

# **AN AUGMENTED UK PRIVATE EXPENDITURE FUNCTION**

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by

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## **Abstract**

This paper re-examines the UK private sector expenditure function invented in the 1970s by the 'New Cambridge' School of economists led by Wynne Godley. Evidence is found that helps to justify the New Cambridge focus on a private sector aggregate. More problematic is the School's basic axiom that posits a simple long-run target norm for private financial wealth in relation to income. The wealth to income ratio is instead subject to shifting trends and persistent oscillations.

One explanation is that the private sector chooses between investments in financial and non-financial assets on the basis of competing expected rates of return. These returns are not easily measured but experimentation with a proxy leads to a tentative augmented private expenditure function with interesting attributes. These include a stable steady-state ratio of financial wealth to income granted unchanging relative rates of return. Preliminary results reveal a powerful connection between UK private expenditure and house prices.

**JEL Classification:** E12, E20, E21, E22.

**Keywords:** New Cambridge, private sector expenditure function, consumption, investment, wealth.

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Further information about the Centre for Business Research can be found at the following address: [www.cbr.cam.ac.uk](http://www.cbr.cam.ac.uk).

## 1 Introduction

Long before it became a mainstay of real business cycle theory, the idea of an aggregate private sector expenditure function had come to prominence in Britain during the 1970s, promoted by the so-called New Cambridge School of Keynesian economists led by Wynne Godley. The New Cambridge function was an innovative empirical relationship with dramatic policy implications. Rapid adjustment of private spending to private income, it was claimed, meant that UK fiscal policy had the power swiftly to affect the level of output and the balance of payments.

After a brief, fiery existence marked by econometric controversy, the New Cambridge function fell prey to changes in theoretical fashion and to the disappearance of the UK historic sector national accounts dataset.<sup>1</sup> Over the last two decades, very little empirical work has been published in a similar vein; extensive searches reveal just four examples for three overseas economies (Bangladesh, France, the US) and none for the UK.<sup>2</sup> This general disinterest is a pity, for at least three reasons.

First, the New Cambridge relationship rests on an axiom of behaviour that usefully challenges the mainstream emphasis on micro-founded macroeconomic models populated by optimising households and firms with rational expectations. Underlying the New Cambridge view is the notion of a rule-of-thumb target norm between the flow of private current disposable income and the stock of private financial wealth, an approach seemingly in sympathy with Akerlof's (2007) critique of mainstream theory. Akerlof contends that the existence of social norms, omitted from the mainstream calculus, helps to explain the otherwise puzzling influence that household current disposable income and corporate cash flow exercise over consumption and investment decisions.

The second point of interest is the unusually high level of aggregation at which the New Cambridge function is struck, conflating the expenditure decisions of households and companies. This feature runs counter to the separation of consumption and investment equations found both in mainstream macroeconomic models, in which agents typically optimise, and in more recent post-New Cambridge theoretical models that are populated by rule-of-thumb agents (Godley and Lavoie (2007)<sup>3</sup>).

One justification for a high level of aggregation rests on the heroic assumption that perspicacious households, as shareholders, 'pierce the corporate veil', adjusting their decisions to offset the saving done on their behalf by corporations. Perhaps surprisingly, this proposition enjoys some empirical

support;<sup>4</sup> the most striking finding, not confined to the UK, is that ‘corporate retentions have a well-determined impact on measured consumers’ expenditure’ (Sumner (2008)). The pierced corporate veil rationale for across-sector aggregation has a limited following, however.

An alternative rationale rests on the gains from aggregation that can result in practice from grubbier considerations: the misspecification of micro-relationships and data measurement errors. That aggregation may have practical advantages is a possibility long recognised by econometricians<sup>5</sup> and has particular relevance in the UK context. Well-known problems of measuring saving and the separate incomes of households and corporations<sup>6</sup> are aggravated in the UK by the likelihood of related sectoral measurement errors that cancel out, or become less potent, at the aggregate level. Sumner (2004a) notably provides evidence in support of his theory that official statisticians in the UK inadvertently include within household final consumption expenditure some intermediate purchases by corporations of consumer goods and services. He maintains this measurement error explains the empirical connection between measured consumers’ expenditure and corporate retentions.

Contemporary concerns provide a third reason to re-examine New Cambridge. The related phenomena of financial imbalances, rising levels of indebtedness and intense booms and busts in housing and securities markets have been features of the British economy, and of some overseas, for the last two decades. Notwithstanding extensive research, the connection between these developments and private spending decisions remains empirically uncertain and the topic of considerable controversy, not least in monetary policy circles.<sup>7</sup> The New Cambridge approach has the potential to throw some light from a neglected angle.

The present paper’s contribution is wholly empirical. It develops, first, a new historical database describing UK sectors’ income, expenditure and balance sheets. Using econometric techniques that have since become standard, I test the implications of the original New Cambridge view for the time-series properties of sectoral financial balances and associated stocks of wealth. This exploration prompts a re-appraisal of the specification of an aggregate expenditure function. A tentative, estimated function is presented and evaluated. The broad conclusion drawn is that a UK private sector expenditure function might be alive and well but, if so, its existence probably depends on a target wealth norm that differs materially from that entertained by the New Cambridge School. As a result, a more disaggregated approach may be required in future research.

## 2 Historical dataset

This study would not be possible without a long-run dataset of sectoral income and expenditure flows and related wealth stocks. Alas, the UK national accounts historic sector record is subject to large gaps and discontinuities, notably before 1987 – the year chosen by the UK Office for National Statistics (ONS) from which to begin comprehensive sector estimates consistent with the European System of Accounts of 1995 (ESA95).<sup>8</sup> Balance sheet information is also patchy.<sup>9</sup> Much of the data used in this study have therefore been specially reconstructed.

Data sources and methods are described in an appendix and in Martin (2007b). It suffices to stress that the resulting estimates for income and expenditure flows and associated balance sheets are more reliable at higher levels of sector aggregation: the private, government and Rest of the World sectors. By contrast, historic data for households and companies are much less reliable. Moreover, measurement errors in the former will feed across to the latter, though with opposite sign, as a result of unavoidably crude estimation methods used for data before 1987.

The definitions used here are largely conventional. The private sector comprises households – including non-profit institutions serving households – and private corporations, both non-financial and financial. The public corporations sector is added to form a ‘market’ sector, for which the counterpart state sector is the general government sector, comprising local and central government. Although the terms ‘market’ and ‘private’ are used interchangeably where the argument is unaffected, the ‘market’ sector definition is preferred empirically since it circumvents most, though not all,<sup>10</sup> of the data distortions that arise from Britain’s history of nationalisation and privatisation. A Rest of the World sector records transactions between UK residents and non-residents.

Private disposable income ( $Y^d$ ) can be broadly construed as the sum of household disposable income and corporations’ retained profits. Disposable income comprises factor incomes, like wages and profits, and transfer payments and receipts, such as property income, direct taxes, social benefits and current and capital transfers.<sup>11</sup> Private sector total expenditure ( $E$ ) comprises final consumption, capital expenditure (fixed capital investment and the change in inventories) and ‘land’ transfers.<sup>12</sup>

The corresponding financial surplus (or financial balance,  $F$ ), also known confusingly in official parlance as ‘net lending’, is identically equal to disposable income less total expenditure:

$$F \equiv Y^d - E \quad (1)$$

With the state (or government) and Rest of the World sectors designated respectively by subscripts 's', and 'w' (but, for descriptive ease, leaving the private or market sector symbol unadorned), conventional national income accounting gives the across-sector adding-up identity:

$$F + F_s + F_w + \Gamma \equiv 0 \quad (2)$$

where  $\Gamma$  denotes the national accounts residual error, the excess of the expenditure measure over the income measure of the gross domestic product (GDP). Adjusted measures of the market sector financial surplus and disposable income are also defined to include the residual error. In this case, the three counterpart financial surpluses sum directly to zero.

### 3 Long-run tendencies under New Cambridge

Tests of New Cambridge can usefully begin with an examination of its long-run predictions. The basic hypothesis holds that, over the long run, private expenditure decisions are taken in order to keep steady the ratio of private financial wealth to disposable income. This axiom has the important implication that the ratio to income of the private financial surplus tends to a constant. From identity (2) it can be inferred that the sum of the same ratios of the financial surpluses of government and the Rest of the World should tend to the same constant, irrespective of the behaviour of the individual balances. The basic theory is similarly silent on the behaviour of the financial balances of households and companies.

These predictions are not unique to New Cambridge. Other theories could be envisaged which would lead to the same steady state: consider, for example, a closed economy in which the government sets its spending to deliver a fixed ratio to GDP of the national debt, a ratio which the private sector accepts passively. Observational equivalence means that tests of long-run tendencies have the power to reject the basic New Cambridge view but cannot establish its dominance over other theories.

Exposition of the New Cambridge steady state is straightforward. In its simplest form, the postulated target for the stock of end-period financial wealth ( $V$ ) may be written:

$$V^* = \varpi Y^d \quad (3)$$

The superscript asterisk denotes the target level.  $\varpi$  is the target ratio of financial wealth to disposable income. The equation describes a long-run aim from which it is acknowledge there might be temporary deviations.<sup>13</sup>

For ease of presentation, variables are defined in constant price terms, equal to the corresponding nominal values, denoted where necessary by a diacritical tilde, divided by the private expenditure price deflator ( $P$ ); for example,  $Y^d \equiv \frac{\tilde{Y}^d}{P}$ . It is helpful to begin with an assumption of price stability in markets for goods and assets in order to equate the financial surplus with the one-period change in financial wealth in constant prices:

$$F = \frac{\tilde{V} - \tilde{V}_{-1}}{P} = \frac{\tilde{V}}{P} - \frac{\tilde{V}_{-1}}{P_{-1}} = \Delta V \quad (4)$$

The numerical subscript indicates the time period and  $\Delta$  denotes the one-period change. By assumption:  $P = P_{-1}$ .

Under these conditions and in a steady growth state it is assumed that<sup>14</sup>:

$$\text{Lim}(F) = \Delta V^* \quad (5)$$

The combination of equations (3) and (5) and identity (1) yields a long-run relationship between total expenditure and disposable income:<sup>15</sup>

$$\text{Lim}(E) = \left(1 - \frac{g}{1+g} \varpi\right) Y^d \quad (6)$$

where 'g' is the steady state constant rate of income growth. The corresponding ratio to disposable income of the financial surplus is given by:

$$\text{Lim}\left(\frac{F}{Y^d}\right) = \frac{g}{1+g} \varpi \quad (7)$$

Equation (7) shows that the long-run ratio to income of the private financial surplus is a constant approximately equal to the product of the target wealth ratio and the steady state rate of growth.

The same points can be stated in the language of cointegration. Under the New Cambridge null, the three variables – the stock of private financial wealth, private disposable income and private expenditure – follow long-run trends that are separated only by constant proportionate differences. The variables

therefore cointegrate.<sup>16</sup> The ratios to disposable income of the private sector financial surplus and financial wealth should be stationary variables, reverting to their respective means.

It is worth emphasising that stationarity of the financial surplus ratio does not guarantee stationarity of the financial wealth ratio. For the financial wealth ratio to be stationary, it is necessary that the financial surplus ratio revert to the mean described by equation (7). More generally, a stationary financial surplus ratio may accompany a financial wealth ratio that is rising or falling depending on the pace of income growth and the outstanding level of the wealth ratio. For it is identically true that:

$$\Delta\left(\frac{V}{Y^d}\right) \equiv \frac{F}{Y^d} - \left(\frac{g}{1+g}\right)\frac{V_{-1}}{Y_{-1}^d} \quad (8)$$

In the long run, the wealth ratio stabilises ( $\Delta\left(\frac{V}{Y^d}\right) \rightarrow 0$ ) only if:

$$\frac{F}{Y^d} \rightarrow \left(\frac{g}{1+g}\right)\frac{V^*}{Y^d} \quad (9)$$

These propositions have been derived assuming constant prices. The introduction of goods price inflation complicates the story but leaves unchanged the essential message. With the price level changing, equation (4) does not hold: the financial surplus in constant prices is not equal the change in financial wealth in constant prices. Instead:

$$F = V - \left(\frac{P_{-1}}{P}\right)V_{-1} = \Delta V + \frac{\pi}{1+\pi}V_{-1} \quad (10)$$

where  $\pi$  denotes the rate of inflation defined by:  $\pi \equiv \frac{\Delta P}{P_{-1}}$ .

