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Income and Transactions Velocities in the UK

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It is widely reported for many countries, including the UK, that *income* velocity has been highly variable around a declining trend in recent years. This paper advances the hypothesis that this is connected to the behaviour of *transactions* velocity which has been more stable. The connection lies with endogeneity of broad money.

Briefly, we argue that the demand for credit and hence the broad money stock, is influenced by *total* spending in the economy, rather than spending only on newly produced goods and services. Since total spending in the economy has generally increased relative to GDP (mainly because of asset transactions) credit and money have expanded more rapidly than GDP, with the resulting fall in income velocity.

Using quarterly data from 1975 to 2008, we estimate a vector error correction model with income velocity as the dependent variable and the ratio of total to GDP transactions as an explanatory variable. The results show substantial support for the hypothesis.

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1. **Introduction**

It is now almost twenty years since we first drew attention to the dramatic fluctuations in the ratio of total transactions by value (*PT*) to GDP at current prices (*PY*) that have become a feature of the UK economy since the mid-1970s. In two papers (Bain and Howells, 1991; Howells and Biefang-Frisancho Mariscal, 1992) we demonstrated that:

- The *PT/PY* ratio was broadly stable at around 2.0 until 1976 whereafter it rose to more than 3.0 by 1989 and then continued to show considerable volatility around that level;

- that transactions velocity (*PT/M*) was more stable than income velocity (*PY/M*) over the period and, motivated by this observation,

- that actual and expected growth in total transactions performed quite well in equations for the growth of bank lending.

In all these cases, we measured total transactions using data from the Association for Payment Clearing Systems (APACS) and we excluded high value, same day payments passing through the 'CHAPS' system. Including these transactions increases the total and thus the *PT/PY* ratio dramatically (to 20 in 1976 and 50 in 1988) and also increases its volatility. Subsequent work showed that *PT* performed well in equations for bank lending (Howells and Hussein 1999) and the demand for money (Howells and Hussein, 1997 and 1998; Caporale and Howells, 2001).

Why do we return to this issue now? The first reason is that the equivalence of *PT* and *PY* continues to be widely asserted (e.g. Mankiw, 2006 p.82) in spite of overwhelming evidence to the contrary, at least for the UK. Secondly, Pedro Leão (2005) [*International Review of Applied* Economics] recently used these pages to focus on cyclical fluctuation in M1 (income) velocity in the USA. His explanation featured changes in the composition of aggregate demand over the cycle. (The velocity of investment and durable goods spending is higher than that for consumption and since the former increases as a fraction of GDP in the upswing, overall velocity increases). However, if the links between the demand for money and credit established in the papers referred to above still hold, then we would expect the *PT/PY* ratio to feature as an explanatory variable for income velocity since a rise in the *PT/PY* ratio would be associated with more rapid money and credit growth and thus a *fall* in income velocity. Indeed, Leão himself recognised that variations in total transactions might be relevant, though his argument was different from ours and, of course, he had no recourse to transactions data but had to use a proxy.

Hence there is a case for some further investigation of income velocity, also looking at the role played by the *PT/PY* ratio, and doing it for the UK. Investigating the UK case involves another novelty, namely that we need to look at broad money (M4) velocity, since no narrow money series is available. After twenty years there is also, of course, a case for returning to this issue in order simply to update the record. Finally, our estimations incorporate some methodological improvements.

In the rest of this paper we discuss the theoretical relationship between GDP and total transactions (section 2) and include a review of earlier work on this issue. (This will be brief since the earliest work was reviewed in our earlier papers). We then reveal the picture for the UK as derived from the APACS data (in section 3) while also explaining some of its limits and potential pitfalls. Section 4 deals with the other data requirements. In section 5, we estimate an error correction model for UK income velocity and section 6 concludes.

2. Income and transactions

Bearing in mind that the quantity theory framework has formed the basis for much of our study of the demand for money since the various forms of the Cambridge equation, it is worth reminding ourselves that in its earliest form it had *PT* (and not *PY*) on the right hand side. The origin of the equation is a matter of some dispute. Jean Bodin (1568/1997), Locke (1692) and Hume (1753) are all plausible contenders as early exponents and even Copernicus is said to have outlined the basic ideas in 1522 (Spiegel, 1991, pp.86-8). In all of these works it is clear that what the authors envisaged as total spending was just that, total transactions, and not the subset involved in the purchase of final output. It is even more interesting to see how early economists conceived of *PT* and its relation to *PY*.

When Irving Fisher undertook his famous exposition, he divided nominal transactions into PT_1 and PT_2 where T_1 were income transactions and T_2 were financial transactions *not related to the level of income* (Fisher, 1911). Similarly, Keynes in the *Treatise on Money* (1930/1971 vol.V) distinguished two velocities of circulation: V_1 , defined as annual money income/income deposits, and V_2, the volume of business transactions/business deposits. V_1 was a form of income velocity (albeit with a rather narrow, personal sector, definition of money). V_2, however, consisted of three distinct groups of transactions:

> (i) transactions arising out of the division of productive functions…
> (ii) speculative transactions in capital goods or commodities;
> (iii) financial transactions e.g. the redemption or renewal of treasury bills, or changes of investments. (1930/1971, vol.V p.41)

Keynes again:

> [Transactions (ii) and (iii) above] need not be, and are not, governed by the volume of current output. The pace at which a circle of financiers, speculators and investors hand round to one another particular pieces of wealth, or title to such, which they are neither producing nor consuming but merely exchanging, bears no definite relation to the rate of current production. The volume of such transactions is subject to very wide and incalculable fluctuations…(1930/1971, vol.V p.42)

So Keynes and Fisher were certainly aware not only that total transactions included real assets (like houses), intermediate goods and (financial) claims on assets, but also that these might behave in a way that diverged significantly from transactions in finished goods.

