Wealth, Credit Conditions and Consumption: Evidence from South Africa

Janine Aron, *Department of Economics, and Institute for New Economic Thinking at the Oxford Martin School, University of Oxford, U.K.*

and

John Muellbauer, *Nuffield College, and Institute for New Economic Thinking at the Oxford Martin School, University of Oxford, U.K.*

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Abstract: There is widespread disagreement about the role of housing wealth in explaining consumption. This paper exploits liquid and illiquid wealth time series from household balance sheet data for South Africa, previously constructed by the authors, to explain fluctuations in the ratios of consumption and household debt to income in South Africa, from 1971 to 2005. The paper emphasizes the role of substantial credit liberalization and of wealth, treating credit conditions as a latent variable with key interactions with drivers of consumption and debt. Credit conditions are proxied by a spline function entering jointly estimated consumption, debt and income expectations equations in a 'latent interactive variable equation system' (LIVES). The empirical results corroborate the theory in the paper, confirming that consumption relative to income is driven by credit liberalization, fluctuations in a range of asset values and asset accumulation, uncertainty and income expectations, inter alia. The paper confirms a collateral interpretation of housing wealth on consumption as opposed to a life-cycle interpretation. The paper also throws important light on the monetary policy transmission mechanism in South Africa.

Keywords consumption, household debt, credit market liberalization, credit conditions, liquid and illiquid wealth, housing collateral and housing wealth

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1. Introduction

There is widespread disagreement about the influence of house prices on consumption, and intensive debate on how monetary policy should react to asset price fluctuations in the context of liberalised credit markets (see Rajan (2005) and associated papers from the Jackson Hole symposium, White (2009) and Mishkin (2011)). Housing markets and their consumption interactions have, in recent years, become an active research area.[1]

Unfortunately, much of the empirical literature exploring the consumption and housing wealth link, both macro and micro, does not control sufficiently for the common drivers both of house prices and consumption. Such controls potentially include income, income growth expectations, interest rates, credit supply conditions, other assets and indicators of income uncertainty (such as the change in the unemployment rate). The easing of credit supply conditions, for instance, is often followed by a house price boom. Failure to control for the direct effect of such credit liberalization on consumption can produce over-estimates of the effect of housing wealth or collateral on consumption. Fluctuations in asset prices and changes in access to credit can lead to large forecasting errors when these variables are absent from the consumption function.

The point above of poor controls is especially pertinent in emerging market economies, where understanding the links between consumption, debt and wealth in the context of liberalised credit markets is of increasing policy importance. One important data deficiency in modelling consumption for emerging market countries is the lack of wealth data for the vast majority of these economies, see Davies (2008). Emerging market stock market prices, house prices when available and private sector broad money have been used as proxies (Funke (2004), Peltonen et al (2009) and Caporale and Sousa (2011)). While these variables are useful proxies for short samples, they cannot capture long-run trends connected with changing household debt and deposit levels, housing accumulation and shifting stock market participation. Secondly, the past two decades have seen extensive domestic credit liberalization in emerging market and developing economies. The micro-data are not available to gauge economy-wide credit conditions. This is a problem for industrialised countries too, and yet the important role of credit markets in influencing consumption and

[1] There are attempts to introduce housing into DSGE models, Iacoviello (2005), and to give some micro-foundations to the financial accelerator via households, Aoki et al. (2004). Recent multi-country empirical studies of the housing-consumption link on macroeconomic data include Slacalek (2009), Case et al. (2005) and Catte et al. (2004). Earlier studies include Kennedy and Andersen (1994). The role of housing in the financial crisis is discussed by Duca et al. (2010).

debt implies credit conditions should be a key control in consumption models. Finally, a coherent treatment of income growth expectations is missing from most published research on consumption, not only for emerging markets.

This paper is a data-intensive exploration of wealth and collateral effects measured by marginal propensities to consume (*mpc*) for a prominent emerging market country, South Africa. We draw on long quarterly time series of wealth estimates on a market value basis developed in Aron and Muellbauer (2006a) and Aron et al. (2006b, 2008). These are the most comprehensive balance sheet data to date for an emerging market or developing economy (generally lacking even a measure of total net worth). An important innovation in this paper is that the *mpc*s are estimated for a three-way split of assets, liquid, illiquid and housing wealth, to emphasise the different "spendability" of such assets. This 'credit-augmented' life-cycle consumption function also includes a measure of consumer credit conditions and its interactions with housing wealth, interest rates, proxies for income uncertainty, and income growth expectations generated by a forecasting model.

South Africa has experienced substantial credit market liberalization as documented in this paper, and rising consumption and debt to income ratios ((Figure 1).[2] Three effects of credit liberalization on consumption are distinguished in this paper. Credit liberalization reduces the credit constraints on households engaging in smoothing consumption when they expect significant income growth. It also reduces deposits required of first-time buyers of housing. Finally, it increases the availability of collateral-backed loans for households already in possession of collateral, see Miles (1992, 1994). The three facets imply a shift in the average propensity to consume, and also important interaction effects as above.

There are no available data to measure credit conditions directly in South Africa. This paper adopts a "latent variable approach", where a credit conditions indicator is proxied by a spline function guided by institutional information on credit market liberalization. Joint debt, consumption and income forecasting equations are estimated and the (unobservable) credit supply indicator enters all three equations. This is the first time the consumption implications of wealth and shifting credit market conditions – especially the time-varying housing collateral effect - have been investigated for an emerging market economy using coherent wealth data, while controlling for other influences on consumption.

We have named this type of equation system a *Latent Interactive Variable Equation System* (LIVES). The latent variable enters interactively as well as additively. The method is

[2] Low saving rates are a symptom of a persistent structural weakness in South Africa (see Aron and Muellbauer, 2000), reflected in a continuing dependence on foreign capital inflows.

an innovative approach[3] to proxy a credit conditions indicator (*CCI*). The paper demonstrates for South Africa that the equations are unstable without controls for structural breaks implied by changing credit market conditions. The empirical evidence supports the three facets of credit liberalization on consumption. For South Africa, where credit markets are now fairly liberal, the *mpc* out of housing wealth has risen; in recent years it has exceeded the *mpc* for illiquid financial wealth, but is less than the *mpc* for net liquid assets.[4] The three-equation sub-system needs to be inserted into a larger econometric model to fully explore the shifting manner in which monetary policy, external and technology shocks are transmitted to output and inflation in a general equilibrium setting.