The basic New Cambridge propositions go through, however, if disposable income and the financial surplus are adjusted by deducting an ‘inflation tax’ approximately equal to the product of goods price inflation and the stock of financial wealth.<sup>17</sup> Specifically:

$$Y^a \equiv Y^d - \left(\frac{\pi}{1+\pi}\right)V_{-1} \quad (11)$$

$$F^a \equiv F - \left( \frac{\pi}{1 + \pi} \right) V_{-1} \quad (12)$$

where the superscript ‘a’ denotes an inflation-tax adjusted measure. Steady states equivalent to those given in equations (6) and (7) follow once the financial wealth target is re-expressed in terms of  $Y^a$ .

Additional allowances could be made for capital gains and losses on financial wealth, although these adjustments would involve a further departure from standard national income accounting concepts of disposable income. Growing capital gains or losses would insert a wedge between the conventional or inflation tax-adjusted measures of the financial surplus, on the one hand, and the change in financial wealth on the other. As a result, long-term trends in either measure of income and in expenditure could diverge, even under the New Cambridge null.

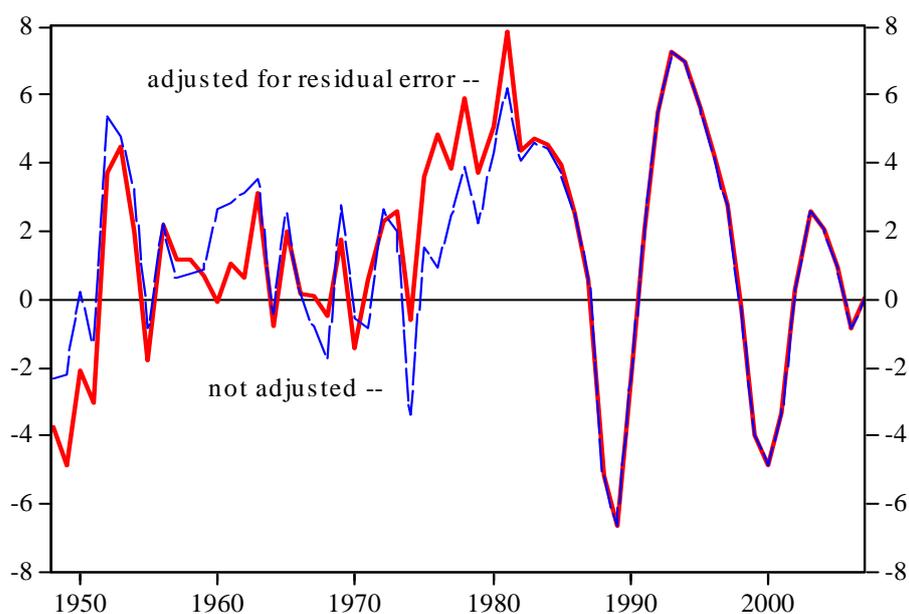
#### 4 Testing long-run tendencies

Standard unit root tests can be employed to test these long-run propositions, but with the caveat that the tests too often indicate non-stationarity. This well-known problem of low ‘power’ is somewhat mitigated by the length of my reconstructed annual dataset which runs from 1948 to 2007. Shiller and Perron (1985) argue forcibly that the power of unit root tests depends more on the span of the data than on the frequency of the observations. Haug (2002), however, stresses the importance of using the highest frequency of data over a long time span. Hence the unit root tests performed here are repeated, where possible, using quarterly data, although these are less reliable than the annual figures and begin in 1955. Conventional tests are also used to examine the possibility of breaks in series mean and variance. Flow relationships, represented by financial balances, are examined before turning to the financial wealth target, the key stock-flow relationship.

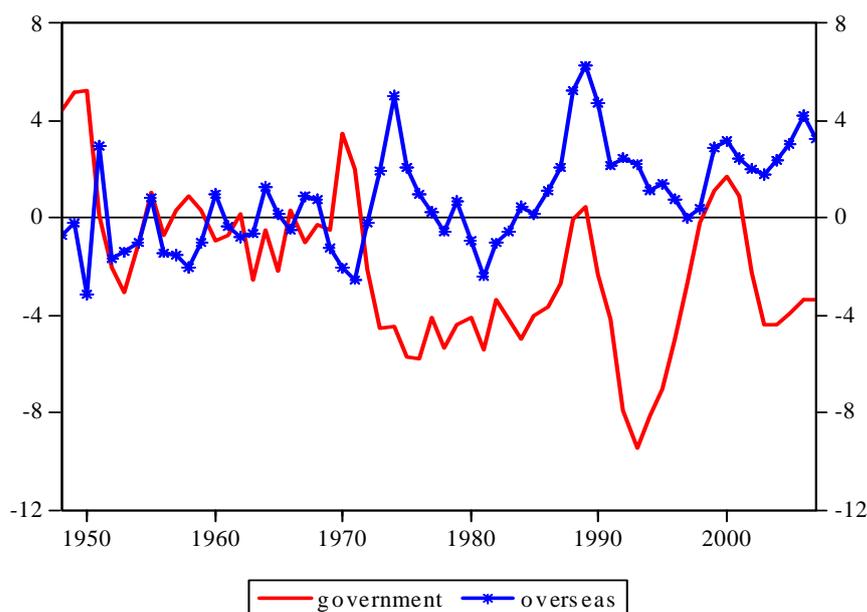
##### *Financial balances*

Visual inspection of the behaviour of Britain’s financial balances over the last 60 years provides some support for the original New Cambridge view. Chart 1 shows the market sector financial surplus with and without the addition of the national accounts residual error, each series being expressed in relation to market sector disposable income (MDI).<sup>18</sup> The chart suggests mean reversion, albeit of series whose oscillations increase in size after the mid-1970s. Within these larger oscillations, fluctuations in year-to-year changes diminish from the mid-1980s onwards, an artefact possibly resulting from the adoption by the ONS of new techniques to balance the national accounts (Officer (2008)).

**Chart 1: Market sector financial surplus, % of MDI**

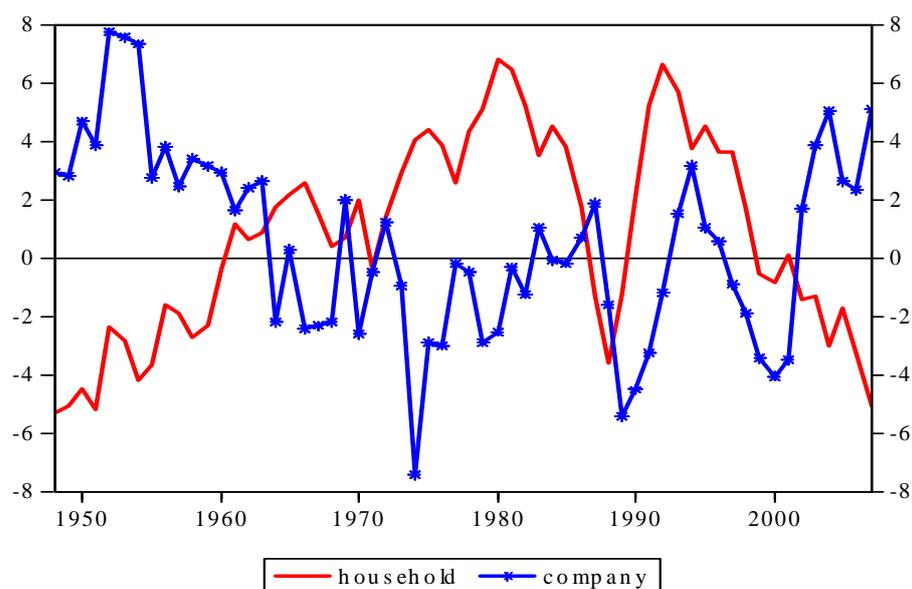


**Chart 2: Government & overseas financial surplus, % of MDI**



Similar characteristics are seen in the case of the government's financial balance shown in Chart 2, but there is a hint of a mild upward trend in the Rest of the World financial surplus. Shifting trends are more easily discerned in the behaviour of the household sector financial surplus in Chart 3, an uptrend in the 1950s and 1960s giving way to an apparent downtrend beginning in the early-1990s. These putative trends find their mirror image in the behaviour of the company sector financial surplus.

**Chart 3: Household and company financial surplus, % of MDI**



Although formal unit root tests do not always speak as one, a not uncommon finding, those in Table 1 using annual data broadly match the visual evidence. They do not reject the hypothesis that the market sector financial balance mean reverts. The same is true for the government and Rest of the World sectors and possibly for two of the three sub-sectors that comprise the company sector (although data quality concerns seriously qualify any conclusion at that level of disaggregation). Two out of three tests indicate non-stationarity in the case of households while the total company sector narrowly escapes a similar verdict.

Results shown in Table 2 using quarterly data paint a slightly different picture. The null of non-stationarity is not rejected on one test in the case of the government sector. On the other hand, the financial surplus ratios of both the corporate and household sectors appear to mean revert, although the conclusion for households is borderline. Whether these contrasting results are informative or the product of measurement error is a question left for future study.<sup>19</sup> Of immediate importance is the unequivocal nature of the findings for the market sector; irrespective of the frequency of the data, its financial surplus appears to be stationary.

**Table 1: Univariate stationarity tests – annual data**

Financial surplus, % of market disposable income	----- Unit root test -----		
	ADF	PP	KPSS
Market sector	-3.50	-3.66	0.07
Market sector adjusted	-3.31	-3.47	0.09
General government	-4.31	-3.64	0.36
Rest of the World	-3.05	-3.64	<b>0.67*</b>
Market sector components:			
Household sector	<b>-2.23*</b>	<b>-1.95*</b>	0.25
Company sector	-2.94	<b>-2.84*</b>	0.32
of which:			
Private non-financial	-3.00	-2.94	0.38
Financial	<b>-2.50*</b>	<b>-2.60*</b>	0.46
Public corporations	-3.86	-3.86	<b>0.60*</b>

Source: author's calculations. Unit root tests estimated with a constant and no trend: ADF – Augmented Dickey-Fuller; PP – Phillips Perron; KPSS – Kwiatkowski, Phillips, Schmidt and Shin. Lag length and residual spectrum at zero frequency determined using the default settings in the software program Eviews 6 by Quantitative Micro Software, LLC. Estimated over a period (1951 to 2007) that ensures an equal number of observations per test (57 observations). Critical values for ADF and PP (null of non-stationarity): -2.91; for KPSS (null of stationarity): 0.46, both at the 5% level of significance. \* indicates non-rejection of the ADF or PP null or rejection of the KPSS null.

**Table 2: Univariate stationarity tests – quarterly data**

Financial surplus, % of market disposable income	----- Unit root test -----		
	ADF	PP	KPSS
Market sector	-3.89	-6.31	0.07
Market sector adjusted	-3.68	-5.45	0.12
General government	<b>-2.70*</b>	-5.27	0.42
Rest of the World	-3.25	-4.09	<b>0.85*</b>
Market sector components:			
Household sector	<b>-2.09*</b>	-2.94	0.28
Company sector	-4.14	-6.71	0.22

Source: author's calculations. See table 1 for details. Estimated over a period (1955Q4 to 2007Q4) that ensures an equal number of observations per test (209 observations). Critical values for ADF and PP: -2.88; for KPSS: 0.46, both at the 5% level of significance. \* indicates non-rejection of the ADF or PP null or rejection of the KPSS null.

Less formal than unit root tests, but perhaps as revealing, are the descriptive statistics and related tests in Tables 3 and 4, which show sometimes marked changes in the average level and volatility of sectors' financial surpluses across three periods of roughly equal length: 1948-1969, 1970-1989 and 1990-2007. The dates broadly demarcate the period of the UK's 'Golden Age' in the 1950s and 1960s, the period of rising and falling inflation in the 1970s and 1980s, and the steady growth, low inflation years of stability that emerged after the early-1990s.