We might expect spending on intermediate goods to change only slowly with trends in the degree of vertical integration in production (which is presumably the basis for the widely held view that short-run divergence between *PT* and *PY* are unlikely). But the purchase of existing dwellings, is a category that has increased substantially over the last fifty years and become extremely volatile in the last thirty, while financial transactions, whose motive we might describe (in broad terms) as speculative has also increased dramatically and become more volatile. The weakness of the theoretical case for focusing on *PY* rather than *PT* was shown up some years ago by the Office for National Statistics (1986 p.108) which apologised for publishing an (income) velocity series. It admitted that a transactions velocity would be preferable (without explaining why) but said a suitable measure of transactions is not available. The textbook explanations for the focus on *PY* are not compelling either. Mankiw's explanation in his widely-used textbook for the disappearance of the *PT* version has nothing to do with the theoretical superiority of *PY*. 'The problem is … that the number of transactions is difficult to measure' (1992, p.83).

What evidence do we have that *PT* and *PY* may have diverged in recent years? Indirect evidence comes from the Council for Mortgage Lenders and the London Stock Exchange whose own data on turnover confirms the increasing importance (and volatility) of housing and financial transactions and shows both growing far more rapidly than GDP in the last fifteen years. More directly relevant is the work done by Cramer on the measurement of total transactions in several countries. The results for the UK were published in 1981. This covered only a nine year period, from 1968 to 1977 (at an annual frequency) but showed *PT* rising as a multiple of *GDP* from 5.25 to 5.86. Interestingly, although Cramer used APACS data, he supplemented this by attempting an estimate for cash transactions but simultaneously excluded all transactions going through 'CHAPS/town clearing' on the grounds that these were nearly all part of the 'financial circulation'. It is not explained why they should be excluded on those grounds, but the decision has echoes of Fisher and Keynes that financial transactions are somehow a category so separate as to be economically uninteresting. Whatever the justification for this may be, it makes a dramatic difference to the size of *PT* and thus to the *PT/PY* multiple, since the value of CHAPS has often exceeded the value of all other payments by a factor of 10 (see table 1 and figures 1 and 2 below).

Why does it matter if the *PT/PY* multiple is unstable? One obvious answer is that *both* the demand for credit and the demand for money may be influenced by *total* transactions, rather than just the subset involving the purchase of final output. Households certainly borrow to finance the purchase of secondhand houses and any household or firm that is simultaneously holding financial assets while it has an outstanding debt to its bank is, in a sense, borrowing to finance the purchase of financial assets. (Imagine a deficit unit which is the position to repay some or all of an outstanding loan by the disposal of financial assets. How is this decision influenced by the expectation of future movements in asset prices?) And since loans create deposits, what does this imply for the outstanding money stock?

The recognition that the demand for credit and money may be related to total transactions has a long history. But the absence of a reliable *PT* measure, for a sufficient length of time and at sufficiently high frequency has been a major problem for empirical work. Typically, any attempt to recognise that demand might be affected by non-GDP spending has to resort to proxies. Mortgage refinancing is one example, used by Richard Anderson in his (1993) study of US money demand. Given the points we have just been making, his opening paragraph is worth quoting in full.

> Money serves as a medium of exchange for transactions involving financial instruments as well as real goods and services. Unfortunately, the total volume of transactions in the economy is not observable, As a result, economic analyses of money demand typically focus on the relationship between the quantity of money demanded and the production of new goods and services, measured by either gross domestic product or personal consumption expenditures. Because aggregate volumes of financial and non-financial transactions likely move in parallel with the output of

> new goods and services the use of output rather than the volume of transactions may cost little in terms of understanding movements in the monetary aggregates. In some periods, however, events occur which remind us that this is not always the case. This article examines the effect of one such ongoing recent event – the refinancing of residential mortgages – on money demand. (Anderson, 1993 p.49)

In 1995 Thomas Palley estimated demand functions for US M1 and M2 that were improved by adding variables which proxied for transactions in financial assets and real estate. As we commented in our opening remarks, the paper by Leão (2005) also recognised that the behaviour of total transactions might have some effect on M1 income velocity. Leão's argument was that an increase in non-GDP transactions would require an increase in the holding of transactions balances and thus a switch from (US) M3 to M1. Hence a fall in the M3/M1 ratio, proxying a rise in the *T/Y* ratio, would be associated with falling M1 velocity. His estimations appeared to confirm this and much the same findings (as regards M3/M1 and the *T/*Y ratio) had appeared earlier in Pollin and Schaberg (1998).

Lieberman (1977) compared estimations for the demand for money including GNP or a 'bank debits' variable as transactions variables. The latter variable was used to estimate the total volume of demand deposit transactions, including final, intermediate and financial transactions. Lieberman stressed that the effect of the use of the 'debits' variable in the regression results is a marked increase in the speed of the disequilibrium adjustment in relation to the use of the GNP variable (Lieberman, 1977, p. 313). In a similar vein, Goodfriend (1985) was (to our knowledge) one of the first to point out that slow adjustments in the demand for money estimations may be due to the divergence between the measured series (GDP) and the underlying, unobserved variable that really influenced the demand for money. The most direct evidence that a UK transactions series might yield useful results in estimates of the demand for money and credit come in the papers by Howells and Hussein (1997, 1999) who found that regressions using an earlier version of a *PT* series derived from APACS data gave more stable results than those based on the more familiar GDP. It is this, combined with the recognition that broad money is endogenously determined through the demand for bank loans, that leads us, in this paper, to explore the relevance of total transactions to the behaviour of (M4) income velocity.