The outline of the paper is as follows. Section 2 provides a theoretical background for the econometric specification. Section 3 summarises information on wealth and on credit conditions in South Africa. Section 4 sets out the specification of the empirical models while Section 5 discusses the estimation results. Section 6 concludes.

2. Theory Background to the Consumption and Debt Models

2.1 Consumption

We follow the exposition in Aron et al. (2011) in setting out the modernization of the text-book life-cycle or permanent income consumption function required to analyse an economy where shifts in credit market conditions have been important. This solved-out Friedman-Ando-Modigliani basic aggregate life-cycle/permanent income consumption function has the form:

$$c_t = \gamma^* A_{t-1} + \omega^* y_t^P \tag{1}$$

where c is real per capita consumption, y^p is permanent real per capita non-property income[5] and A is the real per capita level of net wealth. This consumption function requires an income forecasting model to generate permanent non-property income. Unlike the Euler

[3] The first implementation of LIVES in the public domain, of which we are aware, is for South Africa, and is summarised in non-technical form in Aron and Muellbauer (2000).

[4] These estimates have recently been complemented by new evidence for wealth effects when accounting for credit liberalization in the U.S., U.K., Australia and Japan (Aron at al., 2011; Muellbauer and Williams, 2011). The USA and Australian studies drew on an earlier version of this South African study in applying the LIVES method to proxy unobservable credit market conditions in a multiple equation setting.

[5] Non-property income is the relevant income concept in standard life-cycle models where property income is defined by rates of return on assets, and assets are choice variables.

equation, see Hall (1978), it does not ignore long-run information on income and assets, though in the formulation above the distinction between types of assets is ignored. This general approach also has a basic robustness feature missing in the Euler equation. Euler equations require well-informed households continuously and efficiently trading off between consuming now and consuming next period, but fail basic empirical tests.[6] In contrast, the extension of equation (1) discussed below is consistent with a fairly rudimentary comprehension of life-cycle budget constraints. Any household with some notion of wanting to sustain consumption will realize that not all of its assets can be spent now without damaging future consumption, and that future income has a bearing on sustainable consumption. As we shall see, practical applications of extensions of equation (1) capture these basic ideas.

Since consumption and income tend to grow exponentially, formulating the consumption function in logs has advantages. The log approximation of equation (1) is: [7]

$$\ln c_t = \alpha_0 + \ln y_t + \gamma A_{t-1}/y_t + \ln\left(y_t^P/y_t\right) \qquad (2)$$

where $\gamma = \gamma^* / \omega^*$ and $\alpha_0 = \log \omega^*$.[8] The log ratio of permanent to current income $\ln\left(y_t^p/y_t\right)$ reflects expectations of income growth and in practice can be proxied by functions of forecasted income growth rates.

The difference between log permanent income and log current income in equation (2) can be closely approximated by an expression in logs of expected future non-property incomes:

$$\ln\left(y_t^p/y_t\right) = \left(\Sigma_{s=1}^k \delta^{s-1} E_t \ln y_{t+s}\right) \Big/ \left(\Sigma_{s=1}^k \delta^{s-1}\right) - \ln y_t \qquad (3)$$

[6] The extreme assumption in the Euler equation is one of full rationality: consumers are assumed to face linear budget constraints (they can borrow as much as they like at a given interest rate) and to continuously optimise their spending and portfolio decisions taking full account of all publicly available information. See Campbell and Mankiw (1991) for international evidence rejecting the central prediction of the Euler equation, that consumption growth should be unpredictable given past information.

[7] After taking logs, two approximations are used: first, the fact that $\ln(1+x) \approx x$ for small values of x, and then the further approximation, $\left(y^P - y\right)/y \approx \ln\left(y^p/y\right)$, see Aron et al. (2011).

[8] One important advantage of equation (2) is that it avoids the log assets formulation employed in many studies of consumption. The log formulation is a poor approximation when asset levels are low, as is true for many households, especially in emerging economies. It is also a poor approximation when testing hypotheses on disaggregated assets.

Here δ is a discount factor, for example 0.95, so that future expected incomes are discounted more and more heavily as the horizon extends. This expression is also equivalent to a weighted moving average of forward-looking income growth rates. A dynamic specification of the static form, for instance to introduce habits or adjustment costs, implies a partial adjustment form of equation (2).

If real interest rates are variable, standard consumption theory suggests the real interest rate r_t enters the model with the usual interpretation of inter-temporal substitution and income effects. Extending the model further to include probabilistic income expectations suggests the introduction of a measure of income uncertainty, θ_t . With income uncertainty, the discount factor, δ, in expected income growth as measured by $\ln\left(y_t^p/y_t\right)$ should incorporate a risk premium, allowing the possibility that households may discount the future more heavily than by the real rate of interest..

This gives the following generalisation of the canonical permanent income model of consumption in equation (2):

$$\Delta \ln c_t \approx \lambda(\alpha_0 + \alpha_1 r_t + \alpha_2 \theta_t + \ln y_t + \alpha_3 E_t \ln\left(y_t^p/y_t\right) + \gamma A_{t-1} / y_t - \ln c_{t-1}) + \varepsilon_t \qquad (4)$$

where λ measures the speed of adjustment. In principle, the coefficients: α_3, δ and γ, could depend upon the real interest rate, r_t and on θ_t , since discount factors applied to expected incomes will increase with income uncertainty. For simplicity, this complication and the associated potential non-linearities are ignored here.[9]

In practice, there are a number of reasons why income growth expectations embodied in $\ln\left(y_t^p/y_t\right)$ are likely to reflect a relatively limited horizon. With aggregate data it is difficult to forecast income beyond about three years except by reversion to a trend. Furthermore, shorter horizons are suggested if households anticipate future credit constraints, according to the buffer-stock theory of saving explained in Deaton (1991). Precautionary behaviour also generates buffer-stock saving, as in Carroll (2001a,b), where it is argued that plausible calibrations of micro-behaviour can give a practical income forecasting horizon of

[9] Note that household heterogeneity in equation (1) would make $\gamma^* = \sum_h \gamma_h^* A_{h,t-1} / \sum_h A_{h,t-1}$ and $\omega^* = \sum_h \omega^*_h y^P_{ht} / \sum_h y^P_{ht}$ where the h subscript indicates household h. With a slowly evolving distribution of permanent income and of assets and of the age distribution of the population, this could generate some time drift in $\gamma = \gamma^* / \omega^*$ and in $\alpha_0 = \log \omega^*$.

about three years. This horizon was originally suggested by Friedman in his application of the permanent income hypothesis to aggregate consumption data.