**Table 3: Financial surplus period means and standard deviations**

% of market dis. inc. no. of observations	1948-1969	1970-1989	1990-2007	1948-2007
Market sector				
annual average	1.2	1.5	1.4	1.3
standard deviation	2.2	3.4	3.7	3.1
Market sector adj.				
annual average	0.3	2.3	1.4	1.3
standard deviation	2.4	3.6	3.7	3.3
General government				
annual average	0.1	-3.1	-3.6	-2.1
standard deviation	2.2	2.6	3.2	3.1
Rest of the World				
annual average	-0.4	0.8	2.2	0.8
standard deviation	1.3	2.4	1.2	2.1
Market sub-sectors:				
Household sector				
annual average	-1.4	2.8	1.1	0.8
standard deviation	2.6	2.7	3.5	3.4
Company sector				
annual average	2.5	-1.4	0.2	0.5
standard deviation	3.0	2.3	3.2	3.2

Source: ONS, author's calculations. The table shows averages and sample standard deviations of annual observations. The adjusted market sector financial surplus includes the national accounts residual error. The financial surpluses of the adjusted market sector, general government and the Rest of the World sum to zero, subject to rounding error.

Average financial surplus ratios shifted significantly between the Golden Age and each of the last two periods in all sectors, *except* the market sector (measured before addition of the national accounts residual error).<sup>20</sup> *Period averages for the market sector financial surplus ratio remain insignificantly different from the 60-year average: 1.3% of market sector disposable income (equivalent to 1.1% of GDP).*

**Table 4: Financial surpluses - mean and variance equality tests\*\***

Period mean and variance equality test probability	----- Periods compared -----		
	1948-1969 v 1970-1989	1970-1989 v 1990-2007	1948-1969 v 1990-2007
Market sector			
mean	0.74	0.92	0.86
variance	0.08	0.73	0.05*
Market sector adj.			
mean	0.04*	0.40	0.31
variance	0.07	0.96	0.07
General Government			
mean	0.00*	0.64	0.00*
variance	0.49	0.41	0.13
Rest of World			
mean	0.05*	0.03*	0.00*
variance	0.01*	0.01*	0.70
Market sub-sectors:			
Household sector			
mean	0.00*	0.10	0.02*
variance	0.85	0.33	0.24
Company sector			
mean	0.00*	0.09	0.03*
variance	0.24	0.17	0.78

Source: see Table 3. \*\* Welch-Satterthwaite mean-equality t-test (allows for unequal variances) and variance-equality F-test. \* rejects null hypothesis of equality across periods at 5% level of significance.

Equally striking is the contrasting pattern of volatility. Whereas there is no evidence of a shift in the case of households and companies, *the variance of the market sector financial surplus ratio increases after 1970, and remains high even during the post-1990 period of general stability.*<sup>21</sup> The volatility history of counterpart sectors is less remarkable: an increase, though not of statistical significance, in the case of the government sector and a rise and fall in the case of the Rest of the World.

The contrast in the volatility behaviour of the market sector and its sector components reflects a shift in the correlation between the financial balances of households and companies. Normally offsetting, these financial balances moved together between the mid-1980s and late-1990s, amplifying the volatility of the aggregate market sector balance. The offsetting behaviour of household and

company financial balances reappears thereafter, though not to the extent seen in earlier years.

The conclusion is that the ratio to disposable income of the market sector financial surplus exhibits a behaviour over the last 60 years that is not demonstrably shared by other sector balances: broad constancy of mean combined with increased volatility. These properties, taken with the formal evidence of stationarity, are not inconsistent with New Cambridge, and help justify its focus on the private sector aggregate.

The increase in volatility of the private financial surplus requires further explanation, however. One plausible answer is inflation, which is known to have affected the changing volatility of GDP. Mention may therefore be made, but briefly since little light is shed, of results obtained after adjusting the financial surplus ratio for the ‘inflation tax’. As before, the hypothesis of stationarity is not rejected but the post-1990 level of the market sector inflation-tax adjusted financial surplus ratio appears to be significantly above previous period averages and there is no upbreak in variance. The behaviour of the financial wealth stock is more informative.

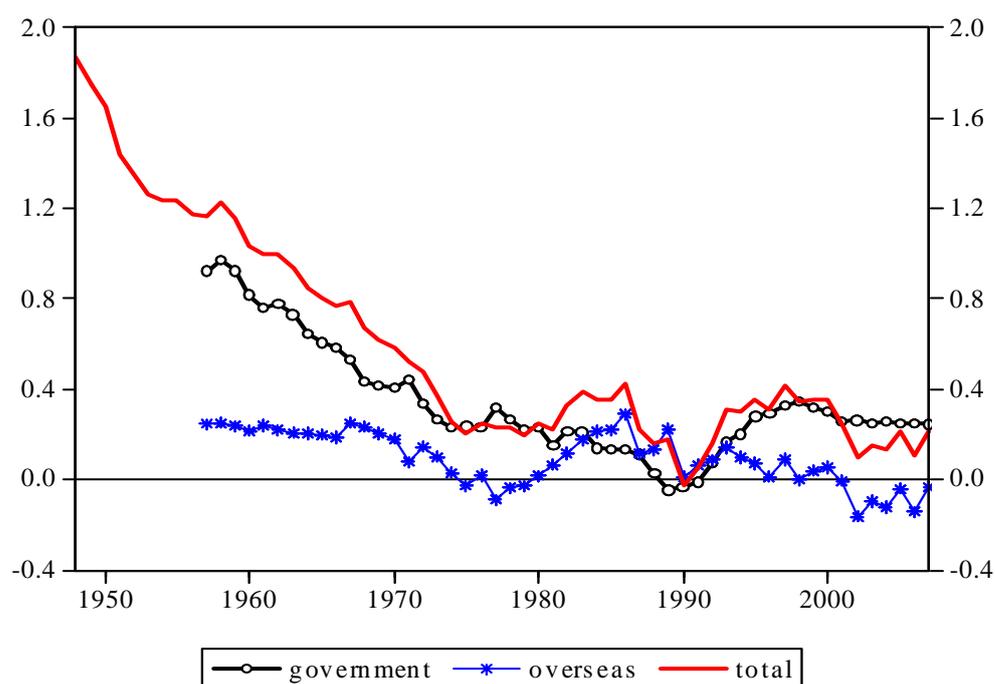
#### *Financial wealth to income ratio*

On tentative estimates, the financial wealth of the market sector at the end of 1948 was nearly double annual disposable income. Ignoring capital gains and losses, the market sector would have had to run a financial surplus worth about 12% of income to achieve the same wealth ratio in 2007. But the financial surplus ratio averaged only 1.3%.

The financial wealth ratio duly fell, precipitously until the mid-1970s, less sharply thereafter but with large oscillations, as Chart 4 shows. By the end of 2007, market sector financial wealth was a fifth of disposable income. This behaviour appears to be wholly inconsistent with the New Cambridge concept of a constant long-run wealth target, even one subject to occasional deviations.

A natural, and not unreasonable, response would be to question the verity of the facts, which could be seriously afflicted by measurement error in a number of ways. The historic data are taken from different sources and spliced together. Before 1957, financial wealth stocks are derived less than ideally from accumulated financial surpluses, albeit with an allowance back to 1952 for capital gains and losses on government debt. Furthermore, crude but necessary adjustments have been made to put the official (book value) record of the UK’s net assets from foreign direct investment (FDI) onto the same basis of market valuation used for other financial assets and liabilities.

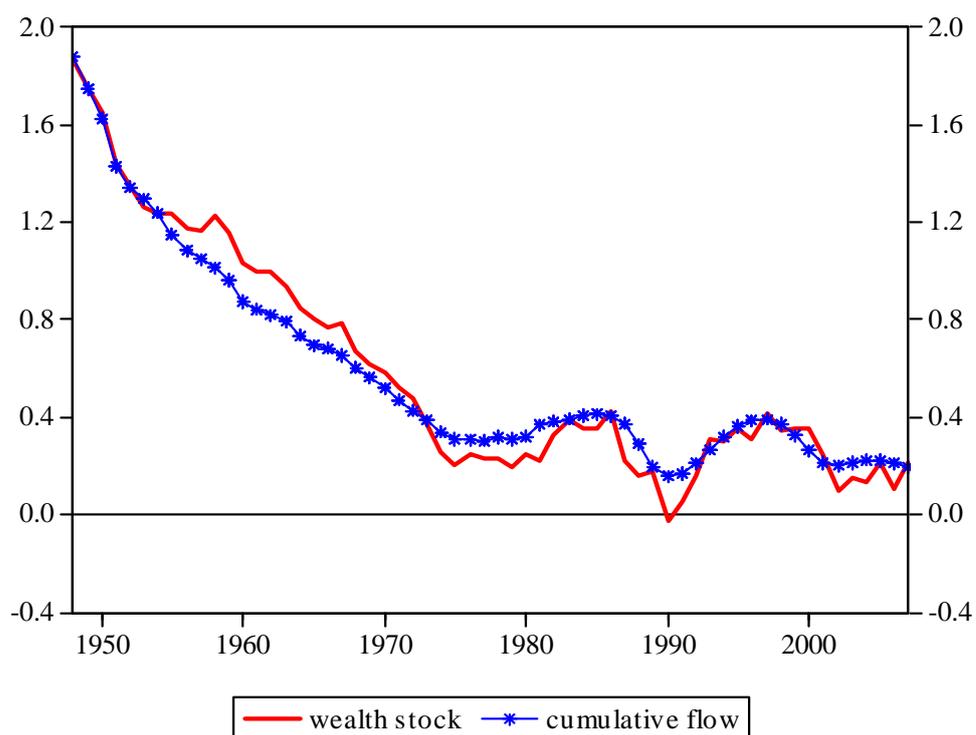
**Chart 4: Market sector financial wealth, ratio to disposable income**



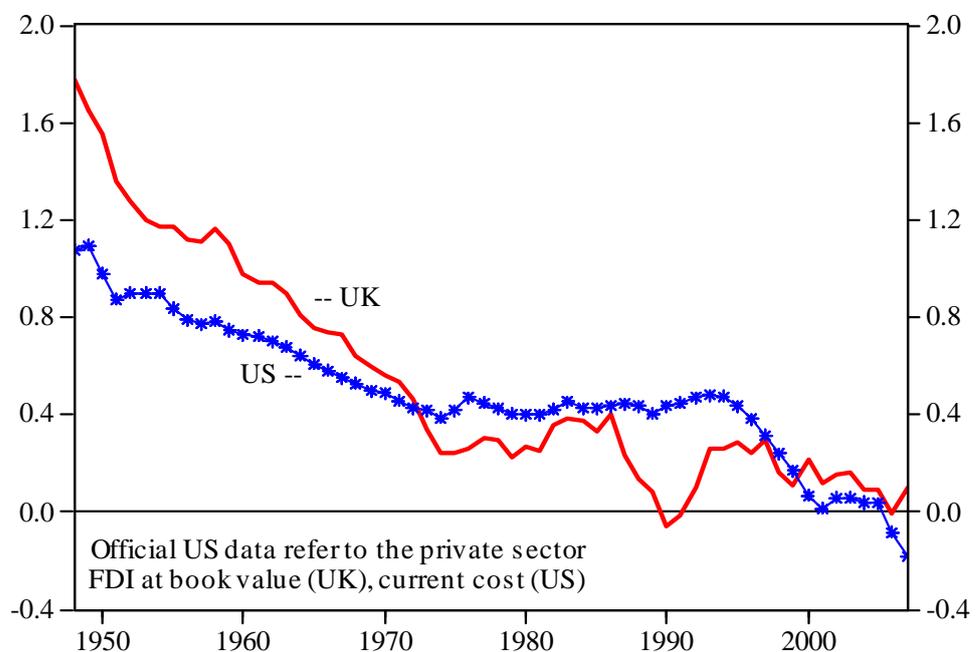
The main counter to these concerns is the magnitude of the change in the financial wealth ratio recorded in Chart 4; it seems improbable that data errors alone could obscure these major trends. Moreover they are replicated in Charts 5 and 6 using different measures. Chart 5 shows that a market sector wealth ratio calculated from accumulated financial surpluses (and therefore without allowance for poorly measured capital gains or losses) follows the same general pattern traced by the wealth ratio derived using balance sheet figures. Chart 6 shows the UK balance sheet measure with FDI valued at book value. The chart also shows that the UK experience is not unique. The private wealth ratio fell sharply in the US until the early-1970s, and again after the mid-1990s, a pattern also seen in US data corrected for FDI misvaluation.<sup>22</sup>

Further reassurance about the verity of the UK evidence comes from the timing and composition of the break in the post-war downtrend in the wealth ratio. Statistical tests corroborate the visual evidence that the trend break occurs in the mid-1970s,<sup>23</sup> largely the result, as Chart 4 and Table 5 show, of the behaviour of market sector holdings of government net debt. This timing fits with the analysis of Homer and Sylla (1996, p451) who note: ‘In 1946 began the long retreat of the English bond market, which lasted, with occasional cyclical interruptions, until 1974.’