3. The UK evidence on transactions

In the UK, the Association of Payment Clearing Systems (APACS) records a wide variety of data relating to the value and volume of payments by different media.[1] Ultimately, however, all non-cash payments must take the form of transfers of bank deposits. These transfers are handled by three companies: the Cheque and Credit Clearing Company (paper-based transfers), Bankers' Automated Clearing System or BACS (electronic transfers) and CHAPS (a same-day facility for transferring large amounts – usually between financial institutions). The data is available at monthly frequencies. However, there are some shortcomings. The Cheque and Credit data does not generally record interbranch transactions (though the CHAPS series does). In this sense the data under-records the total value of transactions. Further under-recording occurs from the omission of cash payments. The effect of both is to reduce the *PT/PY* multiple. However, for our purposes what matters is not the absolute size but

[1] The range of data can be easily seen by visiting the website: www.apacs.org.uk

movements in *PT relative to* movements in *PY* and, so long as the under-recording is consistent, this should be unaffected. The one caveat we have to express, however, concerns the use of notes and coin. APACS reports that cash remains the dominant medium for payments of less than £5 but nonetheless the total volume of cash transactions (for which they publish estimates) is falling as payments migrate to debit cards.[2] This trend away from the use of notes and coin will tend to increase the *PT/PY* divergence over time, though the total value of cash payments is likely to be so small in relation to the total that it is unlikely to make much difference. Certainly, as we shall see in a moment, if we compute the *PT* series including the CHAPS payments, any trend in cash transactions will be swamped.

Table 1 shows the total of non-cash transactions in the final month of 2007 together with the percentage breakdown by type.

Table 1: Total payments by method, December 2007

Payment method		*Value, £mn*	*As % of total*
BACS		324,267	6.04
CHAPS		4,949,520	92.17
Cheque and Credit		96,104	1.79
	Total	5,369,891	100

Source:

Figure 1 plots *PT* (excluding CHAPS) in relation to GDP at current prices for the period December 1972 to December 2008. It shows, as we said at the outset, a fairly steady or slightly downward trend (at about twice the value of GDP) until December 1978, rising thereafter to about three times the value of GDP at the end of the 1980s, since when it has fluctuated around a slightly rising trend.

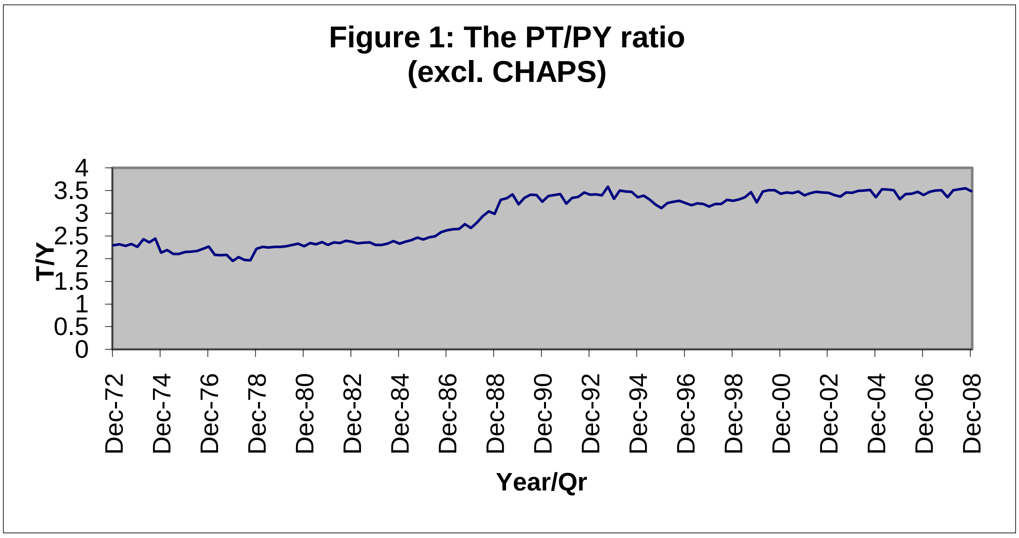

Figure 2 plots *PT* against GDP at current prices but this time includes the value of CHAPS payments. As we would expect from the data in table 1, the inclusion of the latter changes the picture significantly. Firstly, the ratio starts at around 20 (compared

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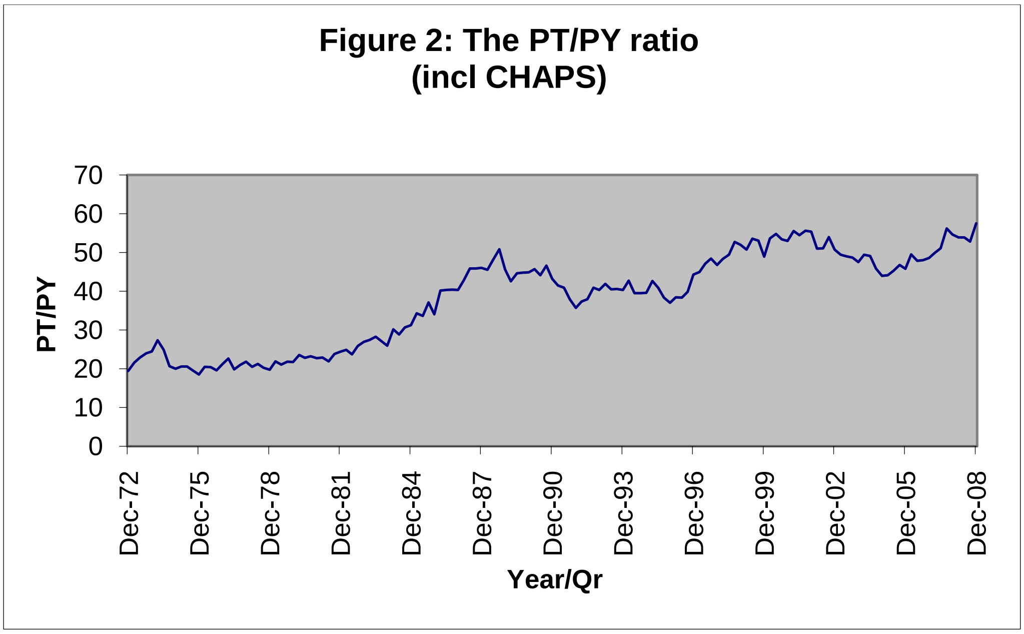
[2] APACS, *UK Payment Statistics 2007*,shows a 3.7 per cent decline in the volume of cash payments between 2006 and 2007. pp.78-9

with 2 in figure 1). During the 1980s it shows a much steeper rise, peaking at 50 (instead of 3) and somewhat earlier. Thereafter it falls back to 40 but then resumes a clearly upward trend with greater volatility.