The formulation in equation (4) still needs to split up assets into different types with different spendibilities. One reason is that housing wealth differs fundamentally from financial assets since a roof over one's head gives shelter (has utility value) as well as having an asset value. The second reason is that, with credit constraints, housing wealth has a collateral role see Muellbauer (2007) or Aron et al. (2011) for further discussion.[10] A third reason is that illiquid financial assets, subject to asset price volatility, and in the case of pensions, to trading restrictions, are different from liquid financial assets[11] and debt. Variations in household access to credit induce time variation in key parameters of the consumption function. This suggests the following 'credit-augmented' version of the Friedman-Ando-Modigliani consumption function:

$$\begin{aligned}\Delta \ln c_t \approx\ & \lambda(\alpha_{0t} + \alpha_{1t} r_t + \alpha_{2t}\theta_t + \alpha_{3t} E_t \ln\left(y_t^p / y_t\right) + \gamma_1\, NLA_{t-1}/y_t \\ & + \gamma_2\, IFA_{t-1}/y_t + \gamma_{3t}\, HA_{t-1}/y_t + \ln y_t - \ln c_{t-1}) \\ & + \beta_{1t}\Delta \ln y_t + \beta_{2t}\Delta nr_t\left(DB_{t-1}/y_t\right) + \beta_{3t}\Delta\theta_t + \varepsilon_t\end{aligned} \qquad (5)$$

The time variation in some of the parameters, seen in their time subscripts, and induced by shifts in credit availability, is discussed below.

The net worth to income ratio has been disaggregated into three elements: *NLA/y* is the ratio of liquid assets minus debt to non-property income, *IFA/y* is the ratio of illiquid financial assets to non-property income, and *HA/y* is the ratio of housing wealth to non-property income, all in real terms. The term $\Delta nr_t\left(DB_{t-1}/y_t\right)$, where *nr*, the nominal interest rate on debt, *DB*, measures the cash flow impact on indebted households from changes in nominal rates. The speed of adjustment is given by λ, and the γ parameters measure the marginal propensity to consume (*mpc*) for each of the three types of assets. The evidence from several countries is that the change in the unemployment rate is a good proxy for income uncertainty, θ_t , or for a shift in income uncertainty. The term in the log change of

[10] Attanasio et al. (2011) use a calibrated partial equilibrium model with a realistic treatment of mortgage constraints to simulate the impact of house prices and income on consumption. Our consumption function can be thought of as an empirical approximation for aggregate date to a micro-simulation model of this type with richness that comes from also distinguishing liquid from illiquid financial assets and linking unemployment and income uncertainty.

[11] Otsuka (2006) has formalised a model in which trading costs for illiquid assets imply a higher spendibility for liquid assets.

income allows for the possibility that some households' spending growth follows current income growth more closely than implied by equation (2). This could also be because some, perhaps less sophisticated, households take current income growth as an indicator for future income growth. Equation (5) has the most basic life-cycle model (i.e. equation (2)) as a special case[12].

The credit channel is reflected in the consumption function through the different *mpc*s for net liquid assets and for housing; through the cash flow effect for borrowers; and by allowing for possible parameter shifts stemming from credit market liberalization. Credit market liberalization potentially should: (i) raise the intercept α_0, implying a higher level of $\ln(c/y)$, mainly because of reduced saving for a housing down-payment – the direct effect of liberalization; (ii) make the real interest rate coefficient, α_1, more negative as scope for inter-temporal substitution rises; (iii) lower α_2 and β_3 because of reduced concern with income uncertainty, though higher debt levels could cancel this tendency; (iv) raise α_3 by increasing the impact of expected income growth; (v) increase the *mpc* for housing collateral, γ_3 with greater access to home equity loans; (vi) lower the current income growth effect, β_1, because fewer credit-constrained households reduces the role of current income; and (vii) lower the cash flow impact, β_2, of the change in the nominal rate since refinancing becomes easier.

With a measurable indicator of the degree of credit market liberality, a credit conditions index (*CCI*), it would be possible to make each potentially time-varying parameter a linear function of the *CCI* and test these hypotheses about time variation.

This equation satisfies long-run homogeneity in income and assets: doubling both, doubles consumption. The long run coefficient on *ln y* is set to 1. This means that the income endogeneity issues which Hall (1978) highlights are not of concern for the measurement of the long-run income and asset effects: variations in asset to income ratios are dominated by movements in lagged asset prices, so that the endogeneity of income is practically irrelevant, except possibly for the estimation of the coefficient on $\Delta \ln y_t$.[13]

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[12] Note that $\lambda = 1,\ \alpha_{1t} = \alpha_{2t} = 0,\ \gamma_1 = \gamma_2 = \gamma_{3t},\ \beta_{1t} = \beta_{2t} = \beta_{3t} = 0$ and $\alpha_{3t} = 1$ are the restrictions which result in equation (2). Equation (5) also encompasses (is more general than, but has as a special case) equation (4).

[13] Note that the long-run coefficient of income equals 1, given the asset to income ratios, and it is not being estimated, so that endogeneity bias cannot arise. Instrumenting the income denominator makes virtually no difference to the estimated coefficients on asset to income ratios. In a wider system, income, asset prices and the portfolios households hold at the end of the previous quarter are, of course, endogenous. Nevertheless, important

2.2 Debt

In contrast to the vast literature on consumption, little systematic econometric work exists on household debt, see the reviews in Fernandez-Corugedo and Muellbauer (2006) and in Meen (1990). The canonical REPIH model of the representative consumer has little to contribute to understanding the determination of aggregate household debt. In that model there is only a single asset, so that it can explain only the evolution of aggregate net wealth. In practice, consumers have multiple motives for holding debt. These include first, consumption-smoothing through temporary income downturns; second, acquiring debt in anticipation of higher future income; third, borrowing to finance the acquisition of consumer durables and housing, human capital investment through education or training, or portfolio investment in financial assets when return prospects look favourable; and finally, using debt to offset what could otherwise be excessive amounts of saving implied by occupational pension rules. Miles (1992) and Brueckner (1994) discuss the borrowing and saving decisions for housing and portfolio investment motives and discuss the consequences of the relaxation of mortgage rationing.