**Chart 5: Financial wealth v accumulated flows, ratio to MDI**



**Chart 6: Financial wealth ratio UK v US**



**Table 5: Market sector financial wealth, ratio to disposable income**

End-year wealth, ratio to annual MDI	1948	1957	1974	2007
Total	1.87	1.17	0.26	0.21
of which counterpart net liabilities of:				
Government	n.a.	0.92	0.23	0.24
Rest of World	n.a.	0.24	0.03	-0.03
of which:				
foreign direct investment	n.a.	0.20	0.09	0.36
other	n.a.	0.04	-0.06	-0.40

Source: author's calculations, including FDI misvaluation adjustment (see appendix). n.a. – not available. Totals subject to rounding error.

To complete the evidence, Tables 6 reports formal tests for the stationarity of the financial wealth ratio.<sup>24</sup> The full sample test using annual data allows for a structural break in the mid-1970s, a procedure due to Perron (1989, 1993). Perron's test is known to suffer from a 'size' defect, too frequently rejecting the null hypothesis of non-stationarity when, as in this case, the dating of the structural break has little independent justification (Christiano (1992)). Even so, the null of a unit root in the financial wealth ratio is not rejected.

In the second set of tests, the full sample period is split before and after the mid-1970s break. There is evidence, using quarterly data of dubious reliability, that the financial wealth ratio is stationary around a declining trend until the mid-1970s. This conclusion is not borne out by the tests on annual data, however. Suitably adjusted for the subsequent (and unexplained) disappearance of this trend, the majority of the tests for the period beginning in the mid-1970s do not reject the hypothesis that the financial wealth ratio does not mean revert. The same tests applied to two alternative measures of financial wealth – one using balance sheet data uncorrected for FDI misvaluation, the other calculated from accumulated financial surplus flows – give similar verdicts.<sup>25</sup>

**Table 6: Financial wealth ratio stationarity tests**

Market sector financial wealth, End-year ratio to annual MDI	----- Unit root test -----		
	ADF	PP	KPSS
Annual data			
Full sample: 1949 – 2007**	-3.57*	n.a.	n.a.
Split sample:			
1951 – 1974	-2.97*	-3.16*	0.18*
1975 - 2007	-2.49*	-2.61*	0.08
Quarterly data			
1956Q2 – 1974Q4	-0.78*	-5.50	0.13
1975Q1 – 2007Q4	-2.20*	-2.71*	0.09

Source: author's calculations. See table 1 for details. \*\* Perron's ADF-equivalent test run on the residuals from a regression with a (significant) time trend split after 1974. Lag length to produce white noise disturbances based on the modified Akaike information criterion recommended by Ng and Perron (2001). Split sample periods chosen to ensure an equal number of observations for each test: constant and linear trend in first period; constant in second period. Critical values: for Perron: -3.92; for ADF and PP: -3.61 (1951 – 1974), -2.95 (1975 – 2007), -3.47 (1956Q2 - 1974Q4), -2.88 (1975Q1 – 2007Q4); KPSS: 0.15 (1951 – 1974, 1956Q2 – 1974Q4), 0.46 (1975 – 2007, 1975Q1 – 2007Q4), all at the 5% level of significance. \* indicates non-rejection of the Perron, ADF or PP null or rejection of the KPSS null. n.a. – not applicable.

## 5 The New Cambridge wealth target reconsidered

The unexplained shifting trends and non-stationarity of Britain's private wealth to income ratio pose a major challenge to the New Cambridge view, one that is surprisingly not addressed in any previous research. The evidence rejects the basic specification of the private wealth target, even with its provisos.<sup>26</sup> Without this axiom, the history of the wealth ratio invites a prosaic interpretation framed largely in terms of changing government behaviour, notably the emergence of much larger budget deficits in the 1970s and 1980s. A rethink is required.

At least two issues warrant investigation. The first concerns the role played by disposable income in the New Cambridge wealth target. Although a wealth-income norm is consistent with several theories of consumers' behaviour, it is not clear that the same motivations can be attributed to the private sector as a whole.<sup>27</sup> Why should the private sector seek to hold its financial wealth stable in relation to income?

An important reason for doubt arises from the nature of private financial wealth itself. The private sector aggregate is formed by consolidating the accounts of households and companies, including the banking system, with all intra-private sector transactions netted off. Consolidation means that 'inside' financial

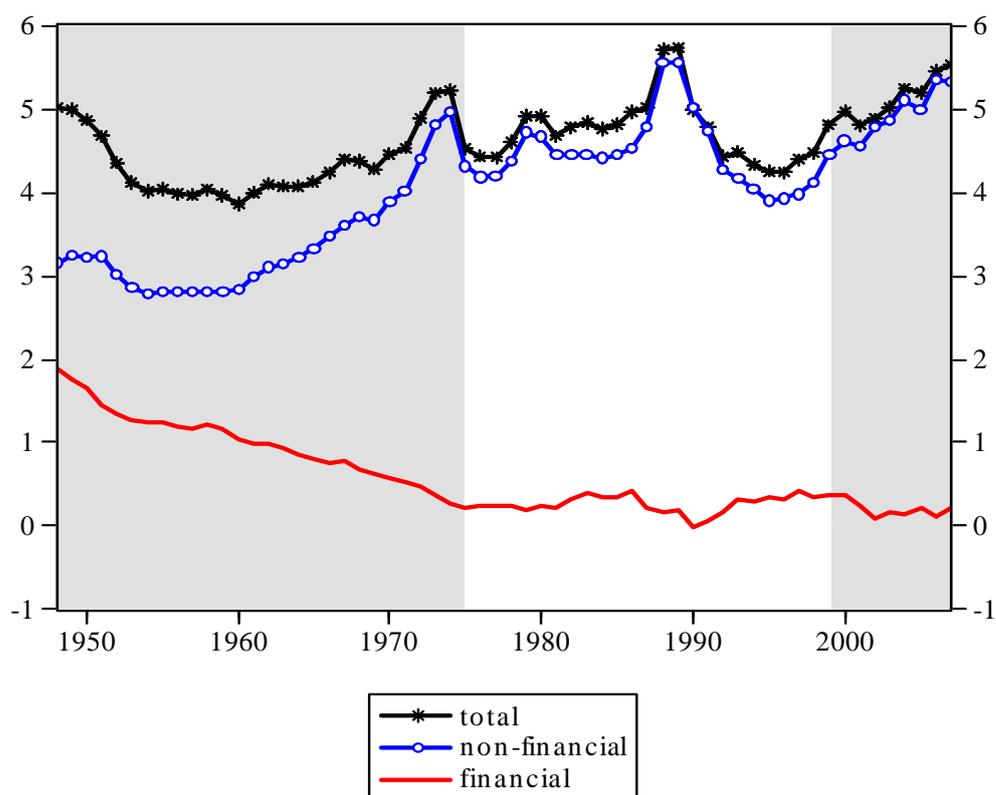
instruments, such as money deposits and equity securities, which are an asset of one sub-sector but the liability of another, cancel out at the aggregate level.<sup>28</sup> Private sector financial wealth comprises only those net financial assets that are counterparts of the net liabilities of the government and the Rest of the World.

It is not clear how private holdings of government net debt and of overseas securities, deposits, loans and stocks of FDI should be related to UK private disposable income. Empirical demand functions for securities like government bonds are typically specified as portfolio decisions that are not driven by income unless the latter proxies for wealth (Spencer (1981)). The driving forces behind FDI are multifarious - tariff hopping, trade friction avoidance, cost-minimising vertical integration and so on (Blonigen (2005)). None suggests a link with domestic income alone.

The second issue deserving further investigation is the role played by competing rates of return on non-financial capital. Matthews and Minford (1980) usefully develop a theoretical model in which private sector agents divide total wealth between non-financial and financial capital depending on the discounted value of future income or utility streams from each asset type. In the authors' world, firms are construed as 'financial holding companies with a multinational and multiasset perspective' while households obey 'similar principles of asset disposition.' Alas, empirical implementation has foundered on the severe problems of measuring properly total wealth and expected rival rates of return. In perhaps the most successful of the econometric studies of the New Cambridge function, Bennett (1986, 1987) is forced to assume that the return on non-financial capital is an unobserved constant.

Nevertheless, there appears to be merit in treating private non-financial and financial wealth as substitutes. Chart 7 and Table 7 show the ratio to the disposable income of the market sector of its total wealth split between the two asset types. Non-financial capital comprises residential dwellings ('housing'), and other non-housing capital such as business equipment, structures and inventories. The data appendix describes the problems of estimating the value of these assets at market prices.

**Chart 7: Market sector wealth, ratio to disposable income**



**Table 7: Market sector wealth, ratio to disposable income**

End-year wealth, ratio to annual MDI	1948	1957	1974	2007
Total	5.03	3.97	5.23	5.54
of which:				
Financial	1.87	1.17	0.26	0.21
Non-financial	3.15	2.81	4.97	5.33
of which:				
housing	1.21	1.01	1.97	3.82
other	1.94	1.80	3.00	1.51

Source: see Table 5 notes. Totals subject to rounding error.

**Table 8: Total and non-financial wealth ratios stationarity tests**

Market sector wealth, End-year ratio to annual MDI	----- Unit root test -----		
	ADF	PP	KPSS
Detrended:			
Total wealth	-3.08*	-2.58*	0.11
Non-financial wealth	-2.64*	-2.05*	0.16*
Demeaned:			
Total wealth	-2.01*	-1.61*	0.59*
Non-financial wealth	-1.72*	-1.42*	0.71*

Source: see table 1 for details. Tests run with a constant and linear trend ('detrended') and with a constant alone ('demeaned'). Sample period 1955 to 2007 excludes data likely to be materially affected by post-war controls and measurement error. Critical values: for ADF and PP -3.50 (detrended), -2.92 (demeaned); for KPSS: 0.15 (detrended), 0.46 (demeaned), all at the 5% level of significance. \* indicates non-rejection of the ADF or PP null or rejection of the KPSS null.

The chart shows two broad tendencies. First, the ratios to disposable income of total and non-financial wealth, like the financial wealth ratio, are non-stationary, whether or not allowance is made for a linear time trend (Table 8). Second, and more important, there appears to be an inverse relationship between the financial and non-financial wealth ratios that suggests substitution. Several phases can be roughly distinguished.

In the first phase that lasts until the mid-1970s, the downtrend seen in the financial wealth ratio coincides with an uptrend in the non-financial wealth ratio, the latter beginning in the mid-1950s as the impact of wartime disruption and early peacetime controls abated.<sup>29</sup> These inverse trends are associated with the Golden Age investment boom, itself propelled by several forces - a large backlog of investment opportunities, technical progress including US catch-up, widening international markets and a low cost of capital. These were circumstances also conducive to a run-down of companies' excess liquid financial assets (Matthews (1968), Matthews, Feinstein and Odling-Smee (1982)).

In the second phase from the mid-1970s to the late-1990s, there is little discernible trend in either the financial or non-financial wealth ratios. The latter is much more variable, however, largely as a result of oscillations in housing wealth, which continued to rise in relation to disposable income while the ratio for other non-financial capital trended lower. These oscillations are associated with the increased variability of the market sector financial surplus ratio seen in Chart 1, a timing that fits with the gradual liberalisation of Britain's home mortgage market. The financial wealth ratio displays weaker, mirror image, oscillations.

In a third phase since the late-1990s, a sharp upward movement in the non-financial wealth ratio, wholly attributable to housing, is associated with a downward drift in the financial wealth ratio.

Were markets in capital goods perfect, with prices appropriately discounting future income and utility streams, the non-financial wealth ratio would help reveal the changing incentives to invest in non-financial as opposed to financial assets. With imperfect capital markets and imperfect data, the ability of the non-financial wealth ratio to act as a suitable proxy is much impaired. More formal tests for cointegration are nevertheless suggestive.

**Table 9: Cointegration summary results - Johansen method**

Dependent variable $V$ Equation specifications	Cointegrating vector $Y^{aa}, Y^a$ $100(k'', k)$		Error Correction $\bar{R}^2$
1 Balance sheet data			
coeff	-0.04	-938.7	0.11
t-statistic	-0.9	-7.8	
2 Cumulative flows data			
coeff.	0.07	-641.0	0.66
t-statistic	2.7	-9.6	
3 $Y^a, k$ weakly exogenous			
coeff.	0.10	-664.8	0.70
t-statistic	4.61	-11.4	

Source: author's calculations using a second order VAR selected on the basis of the Schwarz Bayesian and Akaike information criteria, with a constant but no trend in the cointegrating vector and no constant in the VAR. The number of non-collinear cointegrating vectors is set at 1 based on the maximum eigenvalue and trace statistics. Sample period: 1955 to 2007. Pre-tests indicate that all variables are  $I(1)$  (see appendix).