5. Methodology and estimation

In this section we estimate an M4 income velocity equation for the UK, starting from the velocity function [1] specified by Leão, (2005 p. 122):

$$\underset{}{\mathrm{V1}} = f(\underset{(+)}{W},\ \underset{(+)}{\pi},\ \underset{(+)}{i^s},\ \underset{(+)}{i^l},\ \underset{(+)}{i^e},\ \underset{(+)}{Y},\ \underset{(+)}{\frac{\mathrm{M3}}{\mathrm{M1}}},\ \underset{(?)}{\sigma^{\mathrm{M1}}}) \qquad [1]$$

where V1 is the income velocity of M1, *W* is the weight of investment and durable goods in aggregate expenditure and π is inflation. The various *i* terms show the return on short and long-dated bonds and on equities respectively, *Y* is real income, M3/M1 is the ratio of broad to narrow money and is Leão's proxy for non-GDP transactions and σ^{M1} represents the volatility of M1 growth.

Compared with [1], our modified model is:

$$\mathrm{V4} = f(\underset{(+)}{\pi},\ \underset{(+)}{i^s},\ \underset{(+)}{i^l},\ \underset{(+)}{i^e},\ \underset{(+)}{Y},\ \underset{(-)}{\frac{T^{ex}}{Y}},\ \underset{(?)}{\sigma^{\mathrm{M4}}}) \qquad [2]$$

The signs in parentheses indicate the expected signs of the estimated coefficients. V4 is real GDP relative to real broad money (M4). Inflation (π), the short-term interest rate (i^s), the long-term rate (i^l) and the return on equity (i^e) are all included, as in Leão as representing various opportunity costs of holding money. Also following Leão, real income, *Y*, is included with a positive sign on the Baumol-Tobin basis that an increase in income should have a less than proportional rise in money demand. Additionally, non-GDP transactions are calculated as the ratio of total (real) transactions (excluding CHAPS) to real GDP. This replaces Leão's M3/M1 proxy. Our argument is that a rise in (total) transactions relative to income should increase both the demand for credit (and hence the deposit counterparts) and the demand for money, relative to income and hence *income* velocity should fall. The final term, indicating the volatility in the rate of growth of M4 volatility is included (again as per Leão) in recognition of Benjamin Friedman's (1984) argument that the more uncertain is the path of the money supply, the larger the money balances that agents will wish to hold relative to income. In this argument, the sign should be negative but Leão left it as an open question in view of the lack of support shown in the subsequent literature. The obvious contrast between [1] and [2] is the disappearance of the W term, which represented Leão's central hypothesis that velocity varies cyclically because of the changing 'weight' of capital and durable goods in aggregate expenditure at different points of the cycle. Its absence in [2] has a number of explanations. Firstly, Leão's argument relies upon shifting holdings of narrow versus broad money. Essentially it is that capital expenditures are closely synchronised with M1 balances because these are augmented from savings/time deposits immediately prior to the transaction. In other words, the velocity of these expenditures is very high. But this argument clearly makes no sense where the dependant variable is broad money itself, since all balances, sight and time are contained therein. Secondly, our argument is quite different and relies upon the endogeneity of money in modern economies. Very simply, if total transactions increase more rapidly than income transactions, broad money will expand more rapidly than income and so income velocity will fall. This has no connection with the composition of aggregate demand.

One variable which is missing and which one might argue could play a role where broad money velocity is concerned is money's own rate of interest. This is because the opportunity cost of holding money which is dominated by interest-earning deposits is strictly a 'spread' term capturing the difference between the return on a near substitute and the average rate on money itself. Calculating money's own rate with any precision is of course a difficult task since it requires detailed data on the composition of deposits as well as the interest rates paid on each class of deposit. Needless to say, this data is not available. In the past, we have calculated an 'own rate' by attaching a zero rate to the 'non-interest-bearing M1' components and an arbitrary, single, deposit rate to the rest of M4. But with NIBM1 data no longer available, this is not possible. And, anyway, one might argue that trying to capture the shifting balance between interest and non-interest bearing components was useful for the 1980s when the balance was shifting significantly, but is probably irrelevant now.

For a precise definition of the variables and the data sources, see the Appendix. The sample period is from 1975, first quarter until 4th quarter 2008, so that there are 136 observations for estimation and inference. In empirical work, a semi-loglinear form is generally an acceptable approximation to [2]. The scale variables are seasonally adjusted and in logarithmic form, and all other variables are not. All rates are annualised and in percentages. Rewriting [2] in the light of these modifications results in:

$$(y - m4) = f(\underset{(+)}{\pi},\ \underset{(+)}{i^s},\ \underset{(+)}{i^l},\ \underset{(+)}{i^e},\ \underset{(+)}{y},\ \underset{(-)}{(t^{ex} - y)},\ \underset{?}{\sigma^{M4}}) \qquad [3]$$

Where y is real GDP, m4 are real money balances, the interest rates are defined as before, $(t^{ex} - y)$ is the logarithm of the ratio of real transactions to real GDP and σ^{M4} is the 4-quarter moving average of M4 growth.

A conventional vector error correction model (VECM) is applied, since the variables in [3] may feature as part of several equilibrium relationships that simultaneously determine each of the variables. Using a single equation method to determine one cointegrating relationship when in fact there are more, it is not possible to obtain unique estimates of the cointegrating vectors since all that can be attained is a linear combination of the two or more cointegration relationships. This problem is particularly imperative here, since the set of variables in [3] contains various interest rates and we know that interest rates are pairwise cointegrated. Applying single equation cointegration for velocity as determined by [3] will result in a hybrid estimate of various cointegration relations. But, even if there were only one cointegrating vector, Monte Carlo studies show that the bias can be substantial in small samples and coefficients are estimated inefficiently (Inder, 1993).