Given asymmetric information between lenders and borrowers, assets have an important collateral role. Most debt is backed by collateral in the form of durables, housing and other assets. In a closed financial system, much of household saving in liquid asset form is recycled by the financial system into lending for other households, suggesting that at the aggregate level, current end-of-period household debt should increase with liquid and illiquid asset stocks, including housing, at the end of the previous period. Variables such as income, interest rates and proxies for income uncertainty, reflecting economic conditions during the period, will also influence current debt. We use a log formulation, linking the log debt to income ratio with log ratios to income of the various assets, and to the log of real income to obtain the following long-run equation for debt:

$$\begin{aligned}\ln debt_t &= \delta_{0t} + \delta_{1t} r_t + \delta_{2t} \ln nr_t + \delta_{3t}\theta_t + \delta_{4t}\ln\left(y_t^p / y_t\right) + \delta_5 \ln y_t \\ &+ \varphi_{1t}\ln(HA_{t-1} / y_t) + \varphi_{2t}\ln(LA_{t-1} / y_t) + \varphi_3 \ln(IFA_{t-1} / y_t) + \varphi_4 DEMOG \end{aligned} \tag{6}$$

insights for policy and for short-term forecasting are obtained from estimates of the partial system proposed here.

This equation incorporates both a real interest rate and the log[14] of the nominal rate, *nr*. The latter reflects the cash-flow constraint on the ability to finance debt and both would be expected to have negative coefficients. The equation also incorporates income uncertainty, the log ratio of permanent to current income, log income, three log asset to income ratios and demographic composition since a younger age structure should be associated with higher levels of debt.

Credit market liberalization should impact in several ways on this long-run relationship. A direct, positive effect on debt should result from the different facets of credit liberalization, with, for example, more freely available credit card loans, lower housing down-payments as a fraction of house values, and housing equity loans more freely available to existing owners. This is why δ_0 should increase with *CCI*. There may also be interaction effects from credit liberalization reflected in time subscripts on some parameters in equation (6): for example, real interest rates may matter more with liberalization, making δ_{1t} more negative, while nominal ones perhaps matter less, making δ_{2t} less negative. Income uncertainty may matter less after liberalization, making δ_{3t} less negative. If households borrow more when they have positive income growth expectations, one might expect the effect of income expectations on debt to increase with *CCI,* increasing δ_{4t}.

More liberal use of housing wealth as collateral for a mortgage should increase the coefficient on housing wealth to income, so that φ_{1t} increases with *CCI*. A reduced coefficient on liquid assets is likely, as bank lending then becomes less constrained by liquid deposit holdings of the personal sector, so that φ_{2t} decreases with *CCI*. Indeed, at the micro-level, households holding significant levels of liquid assets have less need to borrow, suggesting a negative relationship between current debt and lagged liquid assets. On the practical implementation, see below, we adopt an equilibrium correction formulation which adds some short term dynamics.

3. Background on Wealth Data and Credit Conditions in South Africa

South Africa is one of the most unequal societies in the world, with a large informal sector alongside a formal economy with many advanced industrial country parallels. Much of

[14] Note that the debt service ratio, defined by the product of the nominal mortgage rate and debt, scaled by current income, is a cash-flow measure of affordability. The log formulation makes sense since the dependent variable is in logs and plausibly depends on the log of the nominal interest rate and on log income.

aggregate consumption expenditure is thus generated by households working in the formal economy. According to the 2005-6 Income and Expenditure of Households Survey, the top three expenditure deciles accounted for 77 percent of total expenditure. Around 90 percent of mortgages were held by the top three income deciles, accounting for 79 percent of labour plus transfer income. The same survey suggests that around 72 percent of households own a home, with a similar proportion for the top three income deciles.

South Africa has a well-developed banking system and financial markets. The quarterly national income and expenditure accounts and flow of funds data go back to 1970. The quarterly disaggregated wealth estimates on a market value basis used in this paper were constructed in Aron and Muellbauer (2006a) and Aron et al. (2006b, 2008) and appear to be the first systematic attempt to construct comprehensive balance sheet data for an emerging market economy.[15]

The estimates of illiquid and liquid personal wealth are shown in Figure 2. The ratio of household liquid assets minus debt relative to non-property income seems to have been relatively stable in the 1970s. From the mid-1980s to the late 1990s, however, this household net liquid assets ratio fell sharply.[16] This coincided with both a drop in the personal saving ratio, as implied by the income and expenditure accounts, and a switch to saving in pension and retirement funds offering superior returns to those on liquid assets.

Pension wealth has grown relative to income since the 1980s.[17] Between 1987 and 2005, pension wealth was the single biggest asset, given the decline of housing wealth relative to income in the later 1980s and the 1990s, though since 2000 there has been a strong rise in housing wealth relative to income.[18]

[15] The South African Reserve Bank has now taken over production and updating of these data, publishing an aggregate measure of net wealth (Kuhn, 2010).

[16] Financial liberalization from 1983 into the 1990s is partly responsible for the decline, as it reduced the precautionary, buffer-stock and consumption smoothing motives for holding liquid assets. Political credibility effects probably induced currency substitution away from domestic assets and toward illegal foreign assets, especially after 1976 until the democratic elections of 1994. However, the main factor is the negative real after-tax return on liquid assets from the early 1970s to the early 1990s - apart from a brief spell in 1984-5 (see Prinsloo, 2000, p.17). Higher returns help explain the renewed rise in the liquid asset to income ratio from the late 1990s.

[17] Much of the rise in the ratio of pension assets to income can be explained by a weighted average of total return indices for equities and bonds. However, there are other factors, including the relaxation of restrictions on official pension funds (for government employees), which had prevented their holding of equities (Mouton Report 1992); improvement in the returns on government and parastatal bonds with deregulation of interest rates after 1980 and declining inflation in the 1990s; and relaxation of prescribed holdings of government bonds for all pension funds. Tax incentives have also favoured investment in pensions over directly held financial securities.