The salient results of an intensive investigation using the Johansen procedure with different measures of financial wealth, disposable income and non-financial wealth are summarised in Table 9. The dependent variable is the end-year stock of market sector financial wealth in constant prices ( $V$ ) calculated either from balance sheet data or from the accumulated flow of financial surpluses. The other two variables in the potentially cointegrating relationship are market sector disposable income in constant prices and the ratio to income of non-financial wealth.

Income is defined consistently with the measure of financial wealth. In the case of the balance sheet measure, constant price disposable income, denoted  $Y^{aa}$ , is adjusted for the inflation tax and includes capital gains, calculated from the change in the difference between the balance sheet and cumulative flows measures of financial wealth. For specifications (2) and (3) using the

cumulative flows measure, constant price disposable income,  $Y^a$ , is calculated after adjustment for the inflation tax alone. The ratios to income of non-financial wealth are defined symmetrically:  $k^n \equiv \frac{K}{Y^{aa}}$  and  $k \equiv \frac{K}{Y^a}$ , where  $K$  is non-financial wealth in constant prices.

These definitions ensure that the specifications reported in Table 9 are stock-flow consistent: the change in financial wealth is identically equal to the difference between disposable income, suitably defined, and expenditure. The table does not report the results of experiments using components of the non-financial wealth ratio or stock market proxies, which added nothing of interest. To avoid inclusion of observations materially affected by post-war controls and measurement error, the estimation period runs annually from 1955 to 2007.

Results from the Johansen procedure come with familiar caveats. Precise results are sensitive to the order of the vector autoregression (VAR) and choice of deterministic components, although the broad message of Table 9 is robust to different selections. More important, finite-sample bias in a systems approach could result were the implicit equations for income or non-financial wealth misspecified.<sup>30</sup> Accordingly, the Johansen procedure is used here to guide the choice of cointegrating vector that can be included with less risk of spuriousness in a single equation error correction model (ECM) of private expenditure.

The key features of the results in Table 9 are straightforward.

First, disposable income forms part of the cointegrating vector when financial wealth and income exclude capital gains, but is insignificant and incorrectly signed when capital gains are included. The coefficients on income in specifications (2) and (3), which use the cumulative flows measure of financial wealth, are statistically significant but small. These findings are in keeping with the stationarity tests on the wealth to income ratio and the doubts that arise from the nature of private financial wealth.

Second, the null hypothesis that financial wealth cointegrates with the ratio to income of the non-financial wealth stock is not rejected. The ratio is highly significant and correctly (negatively) signed in all specifications.

Third, the relationship between the variables is far tighter when financial wealth is calculated from accumulated financial surplus flows rather than from balance sheet data. Table 9 reports the adjusted coefficient of determination ( $\bar{R}^2$ ) for the Johansen systems estimate of the error correction model for the change in financial wealth. The fit is poor in the case of the balance sheet measure but

acceptable in the case of the cumulative flows measure (around 70%). The result is important since the Johansen systems estimate ECM can be construed as a restricted version of a private expenditure function.<sup>31</sup>

The poor performance of the balance sheet measure is puzzling. Measurement error is one possibility. Another explanation is that holders of government and overseas securities target their nominal holdings and largely ignore the effect of market revaluations. This possibility finds empirical support in the study of the UK gilt-edged market by Davidson, Madonia and Westaway (1994). The implication is that the cumulative flows measure of financial wealth is more likely than the balance sheet measure to represent a targeted variable to which private agents adjust.

The last finding of significance is given by specification (3) in Table 9. The hypothesis that the changes in disposable income and the non-financial wealth ratio do not respond to departures from the long-run desired level of financial wealth (measured by cumulative flows) cannot be rejected.<sup>32</sup> Equation fit is also improved by this restriction. Income and the non-financial wealth ratio can therefore be treated as weakly exogenous, justifying the estimation of an aggregate private sector expenditure function within a single-equation framework.

## 6 A new-look New Cambridge expenditure function

The methodology of Hendry (1995) is used to nest a long-run relationship between market sector financial wealth (measured by cumulative flows) and the ratio to income of non-financial wealth within an error correction model for market sector total expenditure of the general form:

$$\Delta E = A(L)\Delta X + \tau_0 \{E_{-1} - \tau_1 Y_{-1}^a - \tau_2 (V_{-1} + \tau_3 k_{-1} + \tau_4)\} \quad (13)$$

where  $X$  is a vector of regressors,  $A(L)$  is a vector polynomial in the lag operator  $L$  such that  $L^i(\Delta X) \equiv \Delta X_{-i}$ .  $A(L)\Delta X$  comprises up to two lags of differenced variables that are integrated of order zero (denoted  $I(0)$ ) whereas all the levels variables are  $I(1)$  (see appendix). Granted cointegration of the latter and weak exogeneity, the variables in the ECM are stationary and inference can be based on standard distributions.

The differenced variables in  $\Delta X$  comprise changes in total expenditure and in inflation-tax adjusted disposable income<sup>33</sup> and components of the change in the non-financial wealth ratio. In addition, allowance is made for the impact of monetary and inflation shocks by including terms in the change in the level of

the short-term (three-month) nominal interest rate, ‘ $i$ ’, and in the inflation rate of the market sector expenditure deflator.

The change in the non-financial wealth ratio that forms part of  $\Delta X$  is decomposed into three parts using an identity that takes advantage of the available data on non-financial asset prices, here confined to house prices. The nominal stock of housing wealth is divided by a house price index to form a series for the volume of the dwelling stock,  $\bar{H}$ , and its ratio to disposable income  $h \equiv \frac{\bar{H}}{Y^a}$ . The level of house prices in relation to the market sector expenditure deflator is denoted ‘ $q^h$ ’; ‘ $h$ ’ and ‘ $nh$ ’ superscripts denote housing and non-housing non-financial wealth respectively, and a diacritical dot denotes rates of change (so that, for example,  $\dot{q}^h \equiv \frac{\Delta q^h}{q_{-1}^h}$ ). An appendix shows that:

$$\Delta k \equiv \left[ \dot{q}^h + \dot{h}(1 + \dot{q}^h) \right] k_{-1}^h + \Delta k^{nh} \quad (14)$$

The component  $\dot{q}^h k_{-1}^h$  can be regarded as a measure of the ratio to income of real capital gains on the housing stock.

Using annual data from 1955 to 2007, estimation of the expenditure function by ordinary least squares begins with a general specification that is subsequently pared down to a more parsimonious form. An appendix summaries the tests applied, and passed, to delete insignificant variables (including lags of  $\Delta E$ ,  $\Delta Y^a$  and several terms in  $\Delta k$ ), to restrict coefficients and to examine the assumed exogeneity of the contemporaneous terms  $\Delta Y^a$  and  $\dot{q}^h k_{-1}^h$ .

**Table 10: Estimation results using inflation-tax adjusted disposable income**

	----- Regressors -----									----- Regression statistics -----						
	$\Delta Y^a$	$\dot{q}^h k_{-1}^h$	$\Delta i_{-1}$	$\Delta i_{-2}$	$\Delta^2 \pi_{-1}$	$E_{-1}$	$Y_{-1}^a$	$V_{-1}$	$100k_{-1}$	$\bar{R}^2$	Z1	Z2	Z3	Z4	Z5	Z6
<i>a</i>	0.32	228.6	-1542.1	-1552.9	-723.9	-0.18	0.16	0.27	171.1	0.87	0.61	0.89	0.83	0.94	1.05	1.21
<i>t</i>	4.0	4.3	-2.5	-3.1	-2.7	-3.5	3.1	8.6	6.4		0.44	0.35	0.66	0.50	0.42	0.32

See text for definition of variables. The coefficient on real capital gains on housing assets is divided by 100. Ordinary least squares regression for the dependent variable  $\Delta E$  using annual data from 1955 to 2007 including an intercept (not reported). *a* - coefficient value, *t* - t-statistic, p - p-value. Regression statistics:  $\bar{R}^2$  - coefficient of determination adjusted for degrees of freedom; Z1 - F-version of Breusch-Godfrey Lagrange Multiplier (LM) test for first order serial correlation; Z2 - F-version of Ramsey's RESET test for functional form; Z3 - LM version of Jarque-Bera's normality test; Z4 - F-version of White's heteroscedasticity test; Z5 - F-version of Chow's predictive failure test (Chow's second test) for the adequacy of the predictions; Z6 - F-version of Chow's (first) test for the stability of the regression coefficients. Stability tests use the last 10 years of the full sample period. The equation specification is a transformation of equation (13), which can be estimated directly using nonlinear least squares with equivalent results.

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**Table 11: Estimation results using conventional measure of disposable income**

	----- Regressors -----									----- Regression statistics -----						
	$\Delta Y^d$	$\dot{q}^h k_{-1}^{h'}$	$\Delta i_{-1}$	$\Delta i_{-2}$	$\Delta^2 \pi_{-1}$	$E_{-1}$	$Y_{-1}^d$	$V_{-1}$	$100k'_{-1}$	$\bar{R}^2$	Z1	Z2	Z3	Z4	Z5	Z6
<i>a</i>	0.38	224.2	-1528.6	-1195.2	-782.2	-0.19	0.16	0.26	170.0	0.88	0.66	0.35	1.15	0.81	1.22	1.41
<i>t</i>	4.4	4.2	-2.6	-2.5	-3.0	-4.0	3.5	8.9	6.3		0.42	0.55	0.56	0.61	0.31	0.22

See notes to preceding table.  $k^{h'} \equiv K^h / Y^d$  and  $k' \equiv K / Y^d$

It is of note that these tests decisively reject a restriction that imposes equal coefficients (of opposite sign) on the lagged levels of expenditure and income. With unequal coefficients, the level of income plays some, albeit small, role in the determination of the long-run desired level of financial wealth. The result should be taken with a degree of circumspection, however, in view of data quality concerns. The equality restriction is accepted over the 1955 to 2002 sample period. In addition to normal revisions, question marks are raised over more recent figures by changes to the method by which the ONS balanced the national accounts from 2004 (Akers and Clifton-Fearnside (2008)).

The preferred results are shown in Table 10. As expected, the change in expenditure is related positively to the change in income, housing capital gains, past levels of financial wealth and the non-financial wealth ratio and related negatively to interest rate and inflation shocks and to past differences between the level of expenditure and income. The fit is acceptable ( $\bar{R}^2$  of 87%) and residuals appear to be normally distributed, free of serial correlation, first and higher order (not reported), and of heteroscedasticity. There is no evidence of functional misspecification.

With the last ten years of the estimation sample period set aside, the equation passes standard Chow tests for the adequacy of out-of-sample predictions and parameter stability. The same conclusion is drawn from the CUSUM test (not reported) based on the cumulative sum of one-step-ahead residuals resulting from recursive estimation. The CUSUM of squares test (not reported) based on the cumulative sum of the same residuals squared indicates some variance instability in the late 1970s. But the departure from the null hypothesis is negligible and the CUSUM of squares generally stays well within the 5% confidence limits.

A test for cointegration can be based on residuals calculated by deducting from the level of expenditure the algebraic long-run static-state solution,  $E^s$ , derived by setting to zero the difference variables in equation (13):

$$E^s = \tau_1 Y^a + \tau_2 (V + \tau_3 k + \tau_4) \quad (15)$$

The estimated solution is:<sup>34</sup>

$$E^s = 0.87Y^a + 1.48[V + 645.0(100k) - 394,223] \quad (16)$$

In static stock-flow equilibrium, the financial surplus is also zero ( $E^s = Y^a$ ). In his case, the estimated level of financial wealth,  $V^s$ , is:

$$V^S = 0.09Y^a - 645.0(100k) + 394,223 \quad (17)$$

a result not dissimilar to the Johansen-based estimates in Table 9. Tests on the residuals formed by deducting these solutions from the levels of expenditure and financial wealth respectively reject the unit root null, consistent with a stationary error correction mechanism (see appendix).

To the best of my knowledge, there are no recent published results for a UK private sector expenditure function with which these estimates can be compared. However, it is feasible to examine two alternative hypotheses, the first concerning the correct measurement of income, the second concerning linearity.