Before estimating the VECM, unit root tests for all variables that have not been hitherto widely tested, are presented in Table 2 below. The transactions ratio has a unit root (see also graphs in the appendix), while both, the measure for volatility and equity return are stationary. Even though Leão reports non-stationarity for US equity returns, our result is in line with the majority of the finance literature which treats returns as stationary. The remaining variables are treated as non-stationary, as in the vast existing literature.

Table 2: Unit root tests

Variable	lag	ADF constant	Probability	ADF trend	lag	Probability	I
$(t^{ex}$-$y)$	0	-2.16	0.224	-1.22	0	0.902	1
d$(t^{ex}$-$y)$	2	-5.49***	0.000	-13.25***	0	0.000	
σ^{M4}	12	-3.34**	0.015	-3.60**	12	0.033	0
i^e	0	-11.22***	0.000	-11.76***	0	0.000	0

'**' and '***' indicates non-rejection of stationarity (at the respective level of differencing) at the significance level of 5% or 1% or lower, respectively.

Interest rates move closely together and the correlation coefficient between the long- and short-term rates is about 0.8. Including both variables may make it difficult to distinguish the individual effect of each rate on velocity. This can be overcome by transforming the two interest rates into a 'spread', which is defined as the difference between the long- and short-term rates. The 'spread' is a stationary variable, since interest rates are cointegrated.[3] Its interpretation in the velocity equation is that a rise in the term structure (an increase in the spread) reduces the demand for real money holdings and thus increases velocity (Dreger and Wolters, 2009).

In view of the results of the unit root tests and the stationarity of the 'spread', the set of non-stationary variables $(y - m4), y, (t^{ex} - y), \pi$ can be tested for cointegration. Table 3 shows the results of the cointegration tests:

[3] The trace test for the long- and short rates is 23.93 with a probability level of 0.014. The coefficient restriction $(i_l = i_s)$ is not rejected with $\chi^2 = 0.522$ and a probability level of 0.47.

Table 3: Cointegration Tests

No of CVs	Trace Statistic	Prob.	Max.-Eigenvalue Statistic	Prob.
0	55.84***	0.0074	38.71***	0.0013
≤1	17.14	0.6299	15.31	0.2677
≤2	1.83	0.9969	1.82	0.9942
≤3	0.005	0.9451	0.005	0.9451

All models are estimated with unrestricted constant. A **, *** indicates significance at the 5% and 1% level or below.

Both cointegration tests show that there is one cointegrating vector. Since our interest is in the relationship as shown in [3], for the estimation of the long-run velocity relationship, the stationary variables (spread, return on equity and money growth volatility) are included. Table 4 shows the long-run relationships, with varying restrictions on the coefficients (models I to III). All cointegrating relationships are normalised as to represent velocity. Firstly, we turn to the long-run relationships in the upper part of the table. This part is followed by the results of the short-run adjustment coefficients. The first cointegrating relationship (I) is just identified and shows that income velocity is correctly and significantly explained by the ratio of total transactions, the inflation rate and the return on equity. The coefficient of total transactions ratio is close to minus one. The second cointegrating vector (II) imposes over-identifying restrictions on the long-run equation, by restricting the coefficients of the insignificant variables (spread and volatility) to zero and the coefficient on the transactions ratio to -1. The four over-identifying restrictions are not rejected. For both long-run equations I and II, all adjustment coefficients (see lower section of Table 4) are insignificant, except the adjustment coefficient of the short-run equity return equation. III restricts jointly all the insignificant adjustment coefficients as well as the long-run coefficients, as in II. The restrictions are not rejected as the chi-squared statistic confirms.

Table 4: Cointegrating Vectors and Tests for Weak Exogeneity

Variables	I	II	III
(y-m4)	-1	-1	-1
$(\boldsymbol{t^{ex}} - \boldsymbol{y})$	-0.816*** (-2.29)	-1	-1
y	-0.093 (-0.46)	0	0
$\boldsymbol{\pi}$	0.030*** (2.95)	0.023*** (3.09)	0.020*** (2.45)
spread	-0.017 (-1.20)	0	0
$\boldsymbol{i^e}$	0.010*** (9.07)	0.012*** (9.54)	0.013*** (9.49)
$\boldsymbol{\sigma^{M4}}$	-0.066 (-1.26)	0	0
Over-identifying restrictions	None	$\chi^2(4)$ =3.07 [0.546]	$\chi^2(9) = 6.69$ [0.700]

	Adjustment Coefficients		
d(y-m4)	0.001 (0.26)	0.002 (0.54)	0.003 (0.90)
d$(\boldsymbol{t^{ex}-y})$	0.011 (1.46)	0.009 (1.41)	0.000
dy	-0.001 (-0.37)	0.001 (0.62)	0.000
d $\boldsymbol{\pi}$	-1.810 (-1.55)	-1.409 (-1.45)	0.000
dspread	0.275 (0.80)	0.130 (0.45)	0.000
$\boldsymbol{di^e}$	-108.08*** (-9.20)	-91.11*** (-9.39)	-87.64*** (-9.47)
$\boldsymbol{d\sigma^{M4}}$	0.214 (1.33)	0.085 (0.63)	0.000

t-statistics are below the estimated coefficients. *** indicates significance at the 1% level or below.