[18] For further discussion of trends, see Aron and Muellbauer (2006a) and Aron et al. (2006b, 2008).

We briefly summarise the key episodes of credit market liberalization in South Africa that qualitatively inform the latent variable we use to proxy for credit conditions, in the absence of micro-data. The government-initiated liberalization following the de Kock Commission reports (1978, 1985) advocated a more market-oriented monetary policy. Interest and credit controls were removed from 1980, and banks' liquidity ratios were reduced substantially between 1983 and 1985. There may have been a temporary reversal after the third quarter of 1985 as a result of South Africa's international debt crisis, when net capital inflows dropped sharply. Competition intensified in the mortgage market following the 1986 Building Societies Act, and amendments to the Act in 1987-88. Demutualization and takeovers in 1989-90 consolidated the stronger competition in the credit market.

In the 1990s, pensions were increasingly used to provide additional collateral for housing loans; and from 1995, special mortgage accounts ("access bond accounts") allowed households to borrow and pay back flexibly from these accounts up to an agreed limit set by the value of their housing collateral. After the 1994 elections, more black South Africans obtained formal employment, particularly in the public sector, gaining access to credit that previously was rationed on racial lines. Exchange controls on non-residents were eliminated in early 1995 and the ensuing large non-resident capital inflows from mid-1994 induced a further financial liberalization. After the international financial crises of 1997-8, capital flows to emerging markets shrank, partially reversing the previous liberalisation. In 1998, tougher capital requirements were imposed on banks where mortgage lending exceeded an 85 percent loan to value ratio. In May 2002, one of South Africa's micro-lenders, Saambou Bank, had to be rescued; although there was no wider banking crisis, it is likely that bank supervision was tightened as a result. A National Credit Regulator was created in 2005, and a series of Credit Acts, e.g. in 2005 and 2007, regulated lenders. The banking system in South Africa has escaped the global financial crisis relatively unimpaired suggesting well-managed financial regulation and supervision (see Nel, 2009).

4. The Joint Empirical System

4.1 The Estimated Consumption Equation

Section 2 explained various extensions to the aggregate consumption equation (3) in order to incorporate different aspects of financial liberalization and a range of weights for different types of assets.[19]

We analyse quarterly data for 1971-2005, constrained by the availability of wealth stock data (Section 3). Several other data issues arise. Although self-employment is part of the theoretical definition of non-property income, these data are not separately available in the South African national accounts. The real, per capita, non-property income measure, y, consists of tax-adjusted income from employment and transfers from the government. To obtain a proxy for income from self-employment, we assume that it is a constant share of mixed property and self-employment income. If tax-adjusted, self-employment income were a constant fraction φ of property income, y^{prop}, we could replace y by $y + \varphi y^{prop} = y(1 + \varphi y^{prop} / y)$. In our log-formulation, this suggests (y^{prop} / y) as an additional regressor.

A second measurement issue concerns developing a proxy for the change in the unemployment rate, an indicator of $\Delta\theta$, a measure of increased uncertainty. South African data on the unemployment rate are thought to be unreliable. The rate of growth of employment is an alternative proxy (with the opposite sign). However, between the early 1990s and 2004, the sampling frame for the employer-based survey of employment became increasingly out of date, resulting in a downward bias in the measured growth rate of employment.[20]

The resulting consumption equation, corresponding to equation (5), but with minor additions, takes the following form (see Table 1 for variable definitions).

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[19] The South African Reserve Bank's core forecasting model, see Smal et al. (2007), uses an equilibrium correction model linking log consumption with log personal disposable income, log net worth and the real interest rate using data from 1985 to 2005. This is an important advance on earlier models which omitted the role of assets. However, the (commonly-made) assumption that all components of wealth have the same effect on consumption runs counter to economic theory. Housing is a consumption good as well as an asset. Thus, inter-temporal consumption theory implies that a rise in house prices, unlike a rise in the stock market prices, has both an income and substitution effect and a wealth effect on consumption, see Muellbauer (2007). Moreover, liquid assets are necessarily more spendable than, say, pension wealth.

[20] We have had discussions with *Statistics South Africa*. We compensate for this by adjusting the annual growth rate of employment up by 2 percent between 1992-3 and 2004:3 and splice at the breaks in the data in 2002Q3 and 2004Q4. The 2 percent adjustment is phased in gradually between 1992Q1 and 1993Q4.

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\begin{aligned}
\Delta \ln c_t = \lambda[&(\alpha_0 + \alpha_{0c} \times CCI_t) + (\alpha_1 + \alpha_{1c} \times CCI_t)(rma_t)^* \\
&+(\alpha_3 + \alpha_{3c} \times CCI_t)E_t \ln(yperm_t / y_t)^* + \alpha_4 (y^{prop} / y)_t \\
&+\gamma_1 NLA_{t-1} / y_t + \gamma_2 DHIFAma_{t-1} / y_t + \gamma_2 PAma_{t-1} / y_t \\
&+(\gamma_3 + \gamma_{3c} \times CCI_t)(HA_{t-1} / y_t)^* \\
&+\ln y_t - \ln c_{t-1}] \\
&+(\beta_1 + \beta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\beta_2 + \beta_{2c} \times CCI_t)(\Delta_4 nr_t \times debt_{t-1} / y_t)^* \\
&+(\beta_3 + \beta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\
&+\beta_4 \Delta_2 \ln pc_t + \beta_5 \Delta \ln c_{t-1} + dummies + \varepsilon_{1t}
\end{aligned} \quad (7)
$$

In the long-run part of the equation, the speed of adjustment is given by λ while α_{0c} measures the shift in the level of consumption due to the easing of credit conditions. The variable *rma* is the 4-quarter moving average of the real prime rate of interest, which moves closely with the mortgage rate. The star superscript on this and other interacted variables means that the variable is normalized by subtracting its value in 1980Q4.[21] The next two terms are income terms; and the ratio of property to non-property income, (y^{prop} / y), was discussed above. These should have positive coefficients, and the interaction coefficient, α_{3c}, should also be positive. Three asset terms follow and include an interaction effect with housing assets. Illiquid financial assets are split between directly-held assets, *DHIFA*, and pension assets, *PA*, and both are represented by the 4-quarter moving average. This fits better than the end-of-previous quarter value and implies a longer lag in the consumption response. Such institutional lags are expected as some of the response of consumption to changes in pension wealth comes from altered contribution rates.