Table 11 shows estimation results using the conventional measure of income, not adjusted for the inflation tax. Equation fit and performance are very similar to those in Table 10. Non-nested hypothesis tests reported in an appendix suggest a modest preference for the conventional measure of income but do not reject use of the inflation-tax adjusted measure, which is analytically purer and more convenient. The same appendix records non-nested tests of the linear model in Table 10 set against a model linear in logarithms. The log-linear model is decisively rejected in favour of the linear specification.

## 7 New Cambridge comparisons

Although an extended disquisition would be inappropriate, there is merit in drawing comparisons between the original New Cambridge view and my augmented specification. The implications of the estimates in Table 10 are considered once allowance is made for the feedback between the accumulation of financial wealth and spending.

The first comparison of note concerns *steady state properties*. Under New Cambridge, the ratio to income of the financial surplus tends to a constant, as shown by equation (7). It is perhaps surprising that the alternative approach has a similar implication. Even though the long-run impact on desired financial wealth of a change in the level of income is very small (equation (17)), the steady state of the augmented specification is characterised by non-negligible ratios to income of financial wealth and the financial surplus. The main reason is that desired financial wealth is sensitive in the long run to income growth.

The point can be explained intuitively. According to the estimates in Table 10, a £100 increase in income raises expenditure initially by £32, thereby adding £68

to financial wealth. The latter is then drawn down as expenditure continues to respond. For there to be a material long-run impact on financial wealth, changes in income need to persist, implying a relationship between the wealth ratio and the rate of income growth.

The precise relationship derived in an appendix is a function of the steady rate of growth, ‘ $g$ ’, the size of the initial impact on expenditure of an increase in income ‘ $a_0$ ’, the impacts of income and financial wealth on the level of the long-run desired level of expenditure, as measured by ‘ $\tau_1$ ’ and ‘ $\tau_2$ ’ in equation (13), and the speed of adjustment of expenditure to departures for this long-run level, as measured by ‘ $\tau_0$ ’. Assuming a constant non-financial wealth ratio, the steady state financial wealth ratio under the augmented specification is described by:

$$\text{Lim}\left(\frac{V}{Y^a}\right) = \frac{(1+g)\{g(1-a_0)-\tau_0(1-\tau_1)\}}{g(g-\tau_0(1+\tau_2))-\tau_0\tau_2} \quad (18)$$

It follows that:

$$\text{Lim}\left(\frac{F^a}{Y^a}\right) = \frac{g\{g(1-a_0)-\tau_0(1-\tau_1)\}}{g(g-\tau_0(1+\tau_2))-\tau_0\tau_2} \quad (19)$$

These results are framed in terms of inflation-tax adjusted disposable income, but equivalent steady state results can be derived in terms of the conventional measure of income granted a constant rate of inflation. To illustrate, Table 12 compares hypothetical steady state financial surplus ratios under the New Cambridge paradigm and under the augmented specification. Growth of disposable income is set at 3% a year, close to the 20-year average, while the financial wealth to annual income ratio relevant to New Cambridge is set at one fifth, close to the low end-2007 value. On this figuring, the steady state financial surplus ratio under the augmented specification is likely to be small but positive and only somewhat below that predicted by New Cambridge.

**Table 12: Hypothetical steady state solutions**

Private financial surplus, % of MDI	----- Inflation rate % -----		
	0	2	4
New Cambridge view	0.58	0.96	1.32
Augmented specification	0.46	0.76	1.05

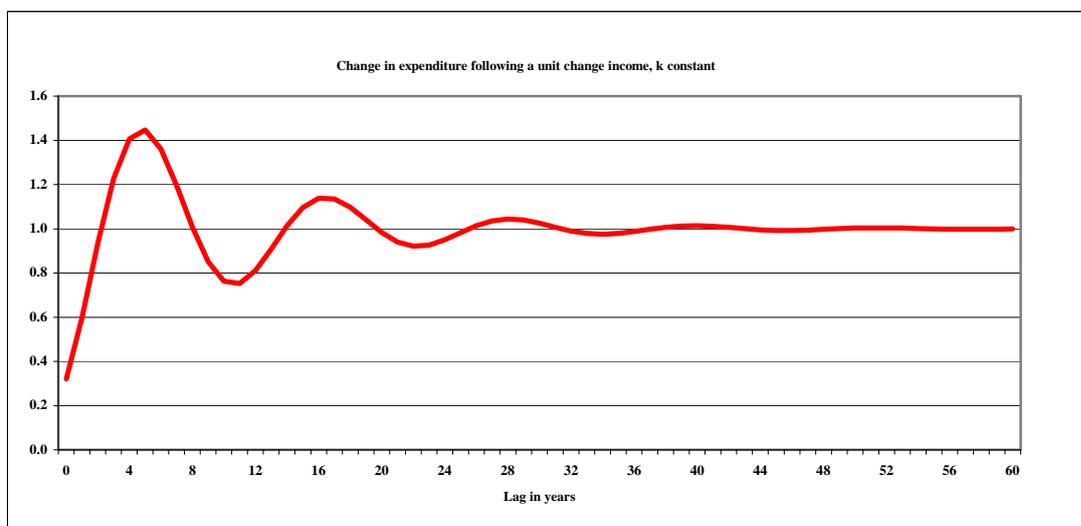
Calculations assume 3% p.a. real income growth and a financial wealth to annual income norm under New Cambridge of 0.2.

The second comparison of note concerns the *speed of adjustment* of expenditure to changes in income. New Cambridge controversially claimed that private expenditure responded very rapidly indeed.<sup>35</sup> According to the School's novel 'mean lag theorem', which Taylor (2008), following Dorfman (1959), refers to as the 'bathtub theorem', the mean lag response of private expenditure to a change in private disposable income is equal to the (low) target financial wealth ratio. An appendix provides a formal proof, which can be understood in terms of the analogy of a bathtub of financial wealth, to which income adds and from which expenditure subtracts. The smaller the bathtub, the less time an inflow of income would be detained before flowing out as expenditure.

As New Cambridge acknowledged, the mean lag theorem loses its power if the adjustment of expenditure to income is oscillatory. In this case, the mean lag comprises an average of positive and negative effects, and ceases to have meaning (Solow (1983), Godley and Lavoie (2007)). Since private expenditure includes consumption of durable goods and fixed investment, oscillatory and drawn out dynamics would not be surprising.

The augmented specification does not surprise. Under it, the response of expenditure to a change in income is subject to persistent overshooting and undershooting, as Chart 7 shows. As with New Cambridge, the long-run impact is one-for-one. But no less than eleven and a half years elapse between successive peaks in the estimated distribution of lag coefficients, a protracted adjustment to which the corresponding mean lag of four and a half *weeks* gives no clue. An appendix provides formal details.

**Chart 7: Estimated response of expenditure to income**



**Table 13: Proximate impact of house price variations**

Market sector financial surplus, % of disposable income*	1955-1979 actual	-----1980-2007 ----- actual	----- simulated**
annual average	1.4	1.6	1.8
standard deviation	1.9	4.0	1.9

\* adjusted for national accounts residual error. \*\* actual less simulated impact of variations in relative house prices around their post-1955 trend.

The final comparison of note concerns the *causes of the increased variability of the private sector financial surplus* noted in section 4. The New Cambridge function offers a partial explanation in terms of inflation, but variations in the inflation tax cannot explain the continued volatility of the financial surplus during the post-1990 period of general macroeconomic stability. The augmented specification stresses in addition the role of asset prices, notably those of residential dwellings. According to the Table 10 estimates, a change in house prices relative to prices in general has a marked impact: a 10% relative price fall curtailing private expenditure by about 1% over a two year period. This finding may be compared with the Bank of England’s contention that house prices have little effect on consumers’ spending (Benito et al. (2006)).

Table 13 reports a simple calculation that removes the simulated impact of off-trend variations in relative house prices from the post-1979 record of the market sector financial surplus. The average financial surplus in relation to income is little affected but the impact on variability is profound. With off-trend house

price movements removed, the variability of the financial surplus ratio shows no increase after 1979.

## 8 Conclusions

The New Cambridge model of UK private sector spending was ahead of its time in formalising empirically, and consistently, the relationship between stocks of financial wealth, on the one hand, and flows of income and expenditure on the other. Stock-flow consistency was combined with novel high-level aggregation that overcame serious defects of national accounting, a lesson still lost on applied economists who treat household disposable income as a suitable measure of consumers' budget constraint.

Using a specially reconstructed historic database, I find evidence that helps to justify the New Cambridge focus on the private sector aggregate, notably the mean reversion of the private sector financial surplus. However, the evidence rejects the New Cambridge axiom that posits the existence of a simple long-run norm linking financial wealth and private current disposable income. The ratio to income of financial wealth is instead subject to shifting trends and persistent oscillations.

An alternative hypothesis not without merit is that the private sector chooses between non-financial and financial assets on the basis of competing expected rates of return.<sup>36</sup> These, alas, are not observable but experimentation with a proxy leads to a tentative augmented private spending function with interesting attributes. Like New Cambridge, it suggests the possibility of stable steady state ratios to income of financial wealth and of the financial surplus, but only if competing expected rates of return are stable. The adjustment of expenditure to changes in income is protracted and oscillatory, a characterisation arguably more plausible than the rapid adjustment stressed by New Cambridge. The results also reveal a powerful connection between house prices and expenditure, a relationship absent from the original New Cambridge function and distrusted by the Bank of England.

Future research needs to focus on the theory of portfolio choice adumbrated in this paper to discover in what way investments in financial and non-financial assets can be regarded as substitutes and the role played by financial innovation and deregulation. A separation of consumption from investment decisions may prove necessary. The development of theory must have regard to the deficiencies of the data, however. I venture that the most rewarding research strategy will combine further theoretical exploration with tests of the gains from aggregation.

## Notes

<sup>1</sup> For claims and counter-claims during this controversy in approximate chronological order see, for example: Cripps, Fetherston and Godley (1974, 1976); Bispham (1975); Rowan (1976); Fetherston and Godley (1978); Blinder (1978); Chrystal (1981, 1983); Anyadike-Danes (1983); Godley (1983); Godley and Cripps (1983). Alternative econometric estimates are given in Bennett (1986) and Matthews and Minford (1980).

<sup>2</sup> Bennett (1987); Hossain (1991); Godley (1999); Godley, Papadimitriou and Zezza (2008).

<sup>3</sup> Godley and Lavoie (2007, p25) argue against the theoretical amalgamation of households and firms into a single private sector:

‘... households and production firms take entirely different decisions.’

<sup>4</sup> Feldstein (1973) finds that US households pierce the corporate veil almost completely. For the UK, Feldstein and Fane (1973) find only a partial piercing. Poterba’s (1991) somewhat inclusive results for Britain, Canada and the US suggest the presence of a veil; those by Auerbach and Hassett (1983) for the US and by Koskela and Virén (1986) for the US and UK do not (though results for other countries vary). Pitelis (1987) finds the veil almost intact in the UK, a result rejected by Sumner (2004a). Sumner (2004a, 2008) finds strong evidence that retained profits have a significant impact on measured UK consumption.

<sup>5</sup> See, for example, Grunfeld and Griliches (1960); Aigner and Goldfeld (1974); Pesaran, Pierse and Kumar (1989); Lee, Pesaran and Pierse (1990).

<sup>6</sup> Acute problems of separating household from company income arise in the case of defined-benefit pension schemes, which are deemed to be the property of households but are materially controlled by the sponsoring company. Other difficulties result from the distinction between income and capital: whereas share repurchases and capital gains are excluded from the system of accounts, equivalent dividend payments and related capital taxes are not. Chamberlin and Dey-Chowdhury (2008) discuss the difficulties encountered in the context of the UK national accounts.

<sup>7</sup> The compendious cross-country study by Altissimo et al., (2005), citing around 150 relevant references, finds little evidence that asset prices affect investment but concludes in favour of a link between wealth and consumers’ spending in a number of economies, including the UK. The link with housing wealth is questioned in Bank of England research (Benito et al., (2006)).

<sup>8</sup> See Martin (2007a) and (2007b) for details.

<sup>9</sup> Recent historic estimates usefully published by the ONS (Sbano (2008)) do not observe the basic constraint that, adjusted for the government’s holdings of

monetary gold and Special Drawing Rights, stocks of financial asset less liabilities should sum to zero across sectors.

