — |

Source: Chrystal (1981b).

In support of Chrystal's conclusion, Chrystal and Darnell (date n.a.) again estimated the aggregate private expenditure function for the period of 1960–82 with the help of the ILS method, taking into account the simultaneity between *PX* and *PDI*, both with and without a constant term in both real and nominal terms.

The results, contained in Table 6, suggest that the NC model does

TABLE 6
CHRYSTAL AND DARNELL'S ILS ESTIMATES OF THE AGGREGATE PRIVATE EXPENDITURE MODEL 1960-82

| Regressors | Parameter estimates | | | |
|---|---|---|---|---|
| | Nominal | | Real | |
| Constant term | — | −1078.870 | — | 548.028 |
| | — | (−693.628) | — | (939.737) |
| Private sector disposable income (*PDI*) | 0.200 | 0.071 | 5.532 | −4.460 |
| | (0.118) | (0.170) | (6.256) | (−10.006) |
| Lagged private sector disposable income ($PDI_{-1}$) | 0.817 | 0.989 | −4.614 | 4.544 |
| | (0.135) | (0.204) | (6.295) | (8.675) |
| Change in hire purchase debt outstanding (*HP*) | 5.642 | 3.788 | −34.091 | 47.624 |
| | (1.830) | (2.253) | (47.858) | (87.559) |
| Stockbuilding (*ST*) | 0.356 | 0.362 | 1.186 | 0.884 |
| | (0.109) | (0.117) | (1.714) | (1.575) |
| $R^2$ | 0.999 | 0.999 | 0.0375 | 0.0309 |
| Durbin-Watson *d* | 1.532 | 1.971 | 1.889 | 1.984 |

Source: Chrystal and Darnell (n.d.).
Note: Values in parentheses represent *t* ratios.

not conform with the data in real terms regardless of whether it contains a constant term or not. Both with and without the constant terms, $R^2$s are 0.030 and 0.037 respectively. Such poor $R^2$s imply that the *PX* model does not fit the data well.

In nominal terms, however, the $R^2$s are 0.999 for the *PX* model both with and without the constant term. This suggests that the model fits the data very well. The parameter estimate of the intercept is found to be negative but highly statistically significant. But all other variables except *HP* have been found statistically insignificant when a constant term is included in the model. When the constant term is excluded in nominal terms, none of the explanatory variables are found to be statistically significant. Moreover, the sum of the parameter coefficients of the income terms exceeds unity, which is against the NC proposition.

Thus, according to the findings of Chrystal and Darnell (date n.a.), the NC hypothesis cannot be unambiguously supported either in nominal or in real terms. The evidence presented by them raises a basic question as to the validity of the revised NC aggregate private expenditure model. Therefore, the NC theory of balance of

payments cannot be taken for granted without further reexamination and verification of the aggregate private expenditure model.

## VII. Summary and Conclusion

The critical analysis of the New Cambridge aggregate private expenditure model makes the following points clear. The specification of the model and the estimation method adopted by the NC school are very much *ad hoc* in nature. The variable such as *BAP* has been included and excluded just to get good fit and not for any theoretical reason. The explanatory variable *ST* in the *PX* model is a proxy variable for bank loans to the business sector. The availability of data on *BAB* makes the use of *ST* unwarranted. More importantly, since the dependent variable *PX* is a linear combination of *ST*, therefore its use as an explanatory variable is econometrically unjustifiable.

Logarithmic transformation has been taken to the NC model on the presumption that the disturbance term does display heteroscedasticity, having no tests performed for it. Appropriate tests for heteroscedasticity are again necessary prior to the logarithmic transformation of the function.

In their model, the NC school has expressed variables, first, in real and then in nominal terms, again without any apparent reason.

The estimation method adopted by the NC school is also *ad hoc*. In the name of taking care of the simultaneity between *PX* and *PDI*, the *PDI* equation has been introduced which is wrongly specified. In this equation, first, the NC school imputed a fixed value to the coefficient of a variable; and second, they did not take any observation on the other variable.

Apart from the specification error with the *PX* function, if it is estimated as a single equation then the parameter estimates will be biased, and if they are estimated simultaneously in the NC manner then the estiamtes will be biased as well, caused by the restriction imposed on the coefficient of *PX*.

Thus it is needless to emphasize that the model needs a thorough modification before any further empirical testing. This modification can be undertaken according to the following set of principles:

1) the variable(s) which do(es) not have a sound theoretical basis should be dropped;

2) the excluded variables which have a theoretical importance

should be reinstated;

3) the endogeneity of the private sector disposable income should be properly maintained;

4) unnecessary imputation of *a priori* values to any parameter should be avoided.

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