The results of III suggest that real broad money grows by the same amount as real GDP (note the zero coefficient on y). Also, there is no support for the Baumol-Tobin hypothesis. A positive coefficient of income would have indicated that balances held for transactions purposes are temporarily invested in securities which are converted into money when required. Thus, the demand for money would fall and velocity rise. It is not surprising that there is not such an effect in the estimations here, since the dependent variable is the income velocity of broad money. There may very well be temporary shifts from transactions deposits to sight and savings deposits. This re-balancing of the portfolio cannot be observed for M4 velocity and thus may explain the insignificant coefficient on income. Additionally, the finding that income and money grow proportionally by the same amount has been empirically supported by a vast amount of the literature on money demand estimations.[4] Furthermore, III shows that (real) broad money rises proportionally with (real) non-GDP transactions, thus reducing velocity proportionally with the rise in non-GDP transactions. III can thus be re-written as a broad money demand relationship, where M4 grows at the same rate as total transactions (GDP and non-GDP transactions). The implication is that money demand estimations, which exclude wealth effects, are mis-specified.[5] This is also supported by Boone and van den Nord (2008), who find significant wealth effects for the euro area.[6] Also, both opportunity cost measures, inflation (π) and the return on equity (i^e) increase income velocity, as expected. Monetary volatility is not significant and thus there is no support for Benjamin Friedman's (1984) hypothesis that monetary volatility increases uncertainty, increasing the demand for money and thus reducing income velocity.

Turning to the lower section of Table 4, ideally, the adjustment coefficient for the short-run velocity equation would have been negative and significant and the remaining adjustment coefficients were insignificant. Even though the coefficient of the speed of adjustment for the short-run velocity equation is not significant, this does not imply that the long-run equation does not represent a velocity equation. There may be a velocity relation in a conditional error correction model (Wolters et al,

[4] Recent references are Dreger and Wolters (2009) and Andrés et al (2009).
[5] They typically depict a coefficient of greater than one wrt the income variable.
[6] See also Dreger and Wolters (2009), and many more.

1998). Since Inder (1993) shows that even in the presence of endogenous variables, estimates are precise and the t-statistics are valid, we continue with estimating a single equation error correction model for income velocity, where the only endogenous explanatory variable may be the return on equity.[7]

Initially, the contemporaneous first differences of the non-stationary variables and the first three lags of the variables and the residuals of the cointegrating vector (III) are included to estimate the error correction model for income velocity. Additionally, the stationary variables *spread*, *return on equity* and *volatility* were included. Insignificant variables were excluded and the result of the structural error correction equation is:

$$\underset{}{d(y-m4)_t} = \underset{(0.027)}{-0.004} - \underset{(0.000)}{0.035ecm_{t-1}} + \underset{(0.000)}{0.001\Delta\pi_t} - \underset{(0.021)}{0.01{i^e}_{t-1}}$$
$$+\underset{(0.000)}{0.783d(y-p)_t} + \underset{(0.000)}{0.339d(y-m4)_{t-1}} + u_t \qquad (6)$$

$R^2 = 0.33$ SE = 0.012 LM(1) = 1.24 (0.265) ARCH(1) = 0.56 (0.453)

The values below the coefficients and those following the diagnostic tests are significance levels. As expected in a stable system, the error correction term is negative and significant, albeit, it is very small, indicating a high degree of inertia. Also, in the short-run, there is no effect of volatility on velocity. This is in contrast to Leão, who finds a significant short-run effect.

A systematic comparison of our results against Leão's makes little sense since he was estimating a narrow money velocity in which the composition of aggregate demand played a role, while we have focused on M4 velocity where the weight attaching to durable expenditures is not going to be relevant. However, it is of some interest that both sets of results indicate a similar role for non-GDP transactions. The M3/M1 term in Leão was significant and positively signed (recall that a *rise* in M3/M1 indicates a *decrease* in non-GDP transactions).[8] A decrease in non-GDP transactions in our model also leads to a rise in velocity. Moreover, in Leão's preferred cointegrating equation (2.6 p. 125 and p. 128) the income variable is also restricted to proportionality with the demand for transactions balances, a restriction which was also found valid in the estimation for the UK. In line with Leão's results, we find no support for Friedman's idea that the volatility in money's growth rate exercises a positive influence on the (cointegrating) demand for money (a negative effect on velocity). Leão finds this term important in the error correction model, while for the UK, there is no such evidence.

6. Conclusion

In this paper an income velocity equation for broad money is estimated for the UK. The specification of the relationship incorporates the selection of explanatory variables as suggested by Leão for income velocity of narrow money in the US, with the important omission of the weight variable, which has no place in the estimation of broad money velocity. The importance of non-GDP transactions was recognised and measured with a proxy by Leão. This paper benefits from including an explicit non-

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[7] The equation can be estimated by instrumental variables should return on equity enter contemporaneously.

[8] Unfortunately, the importance of the variables in the long-run relationship is difficult to judge since no tests of significance could be reported.

GDP transactions variable and the results show a significant reverse relationship between income velocity and non-income transactions. Furthermore income velocity falls at the same rate as non-income transactions increase. This implies that the income velocity equation can be re-written as a broad money demand equation showing that M4 grows at the same rate as total transactions. It follows that money demand equations that ignore wealth effects in the UK are mis-specified.