<sup>10</sup> Transfers of activity between public corporations and general government distort market sector data.

<sup>11</sup> The official definition of disposable income is struck before taking account of capital transfers.

<sup>12</sup> Land transfers are formally known as the net acquisition of non-produced, non-financial assets (land and subsoil assets like oil and gas).

<sup>13</sup> Godley (1983) acknowledges that the target norm might be sensitive to the rate of interest and subject to shocks.

<sup>14</sup> In the earliest versions of New Cambridge, this equality was assumed to hold over one period with  $F = \Delta V = \Delta V^*$  (Blinder (1978)). Later expositions deployed partial adjustment of the form:  $\Delta V = \lambda(V^* - V_{-1})$ . It was perhaps not sufficiently stressed that the implied steady growth state is not one of equality between actual and target financial wealth but rather a constant proportionate relationship such that:  $Lim(F) = \frac{\lambda(1+g)}{\lambda+g} \Delta V^*$ . The corresponding long run

financial surplus ratio -  $Lim\left(\frac{F}{Y^d}\right) = \frac{\lambda g}{\lambda+g} \varpi$  - is stationary but implies persistent targeting errors. Flemming (1976) argues that the adjustment process could ‘change gear’, targeting growth rates rather than levels. With suitable parameter values, an adjustment process such as:  $\Delta v = \lambda_1(g - v_{-1}) + \lambda_2\left(\frac{V_{-1}^*}{V_{-1}} - 1\right)$  where ‘v’ is the growth rate of ‘V’, would ensure  $Lim(F) = \Delta V^*$  in the steady growth state.

<sup>15</sup> Use is made of the definitions:  $Y^d \equiv (1+g)Y_{-1}^d$  and  $\Delta Y^d \equiv \frac{g}{1+g} Y^d$ .

<sup>16</sup> Standard definitions are used. A time series with no deterministic component which has a stationary, invertible, auto-regressive moving average representation after differencing  $d$  times is said to be integrated of order  $d$ , denoted  $x \sim I(d)$ . Variables are cointegrated if a linear combination of them exists which is  $I(0)$  with zero mean (Engle and Granger (1987)). The New Cambridge hypothesis is an example of multicointegration (Granger and Lee (1989)) for which specialised estimation techniques exist (Engsted, Gonzalo and Haldrup (1997)).

<sup>17</sup> See, for example, Godley and Lavoie (2007, p293). Although the rationale is different, the adjustment is similar to that used in a seminal article by Taylor and Threadgold (1979).

<sup>18</sup> Nothing of substance would alter were GDP chosen as the denominator.

<sup>19</sup> Rowthorn and Glyn (2006) argue that measurement error in the dependent variable causes negative autocorrelation of the disturbance terms, and ‘may therefore exaggerate the appearance of stationarity.’

<sup>20</sup> The average market sector financial surplus inclusive of the national accounts residual error shows less stability across periods, but some part of this error should be apportioned to other sectors.

<sup>21</sup> The precise date at which behaviour changes has not been exactly identified. At the 5% level of significance (critical value of the F-statistic of 4.7), the heteroskedasticity-robust Quandt likelihood ratio (QLR) test indicates an evolving breakdown in the coefficients of a time-varying autoregressive representation of the market sector financial surplus ratio beginning in 1976 (F-statistic 7.6) – or in 1975 in the case of the ratio adjusted for the national accounts residual error (F-statistic 5.2) - and reaching a maximum in 1986.

<sup>22</sup> Bureau of Economic Analysis FDI data at market value are available from 1982.

<sup>23</sup> According to a QLR test, an autoregressive trend stationary representation of the financial wealth to income ratio breaks unequivocally in 1974 (F-statistic of 4.7).

<sup>24</sup> It is of note that the null of a unit root in the wealth ratio series over the full sample period is rejected at the 5% level of significance according to the augmented Dickey-Fuller statistic. This inference is false, however. Disturbances in the difference of the wealth ratio series contain a moving average process with a large negative root, a feature known to create severe size distortions and over-rejection of the unit root null in standard tests (Schwert (1989), DeJong, Nankervis, Savin and Whiteman (1992)).

<sup>25</sup> Tests on annual data using the cumulative flows measure reject the hypothesis of non-stationarity around a linear trend in the period to 1974.

<sup>26</sup> Fetherston and Godley (1978) assume the wealth target responds positively to the real rate of interest, a proposition that finds empirical support in Bennett (1986). A relationship of this sort survives in my data over Bennett’s sample period (1967 to 1980), but not before or since.

<sup>27</sup> Solow (1983) and Vines (1984) question the form of the wealth target on other grounds.

<sup>28</sup> Godley, Papadimitriou and Zezza (2008) nevertheless include private sector borrowing flows in their specification, which succeeds empirically for the US, but not (on the basis of limited trials) for the UK. The inclusion of inside liability flows (and the exclusion of inside financial assets flows) raises question

marks over the appropriate level of aggregation (Rowan (1976)) and warrants further theoretical examination.

<sup>29</sup> The downtrend in the non-financial wealth ratio until the mid-1950s can be significantly attributed to the unwinding of an aberrantly high level of capital goods prices in relation to consumer prices in the late-1940s, the result of wartime dislocation of the construction industry and post-war rent and food price controls. Statistical error is also probable. See Matthews, Feinstein and Odling-Smee (1982), appendix H.

<sup>30</sup> See, for example, Bredin and Cuthbertson (2002); Sumner (2004b).

<sup>31</sup> The systems ECM can be written:  $\Delta V = c_1 \Delta V_{-1} - c_2 \Delta k_{-1} + c_3 (V_{-1}^* - V_{-1})$  where the coefficients  $c_i$ ,  $i=1,2,3$  are positive. In the case of financial wealth calculated from cumulative flows,  $\Delta V \equiv Y^a - E$ . The ECM may be re-written  $E = c_1 E_{-1} + (1 - c_1) Y^a + c_1 \Delta Y^a + c_2 \Delta k_{-1} - c_3 (V_{-1}^* - V_{-1})$ .

<sup>32</sup> The asymptotically Chi-square distributed likelihood ratio test statistic for this restriction conditional on the presence of a single cointegrating vector is 2.4 (probability 0.30).

<sup>33</sup> Also inclusive of the national accounts residual error.

<sup>34</sup> Non-linear least squares estimation gives t-statistics on the parameters  $\tau_1$ ,  $\tau_2$  and  $\tau_3$  of 19.2, 3.3 and 10.9 respectively.

<sup>35</sup> The School's original claim regarding lag length was based on the controversial finding that financial wealth adjusted fully to its desired level within one year (Blinder (1978)). The mean lag theorem holds irrespective of the lags in the financial wealth adjustment process.

<sup>36</sup> This theory offers an interpretation, not mentioned by the authors, of the term in relative stock market prices that appears in the US private expenditure function estimated by Godley, Papadimitriou and Zezza (2008)). Preliminary experiments suggest that stock prices may be better suited than the non-financial wealth ratio to capture relative returns expectations in the US, although the absence of a role for house prices, included in Godley's (1999) US estimates, is puzzling.

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## Appendix 1: Data sources and methods

### *Flow data in current prices*

The construction of government, Rest of the World and private sector income and expenditure flow data is largely explained in Martin (2007b). A correction is applied to remove errors in the national accounts related to a reclassification of the Housing Revenue Account (HRA), which distort local government and public corporations data from 1974.

The derivation of historic data for households and companies is problematic. Pre-1987 figures for the financial surplus of households are derived using an ONS series for disposable income and saving of dubious quality and now partly suspended (Martin (2007a), (2007b)), and own estimates of the household capital account that draw on available data for housing investment and pre-ESA95 figures consistent with the 1997 national accounts Blue Book. Pre-1987 data for private corporations as a whole and for private financial corporations separately are derived by residual using estimates for the private sector, for households and for private non-financial corporations. Historic estimates for the latter use ONS-suspended, ESA95-consistent data back to 1965 and, before then, scaled pre-ESA95 data for industrial and commercial companies.

**Table A1: Stationarity tests – latest data versus 1997 Blue Book data**

Financial surplus, % of GDP	----- Unit root test -----		
	ADF	PP	KPSS
<b>Household or personal sector</b>			
Latest data	-2.57*	-2.06*	0.58*
1997 Blue Book data	-2.70*	-2.34*	0.42
<b>Private non-financial corporations**</b>			
Latest data	-2.84*	-2.73*	0.54*
1997 Blue Book data	-2.97	-2.86*	0.46*
<b>Financial corporations</b>			
Latest data	-2.18*	-2.28*	0.53
1997 Blue Book data	-3.26	-3.20	0.18

See Table 1, main text, for details of tests. Estimated over a period (1951 to 1996) that ensures an equal sample for each test (46 annual observations). Critical values for ADF and PP: -2.93; for KPSS: 0.46, both at the 5% level of significance. \* indicates non-rejection of the ADF or PP null or rejection of the KPSS null. \*\* Industrial and commercial companies in 1997 Blue Book.

Table A1 compares the stationarity properties of the reconstructed data for the financial surplus of the household and private company sectors (as a share of the gross domestic product) with the last available pre-ESA95 estimates taken from the 1997 Blue Book. There is, perhaps, some reassurance to be had from the fact that these properties are not dissimilar, despite the large revisions and changes in statistical definitions and concepts, which are especially marked for the household sector (Dolling (1998)). Over the 1951 to 1996 interval, there is evidence of non-stationarity in the comparable series for households and private non-financial companies. Only the results for financial companies diverge.

#### *Expenditure data in constant prices*

Constant-price equivalents of market sector expenditure, comprising consumption and capital spending, are derived where necessary using ONS chain-linking methodology (Robjohns (2006)). With an allowance for HRA-related errors, general government fixed investment data are chain-subtracted from the economy total to give equivalent estimates for the market sector. The general government investment price deflator is estimated from pre-ESA95 sources and national totals prior to 1987.

#### *Balance sheet in current prices: financial assets and liabilities*

Official figures are available for the stocks of financial assets and liabilities of each sector from 1987, but not on a consolidated basis. Before 1987, private and market sector net financial asset stocks are inferred from public sector and Rest of the World counterparts. With some corrections, the official data can be taken back to 1966 and spliced to estimates in Roe (1971) available from 1957.

Before 1957, cumulative financial surpluses are used to backcast figures for government and Rest of the World net financial asset stocks with an allowance, in the case of central government, for revaluations of the debt stock. The revaluation adjustments, available back to 1952, are based on a comparison of the nominal and market values of British government securities quoted on the London Stock Exchange.

A major qualification concerns the valuation of foreign direct investment (FDI). Official figures that value FDI stocks at book value are likely substantially to underestimate market values, the yardstick used for other financial assets and liabilities. To convert the FDI figures to market values, a valuation adjustment is applied using infrequent benchmark market-to-book valuation estimates (Reddaway (1968); Pratten (1996)). The inferred market values are backcast and extended using stock market indices with a correction for reinvested FDI

earnings. The FDI valuation adjustment is taken back to 1957 and, before then held constant.

#### *Balance sheet in current prices: non-financial assets*

Non-financial assets comprise residential buildings, other structures (such as commercial and industrial buildings), equipment (such as plant and machinery), inventories and various intangible assets (such as computer software). Official valuation methods vary. Market valuations are given for residential dwellings and some structures and, in part, for transport equipment. But where second-hand markets are thin or non-existent, as in the case of much plant and machinery, the ONS reports the replacement cost of assets calculated using its Perpetual Inventory Model (PIM).

Historic data for each major asset category are derived by splicing the latest Blue Book estimates to pre-ESA95 1997 Blue Book figures back to 1957. Prior to 1957, estimates for the household sector residential dwelling stock are linked to those for the personal sector given in Solomou and Weale (1997). Holdings of public corporations are inferred by residual from a national total based on figures for the total dwelling stock given in Blake and Orszag (1999). The Solomou-Weale and Blake-Orszag data are both adjusted to reflect movements in house price data published by the Department of Communities and Local Government.

Before 1957, figures for the non-housing tangible asset stocks of households are pro-rated backwards using Solomou and Weale's estimates. ONS PIM data, generally available from 1947, are used to backcast national accounts structures and equipment data. The main qualification concerns the backcast of structures data, where the PIM estimates exclude the value of land that is implicit in the national accounts figures. For inventories, a national figure is estimated from the cumulative value of changes in the book value of inventories recorded in the 1997 Blue Book and attributed to sectors based on 1957 shares.