The remaining terms are the dynamic terms and dummies. As noted above, the uncertainty indicator, $\Delta\theta$, is proxied by the adjusted growth rate of employment. However, the inflation rate could also be an uncertainty indicator, with a negative coefficient, β_4. South Africa suffered relatively high and volatile inflation compared to advanced industrial countries, especially before 2002. The recent inflation rate could also proxy for negative expected income growth effects since nominal wages lag behind prices, or indicate an expected rise in interest rates with negative growth consequences. Negative feedback from the previous quarter's consumption growth onto the current quarter is captured by the lagged change in log consumption.

[21] The purpose of this normalisation is to distinguish the level of CCI alone from its effects when interacted with various variables. CCI is zero at the end of 1980 and then rises.

This equation corresponds closely to the theory discussed in section 2, and tests of more general dynamics accept this specification, though some dynamic and interaction effects prove insignificant.

4.2 The Estimated Debt Equation

An equilibrium correction formulation of the long-run debt equation given by equation (6) is shown in equation (8).

$$\begin{aligned}\Delta \ln debt_t = \delta[&(\delta_0 + \delta_{0c} \times CCI_t) + (\delta_1 + \delta_{1c} \times CCI_t)(rma8_{t-1})^* \\ &(\delta_2 + \delta_{2c} \times CCI_t)(\ln nr_t)^* + (\delta_4 + \delta_{4c} \times CCI_t)E_t \ln(yperm_t / y_t)^* \\ &+\delta_5 \ln y_t + \delta_6 (y^{prop} / y)_t + \varphi_1 \ln(HA_{t-1} / y_t) + \varphi_2 \ln(LA_{t-1} / y_t) \\ &+(\varphi_{1c} \times CCI_t)(\ln(HA_{t-1} / y_t)^* - \ln(LA_{t-1} / y_t)^*) \\ &+\varphi_3 \ln(DIFAma_{t-1} / y_t) + \varphi_{3a} \ln(PAma_{t-1} / y_t) - \ln rdebt_{t-1}] \\ &+(\eta_1 + \eta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\eta_2 + \eta_{2c} \times CCI_t)(\Delta \ln nr_t)^* \\ &+(\eta_3 + \eta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\ &+\eta_4 \Delta \ln debt_{t-1} + \eta_5 \Delta_3 \ln pc_t \\ &+\eta_6 \Delta_8 \ln(popma_t) + dummies + \varepsilon_{2t}\end{aligned} \quad (8)$$

Beginning with the long-run part of the model, the speed of adjustment is given by δ, while δ_{0c} measures the shift in debt levels due to the easing of credit conditions. The real interest rate, *rma8*, enters as an 8-quarter moving average, as the implied dynamic restrictions are satisfied. Its coefficient, δ_1, is expected to be negative. The interaction effect, δ_{1c}, should also be negative, since inter-temporal substitution matters more with easier credit availability. As in the consumption equation, the star superscripts denote that the variable is measured as the deviation from its 1980Q4 value. The log of the nominal rate, *nr,* should have a negative coefficient, δ_2; but since short-run cash flow constraints are reduced with easier credit, the interaction coefficient δ_{2c} is likely to be positive.

The next three terms are in income growth expectations, income and the ratio of property to non-property income. Their coefficients, δ_4, δ_5 and δ_6 , should be non-negative as should the single interaction coefficient δ_{4c}. Note that δ_5 is the overall scale effect measuring the proportionate impact on debt of increasing the other assets and income in the same proportion. The following five terms are the log ratios of assets to income, with coefficients $\varphi_1, \varphi_2, \varphi_3$, and φ_{3a} (where directly-held securities are distinguished from pensions), plus an interaction term in housing and liquid asset wealth with coefficient φ_{1c}. The sign on directly-held securities φ_3 is ambiguous and could be negative since households with such disposable wealth are less likely to need large mortgages. Pension wealth should have a positive coefficient, φ_{3a}, for two reasons: illiquid wealth provides future financial security against which borrowing can make sense; in South Africa, a portion of pension assets can be pledged as collateral for mortgages (see Ling (2009) on the pension-secured mortgage market). Thus, an increase in the size of retirement funds is likely to boost mortgage debt levels.

The interaction term, $(\varphi_{1c} \times CCI_t)(\ln(HA_{t-1} / y_t)^* - \ln(LA_{t-1} / y_t)^*)$, captures interaction effects with the log ratios of housing and liquid assets to income (measured relative to their end-of-1980 values). Mortgage market liberalization should increase the effect of housing collateral on debt, while credit liberalization reduces the constraint on lending from household liquid asset deposits. The final term in the long-run part of the model is log real per capita debt at time t-1.

The short-run dynamics include changes in logs of real per capita non-property income, of nominal interest rate, of employment, of the price level and finally in population, see further discussion below.

4.3 The Estimated Income Forecasting Equation

There were significant regime changes in South Africa during the 1980s with the move to new operating procedures for monetary policy and a series of internal financial liberalizations. Political crises entailed the increasing international isolation of South Africa, reflected in diminished trade and finance, while its mineral dependency as a primary exporter gives an important role to terms of trade shocks in determining income growth.

We derive a forecasting model for the rate of growth of real per capita disposable non-property income, $\log(yperm / y)$, as defined in equation (3). The long-run changes in productivity growth expected in an economy subject to such regime changes are captured with split trends. By incorporating these shifts, the consumption function including the income growth forecasts should be robust to the Lucas critique (Lucas, 1976).

The model has the following form:

$$\ln(yperm_t / y_t) = \alpha_0 + Split_t + \alpha_1 \ln y_t + \sum_{i=2}^{n} \alpha_i X_{i,t} + \sum_{i=1}^{n} \sum_{s=0}^{k} \beta_{is} \Delta X_{i,t-s} + \varepsilon_t \tag{9}$$

where y_t is real per capita disposable non-property income; $Split_t$ are split trends reflecting the evolution of the capacity of the economy to produce and to sustain per capita personal incomes; and the X_is for i=2...n indicate other explanatory variables excluding *ln y*, where $\Delta X_1 = \Delta \ln y$, and k is the maximum lag length considered on changes in the X_is.