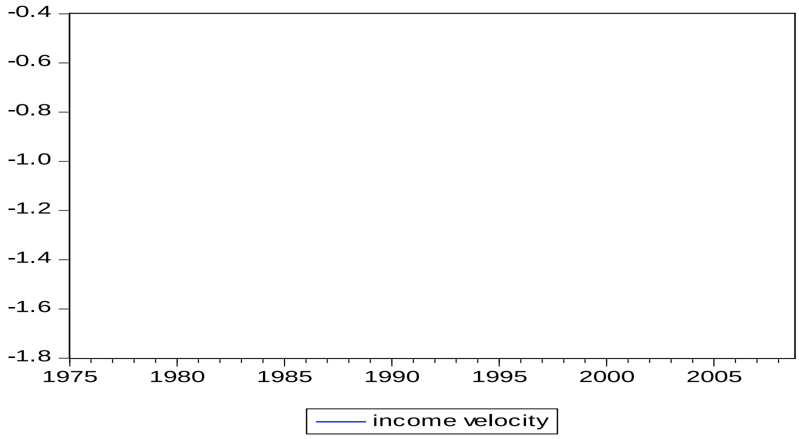
Data Appendix

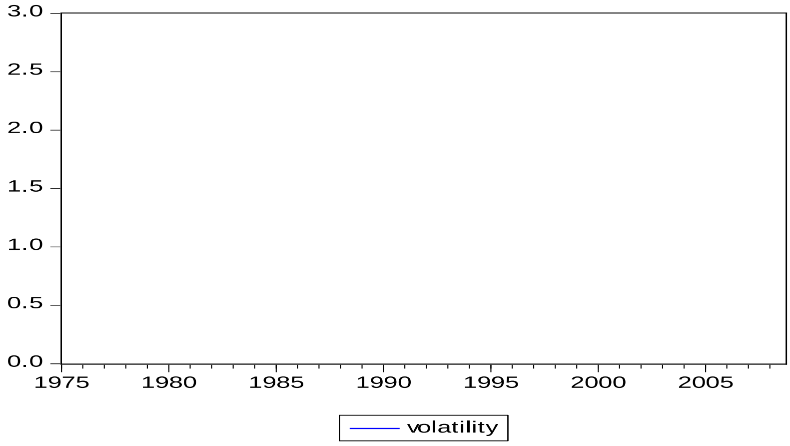
Quarterly and seasonally adjusted data from 1975Q1 – 2008Q4

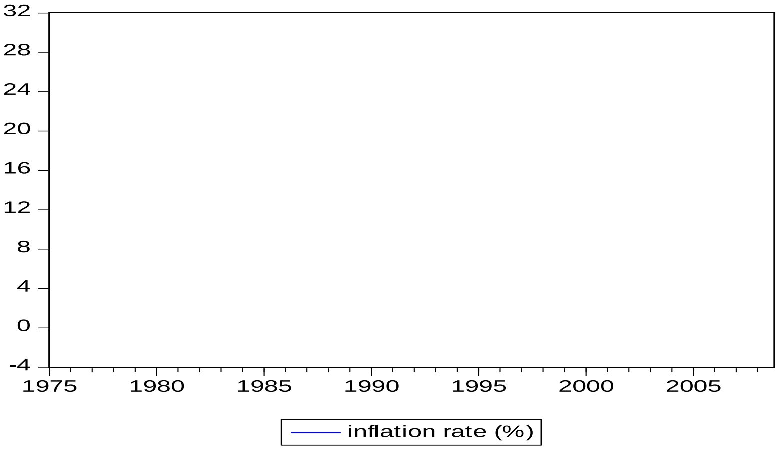
Tex:	total transactions exclusive CHAPS (s/a, Censor 12)
TT:	total transactions (s/a, Censor 12)
π:	annualized inflation in %; $4 \times (\ln def_t - ln\ def_{t-1}) \times 100$
def:	GDP deflator; datastream
Y^r:	real GDP (s/a); ONS
Y:	nominal GDP (s/a); ONS: YBHA
M4:	s/a, BoE: LPQAUYN in £m
σ^{M4}:	moving average of standard deviation of M4 growth over 4 quarters (in percent)
i^s :	BoE: 3-months Treasury Bill rate (%), IUQAAJNB
i^l :	BoE: long rate (%)
i^e :	ONS: HSEL % change in FTSE all share; annualized

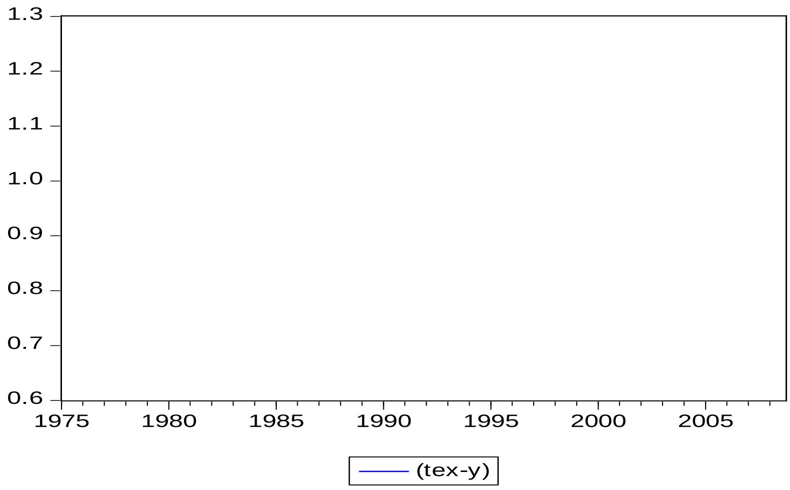
All rates are annualized and lower case letters denote variables in logarithms. The exception are interest rates and volatility, which are in levels. All data are seasonally adjusted. Note that we only calculated capital appreciation in the equity return. The time series that we could obtain including dividend yield, too, was too short.

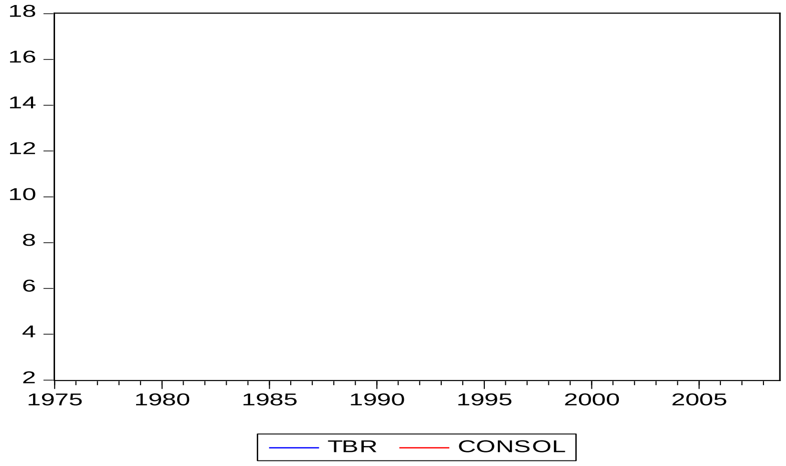
Graphs of the variables used in the analysis