#### *Quarterly data*

The estimation of the quarterly dataset uses exact quarterly equivalents to the annual series where available. In other cases, recourse is made to interpolation based on closely related quarterly series and straight-line methods. A number of series are seasonally adjusted using the software package 'Demetra'<sup>36</sup> but with its output calendar-year constrained.

*US data*

Official data are taken from the National Income and Product Accounts and Flow of Funds Accounts.

Data include revisions published up to December 2008. Further details of the data construction are available on request.

## Appendix 2: Detailed econometric results

**Table B1: Integration tests of market sector regression variables**

ADF statistic Variables in constant prices (unless noted *)	Variable expressed in	
	Levels	First differences
Financial wealth		
balance sheet data	-2.40	-8.41
cumulative flows data	-2.79	-4.56
Non-financial wealth to income ratio		
conventional income measure	-1.72	-5.02
inflation-tax adjusted income measure	-1.86	-5.06
Disposable income		
conventional measure	3.99	-5.24
inflation-tax adjusted measure	3.76	-5.72
Total expenditure	2.73	-3.74
Weighted relative house price inflation*	-4.38	-8.54
Weighted growth in housing to output ratio*	-5.69	-7.56
Residual change in $k^*$	-6.69	-6.50
Nominal short-term interest rate*	-1.98	-6.81
Inflation rate*	-1.87	-6.48

See notes to Table 1 in main text. Sample period 1955-2007. Critical value of ADF statistic at 5% level: -2.92.

**Table B2: Hypothesis tests on  $\Delta E$  error correction model**

Test	F-statistic*	Probability
Restrictions:		
1) Drop insignificant variables	0.44	0.93
2) Restrict coefficients on $E_{-1}$ & $Y_{-1}^a$	9.07	0.00
3) Restrict coefficients on $\Delta\pi_{-1}$ & $\Delta\pi_{-2}$	0.09	0.76
4) All accepted restrictions	0.42	0.95
5) Wu-Hausman test for exogeneity	0.50	0.61
6) ADF test on $E - E^s$	-5.24	0.0
7) ADF test on $V - V^s$	-5.32	0.0

Notes on tests: (1) F-test for the redundancy in the unrestricted ECM of lagged values of  $\Delta E, \Delta Y^a, \dot{q}^h k_{-1}, \dot{h} k_{-1}, \Delta k_{-1}^{nh}$  and contemporaneous values of  $\Delta i$  and  $\Delta \pi$ ; (2) and (3) F-version of Wald tests for equality, with opposite sign, of coefficients on  $E_{-1}$  and  $Y_{-1}^a$  (2),  $\pi_{-1}$  and  $\pi_{-2}$  (3); (4) combined effect of restrictions (1) and (3); (5) exogeneity test based on redundancy of residuals from auxiliary regressions for  $\Delta Y^a$  and  $\dot{q}^h k_{-1}$  (all test statistics

based on likelihood ratios give similar results); (6) and (7) ADF on residuals derived using the algebraic long-run solutions; critical values:  $-4.32$  and  $-3.92$  at the 5% level. \* unless stated.

**Table B3: Non-nested tests for alternative income definitions**

Statistic (probability) Test type	Model using $Y^a$ versus model using $Y^d$	Model using $Y^d$ versus model using $Y^a$
Adjusted Cox	-1.59 (0.11)	0.47 (0.64)
Wald	-1.53 (0.13)	0.48 (0.63)
Encompassing	1.42 (0.25)	0.82 (0.52)

See Godfrey and Pesaran (1983) for an evaluation of these tests. Model specifications are shown in Tables 10 and 11 of the main text.

**Table B4: Non-nested tests for linear versus log-linear models**

Statistic (probability) Test type	Linear model versus log-linear model	Log-linear model versus linear model
Simulated Cox	-1.22 (0.22)	-7.49 (0.00)
MacKinnon et al.	1.51 (0.13)	3.07 (0.00)
Bera-McAleer	1.09 (0.28)	2.05 (0.04)
Davidson-MacKinnon	1.76 (0.08)	4.24 (0.00)

The log-linear model substitutes logarithmic equivalents for all variables in the specification in Table 10 except for  $\hat{q}^h k_{-1}^h$  and terms in  $\Delta i$  and  $\Delta \pi$ . The tests are explained in Pesaran and Pesaran (1997).

### Appendix 3: Detailed proofs

#### 1 Decomposition of $\Delta k$

The change in the non-financial wealth ratio comprises changes in its housing and non-housing components, the former being the product of the relative house price and the ratio to constant-price income of the (own-price deflated) housing stock.

The change in the housing wealth ratio is given by:

$$\Delta k^h \equiv q^h h - q_{-1}^h h_{-1} \equiv \Delta q^h h_{-1} + \Delta h q^h \quad (C1)$$

The two expressions on the right-hand side can be re-arranged as follows:

$$\Delta q^h h_{-1} \equiv \dot{q}^h q_{-1}^h h_{-1} \equiv \dot{q}^h k_{-1}^h \quad (C2)$$

$$\Delta h q^h \equiv \dot{h} (h_{-1} q_{-1}^h) \frac{q^h}{q_{-1}^h} \equiv \dot{h} (1 + \dot{q}^h) k_{-1}^h \quad (C3)$$

Identity (14) in the text combines identities (C1) to (C3) and adds  $\Delta k^{nh}$ .

#### 2 Dynamic path of $V$

The estimated equation in Table 10 can be written in the form:

$$\Delta E = a_0 \Delta Y^a + a_1 \dot{q}^h k_{-1}^h - a_2 \Delta i_{-1} - a_3 \Delta i_{-2} - a_4 \Delta^2 \pi - a_5 E_{-1} + a_6 Y_{-1}^a + a_7 V_{-1} + a_8 k_{-1} - a_9 \quad (C4)$$

where each coefficient 'a' takes a positive value.

Equation (C4) re-written using the lag operator becomes:

$$E = \frac{\{a_0 + (a_6 - a_0)L\}Y^a + \Delta B + a_7 V_{-1} + a_8 k_{-1} - a_9}{1 - (1 - a_5)L} \quad (C5)$$

where  $\Delta B \equiv a_1 \dot{q}^h k_{-1}^h - a_2 \Delta i_{-1} - a_3 \Delta i_{-2} - a_4 \Delta^2 \pi$ .

The identity for the change in financial wealth is:

$$\Delta V \equiv (1-L)V \equiv Y^a - E \quad (C6)$$

Substitution for  $E$  in identity (C6) using equation (C5) yields after rearrangement:

$$V = \frac{(1-a_0)\Delta Y^a + (a_5 - a_6)Y_{-1}^a - \Delta B - a_8 k_{-1} + a_9}{1 - (2 - a_5 - a_7)L + (1 - a_5)L^2} \quad (C7)$$

The inverse characteristic equation in the lag operator has these estimated values:  $2 - a_5 - a_7 = 1.56$  and  $1 - a_5 = 0.82$ . The discriminant is negative:  $(2 - a_5 - a_7)^2 - 4(1 - a_5) = -0.86$ . The roots are therefore complex, implying oscillatory dynamics, but with an absolute value less than unity since  $\sqrt{1 - a_5} < 1$ . The system is thus convergent.

The periodicity of the cyclical response, the time that elapses between successive peaks, is determined by the value of  $\frac{2\pi i}{\theta}$  where the angular frequency,  $\theta$ , measured in radians, is given by:

$$\theta = \cos^{-1} \left\{ \frac{2 - a_5 - a_7}{2\sqrt{1 - a_5}} \right\} = 0.54$$

This estimate implies cycle periodicity of 11.7 years.

### 3 Dynamic path of $E$

The first difference of equation (C7) gives an expression for  $\Delta V$ , which substituted into the identity  $E \equiv Y^a - \Delta V$ , yields the following equation for the level of expenditure:

$$E = \frac{\{a_0 - (2a_0 - a_6 - a_7)L + (a_0 - a_6)L^2\}Y^a + \Delta^2 B + a_8 \Delta k_{-1}}{1 - (2 - a_5 - a_7)L + (1 - a_5)L^2} \quad (C8)$$

### 4 Steady state solutions

Division of equation (C7) by  $Y^a$  gives the following expression for the financial wealth ratio when income grows at a constant rate 'g':

$$\frac{V}{Y^a} = \left( \frac{1-a_0}{1+g} \right) \frac{\Delta Y^a}{Y_{-1}^a} + \frac{a_5 - a_6}{1+g} + \left( \frac{2-a_5-a_7}{1+g} \right) \frac{V_{-1}}{Y_{-1}^a} - \left( \frac{1-a_5}{(1+g)^2} \right) \frac{V_{-2}}{Y_{-2}^a} - \Phi \quad (C9)$$

where  $\Phi \equiv \frac{\Delta B + a_8 k_{-1} - a_9}{Y^a}$ .

Granted a constant non-financial wealth ratio and assuming  $Lim(\Phi)=0$ , the financial wealth to income ratio converges in the steady state to a constant given by:

$$Lim\left(\frac{V}{Y^a}\right) = \frac{(1+g)\{g(1-a_0)+a_5-a_6\}}{a_7+g(a_5+a_7+g)} \quad (C10)$$

The steady state financial surplus ratio also tends to a constant. The combination of the identity:

$$\frac{F^a}{Y^a} \equiv \left( \frac{g}{1+g} \right) \frac{V}{Y^a} \quad (C11)$$

and equation (C10) gives the following expression:

$$Lim\left(\frac{F^a}{Y^a}\right) = \frac{g\{g(1-a_0)+a_5-a_6\}}{a_7+g(a_5+a_7+g)} \quad (C12)$$

Formulae reported in the text use the substitutions:

$$a_5 = -\tau_0, \quad a_6 = -\tau_0\tau_1, \quad a_7 = -\tau_0\tau_2.$$

These expressions in terms of inflation-tax adjusted disposable income may be re-expressed in terms of conventionally measured income assuming a constant rate of inflation.

Re-arrangement of identity (11) in the main text gives:

$$Lim\left(\frac{Y^d}{Y^a}\right) = 1 + \frac{\pi}{(1+\pi)(1+g)} Lim\left(\frac{V}{Y^a}\right) \quad (C13)$$

the reciprocal of which can be used in combination with equation (C10) to derive the conventional financial wealth ratio:

$$\text{Lim}\left(\frac{V}{Y^d}\right) \equiv \text{Lim}\left(\frac{V}{Y^a}\right) \text{Lim}\left(\frac{Y^a}{Y^d}\right) \quad (\text{C14})$$

Similarly for the financial surplus ratio, re-arrangement of identity (12) in the main text gives:

$$\text{Lim}\left(\frac{F}{Y^d}\right) = \left\{ \text{Lim}\left(\frac{F^a}{Y^a}\right) + \frac{\pi}{(1+\pi)(1+g)} \text{Lim}\left(\frac{V}{Y^a}\right) \right\} \text{Lim}\left(\frac{Y^a}{Y^d}\right) \quad (\text{C15})$$

### 5 The mean lag theorem

Assume the adjustment of financial wealth to its target level determined by the New Cambridge norm (equation (3)) is described by:

$$V = \lambda(L)V^* \quad (\text{C16})$$

The lag polynomial is subject only to the restriction  $\lambda(1) = \sum_{i=0}^{i=\infty} \lambda_i = 1$  where  $\lambda(1)$  denotes the value of the lag polynomial with  $L=1$ .

The first difference of equation (C16) combined with the New Cambridge norm and the identity for expenditure yields:

$$E = \left(1 - (1-L)\lambda(L)\varpi\right) Y^d \quad (\text{C17})$$

The mean lag response,  $\Omega$ , is defined as (Dhrymes (1971)):

$$\Omega_{E,Y^d} \equiv \sum_{i=0}^{i=\infty} i\beta_i = \frac{\beta'(1)}{\beta(1)} \quad (\text{C18})$$

where  $\beta(L) = 1 - (1-L)\lambda(L)\varpi$  and  $\beta'(1)$  is the first derivative of  $\beta(L)$  with respect to  $L$  ( $= \lambda(L)\varpi - (1-L)\lambda'(L)\varpi$ ) evaluated at  $L=1$ . It follows that:

$$\Omega_{E,Y^d} = \frac{\beta'(1)}{\beta(1)} = \frac{\lambda(1)\varpi}{1} = \varpi \quad (\text{C19})$$

The same procedure applied to equation (C8) produces a mean lag equal to  $\frac{a_5 - a_6}{a_7}$ .