This equation can be reformulated as an equilibrium correction formulation with a long-run solution given by

$$\ln yperm = -(\alpha_0 + Split \; + (1 + \alpha_1) \ln y + \sum_{i=2}^{n} \alpha_i X_i) \tag{10}$$

The broad set of explanatory variables in a general formulation from which a parsimonious model was selected include: the level of real interest rates and changes in nominal interest rates, the government surplus to GDP ratio, capacity utilization (as a proxy for the unemployment rate), terms of trade, a measure of trade openness, the real exchange rate, the growth rate of OECD industrial production, domestic credit growth in South Africa, real house prices and a real stock market price index. The changing sensitivity of income growth to interest rates as the monetary policy regime changed is captured by a dummy indicator based on prescribed liquid asset requirements for commercial banks, see Aron and Muellbauer (2002).

To construct log permanent income using equation (3), a 40 quarter horizon was adopted and a quarterly discount factor of 0.95, equivalent to an annual discount rate of about 20 percent.[22] We used actual data on personal per capita income to 2010Q4 and assumed a quarterly growth rate of 0.6 percent thereafter.

4.4 The Credit Conditions Index

Our innovation is to treat credit liberalization as a 'latent variable', an unobservable indicator entering each of the household debt, consumption and income forecasting equations. The indicator, *CCI*, is proxied by a non-linear spline function whose parameters are estimated jointly in the three equations. The common latent variable enters the equations interactively, introducing time variation in key parameters, as well as additively. Hence we term this type

[22] Such a high discount rate is consistent with empirical micro estimates by Hausman (1979) and Warner and Pleeter (2001).

of equation system a Latent Interactive Variable Equation System (LIVES). The method of constructing the CCI is explained in Appendix 1.

5. Empirical Results for South Africa

Variables are defined in Table 1. Stationarity tests[23] indicate that all underlying variables are non-stationary and I(1), except for the real prime rate and the ratio of property income to non-property income, (y^{prop} / y).

To begin with, Table 2 provides estimates of two more standard life-cycle consumption functions *excluding* the latent variable proxy for credit conditions. In columns 1-2, the function corresponds to equation (4) but including net worth as the wealth concept. In columns 3-4, wealth is disaggregated into net liquid assets, illiquid financial assets and housing wealth. Columns 1 and 3 show estimates for 1971Q2 to 2005Q4, excluding a period of 8 quarters just after the release of Nelson Mandela when behaviour may have been affected by temporary euphoria.[24] Columns 2 and 4 show estimates for 1971Q2 to 1994Q1, to check parameter stability before and after democratic elections in 1994Q2. The results are most unsatisfactory: the speed of adjustment and the *mpc* for net worth are not significant, while the coefficient of the log ratio of permanent to current income is negative, though insignificant[25]. The coefficient on the ratio of total personal disposable income to non-property income exceeds unity. In column 3 with disaggregated net worth, the speed of adjustment is now significantly different from zero, and the coefficient on the ratio of disposable income is more plausible, but the estimated *mpc* for net liquid assets is negative, while that on housing wealth is close to zero. For the shorter sample to 1994, the speed of adjustment more than doubles, while the coefficient on net liquid assets is significantly negative. Since the ratio of net liquid assets to income declines as the debt to income ratio

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[23] Stationarity tests are performed for the variables in levels before time-transformation. (These tests are available from the authors on request.

[24] One of the most significant and unexpected events, perhaps the most significant in South Africa's history in this period, was the release from prison of Nelson Mandela in February 1990. This signalled a sea-change in politics towards reconciliation, the abandonment of Apartheid, and the transition to democratic elections. The behaviour of consumption and to a lesser extent of debt in the period immediately after 1990Q1 looks anomalous, suggesting a kind of temporary euphoria. This seems to be hard to explain either as a shift in credit conditions or as a shift in income expectations. Estimating the equation with a single dummy for these quarters produced similar results, but with a slightly worse fit.

[25] For these runs, an income forecasting equation of the same form as those presented in Table 5 below is used, except that log real house prices appears without any interaction with a credit conditions indicator.

rises, it looks as though these results are driven by an *omitted variable* positively correlated with the debt to income ratio. This omitted variable is the credit conditions index.

We now turn to a more richly parameterized system of equations as set out in Section 4.[26] Identification of the latent credit conditions indicator is improved by using information from all three equations. To avoid convergence problems, a set of very loose prior constraints on key parameters in the three equations was imposed, including sign priors on interest rate effects and interaction effects. For the consumption function, estimates were constrained to lie in the following broad ranges: 0.05 to 0.25 for net liquid assets; 0.015-0.06 for illiquid financial assets; and 0.015-0.20 for housing wealth (at the end of the sample). These ranges cover estimates in the international literature.[27] For the debt equation, positive long-run interest rate effects were excluded, and the long-run scale elasticity (to the combination of income and different kinds of wealth) was constrained to lie in the range 1 to 1.6.[28]The latent variable *CCI* could pick up omitted variables unrelated to credit conditions. It is important that all plausible controls, such as income expectations, income uncertainty and interest rate effects, are included in or at least tested in the empirical model, or biases could result in the estimates of wealth or collateral effects and *CCI*.

South Africa has a banking and financial structure more comparable to the Anglo-Saxon economies than to other African economies. The parameter estimates are therefore put into the context of comparable estimates for the UK, US and Australia in what follows.

5.1 The Consumption Equation

The equation system was estimated (omitting the observations just after Mandela's release for 1990Q1 to 1991Q4, see above) and these results are shown in Table 3 column 1. The speed of adjustment λ is estimated at 0.45 (t=10.9), similar to estimates for the UK and US (Aron et al., 2011) and Australia (Williams, 2011). This suggests a well-determined long-run

[26] The FIML estimation for 1971-2005 of the three equation system consisting of equations for consumption, debt and log permanent income/current income was performed in Hall, Cummins and Schnake's Time Series Processor (TSP 4.5) package.