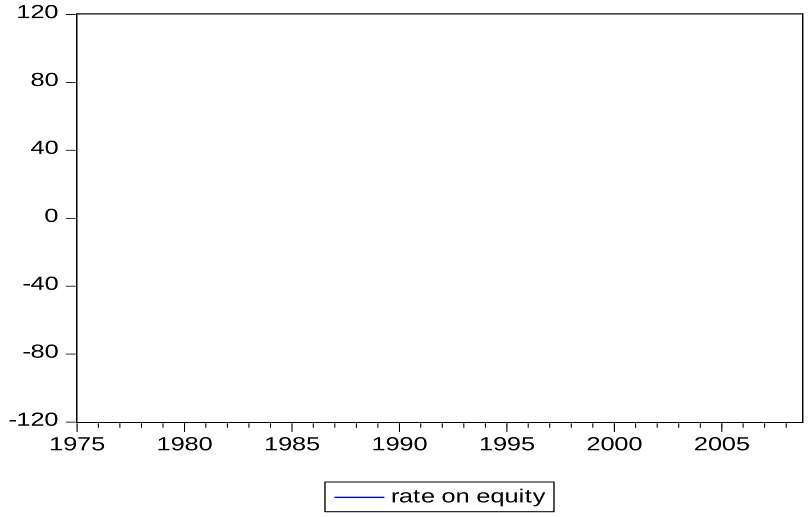


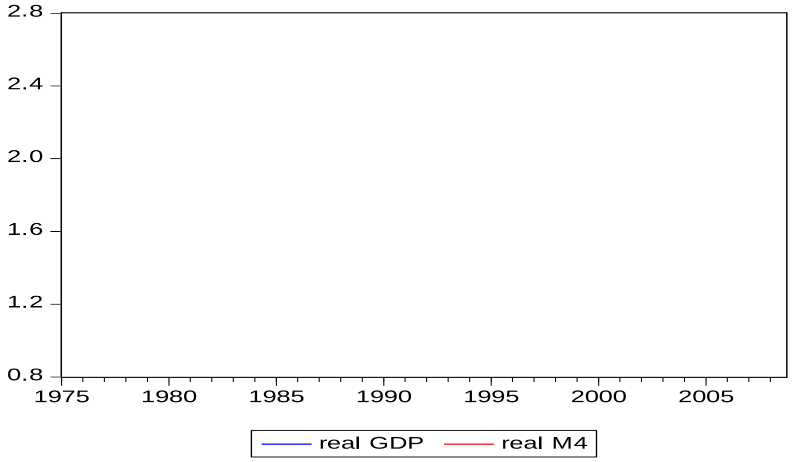

3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1980
1985
1990
1995
2000
2005
volatility

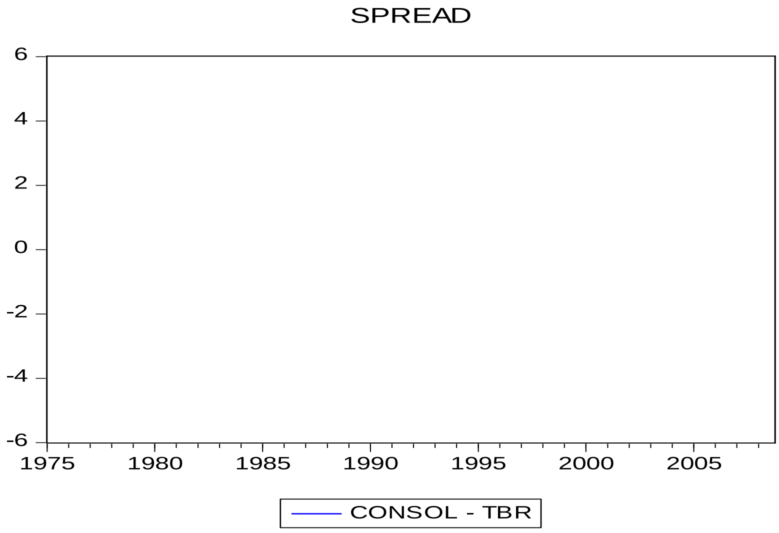

32
28
24
20
16
12
8
4
0
-4
1975
1980
1985
1990
1995
2000
2005
inflation rate (%)


1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
1975
1980
1985
1990
1995
2000
2005
(tex-y)

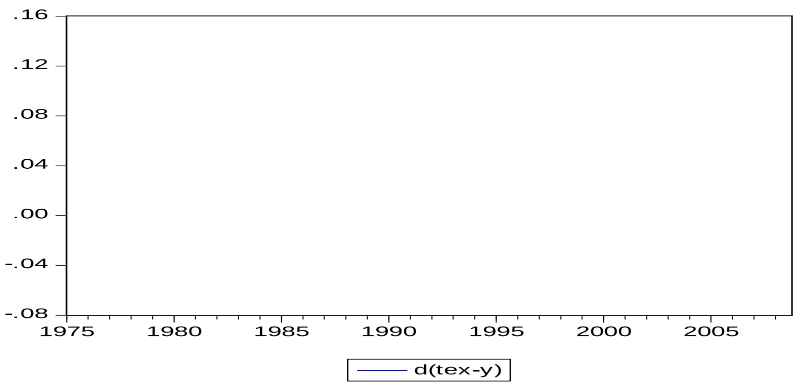

18
16
14
12
10
8
6
4
2
1975
1980
1985
1990
1995
2000
2005
TBR
CONSOL


120
80
40
0
-40
-80
-120
1975
1980
1985
1990
1995
2000
2005
rate on equity


2.8
2.4
2.0
1.6
1.2
0.8
1975
1980
1985
1990
1995
2000
2005
real GDP
real M4



First differences of the transactions ratio



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