[27] See for example, Slacalek (2009) where his Table 3 reports *mpc*s for the four Anglo-Saxon economies in the ranges 0.037 to 0.081 for aggregate financial wealth, and 0.013 to 0.071 for housing wealth. For the liquid component of financial wealth, the *mpc*s should be higher and lower for the illiquid, mainly stock market, holdings. Slacalek also reports higher *mpc*s out of housing wealth after 1989, consistent with liberalisation of credit conditions, and lower *mpc*s out of financial wealth, consistent with a higher illiquid (stock market) share of total financial assets.

[28] The minimum value of 1 implies that debt grows at least in line with the scale of the economy. The maximum value of 1.6 exceeds estimates for the UK by Fernandez-Corugedo and Muellbauer (2006) and earlier studies, and for Australia by Muellbauer and Williams (2011).

solution for consumption, in sharp contrast to the results in Table 2 that exclude a credit conditions indicator.

Turning to the CCI and its interaction effects, the long-run coefficient, α_{0c}, on *CCI* is highly significant (t=9.0), indicating its crucial direct importance for the long-run behavior of the ratio of consumption to income. Two interaction effects are well determined: the interaction with income growth expectations (discussed further below), and the interaction with housing wealth (t=3.5). Other interactions with the real interest rate and the income uncertainty proxy are not significant, and while the debt/income weighted change in the nominal prime rate interest and its interaction have the right signs, these terms are statistically insignificant. In 2005, *CCI* is estimated to be 0.38 (or 0.47 on an alternative measure, see below) with a peak in 1996 of 0.62 (0.68). The peak estimate of *CCI* of 0.62 is based on a version of the model, under which the maximum value of the coefficient, $(\alpha_3 + \alpha_{3c} \times CCI_t)$ on $E_t \ln(yperm_t / y_t)$ is constrained by the value implied by the permanent income hypothesis.[29]

Including CCI gives plausible marginal propensities to consume out of disaggregated wealth (unlike results in Table 2). Housing wealth when not interacted with *CCI* is completely insignificant (also found for the US, UK and Australia), supporting the collateral interpretation of housing wealth for consumption as against a wealth effect according to life-cycle theory without credit constraints (see Aron et al. (2011) for more detail). The estimated *mpc* for housing collateral in South Africa in 2005 was 0.248x0.38=0.09, and would have been around 0.15 at the *CCI* peak in 1996. The *mpc* out of net liquid assets is estimated at 0.17 (t=3.6) and the *mpc* out of illiquid financial assets is estimated at 0.025 (t=3.2). Splitting illiquid financial assets gives point estimates of around 0.03 for directly held securities and around 0.02 for pension assets, but the differences are not significant. All these *mpc* values are close to those found for the Anglo-Saxon economies, except for housing collateral, where it is far higher than the peak estimates (of the order of 0.05) for the U.K., U.S. and Australia

Figures 3a and 3b show the fitted contributions of the main long-run factors to explaining variations in the log consumption to income ratio. The large contribution of the fitted value of $(\alpha_3 + \alpha_{3c} \times CCI_t) E_t \ln(yperm_t / y_t)$ to the rise in *ln c/y* since around 1990 is notable. It is offset by the decline in the estimated value of *CCI* after 1996, see Figure 4. If

[29] Since $\ln(yperm_t)$ is defined as permanent income at t+1, using a 0.95 discount factor, log permanent income at t is defined as $0.05 \ln y_t + 0.95 E_t \ln(yperm_t)$. This implies that the peak value of $(\alpha_3 + \alpha_{3c} \times CCI_t)$ should not exceed 0.95. However, the freely estimated value is about 0.99. With the constraint imposed that $(\alpha_3 + \alpha_{3c} \times peakCCI_t) = 0.95$, a hypothesis that is easily accepted, we obtain the estimates shown in Table 3, column 1. They imply a coefficient of 0.26 on ln (yperm/y) when CCI=0.

households were not quite as forward-looking at the peak value of CCI, so that $(\alpha_3 + \alpha_{3c} \times CCI_t) E_t \ln(yperm_t / y_t)$ made a smaller contribution, then the estimated *CCI* might fall less after 1996. This could also affect the estimated *mpc* out of housing wealth and out of other assets.

To examine the consequences of slightly less forward-looking households , the system was re-estimated under the constraint $(\alpha_3 + \alpha_{3c} \times peakCCI_t) = 0.75$ which implies that at the peak *CCI*, 20 percent of consumption (=0.95 minus 0.75) is governed by current income rather than by permanent income. This hypothesis is just acceptable, with a probability of 7 percent against the alternative hypothesis that consumption is entirely governed by permanent income. Under this hypothesis, the alternative *CCI* is estimated, peaking at 0.68 and with a value of 0.47 in 2005. This alternative CCI is also shown in Figure 4. The estimated coefficient on the interaction of the alternative CCI and the housing wealth to income ratio in $(\gamma_{3c} \times CCI_t) HA_{t-1} / y_t$ is 0.158, so that the peak *mpc* is estimated as 0.107, and 0.074 in 2005, while the estimated *mpc* out of net liquid assets drops slightly to 0.16, but the *mpc* out of illiquid financial assets is little changed. This robustness check giving greater weight to current income thus results in a lower *mpc* out of housing wealth, reduced by a third at its peak, and closer to what is found for other Anglo-Saxon economies.

The level of the real prime rate has a strongly significant negative effect on consumption (t=-4.2). Employment growth, an indicator of shifting income uncertainty, is also significant (t=4.4), and parallels strong effects for changes in the unemployment rate for the U.K., U.S. and Australia. Its interaction effect with *CCI* is not significant, however. The change in the nominal interest rate, weighted by the debt to income ratio, has a negative point estimate, offset by a positive estimate for the interaction with *CCI*, but neither is significant. This result is similar for Australia, but different from the U.K. where consumer debt-to-income ratios are far higher, and where a larger proportion of households may be vulnerable to changes in nominal rates. However, there is a significantly negative effect on consumption of inflation over the previous two quarters (t=-3.3) which may be an indicator of higher interest rates in prospect. The lagged change in log consumption has a significant negative coefficient (t=-6.2). This could be a reaction to overspending in the previous period and could also reflect the inclusion of durable goods in consumption expenditure, where the need for replacement spending declines if recent purchases were high.

Ideally a demographic proxy could be relevant in the consumption equation. One might expect a negative coefficient for the proportion of the adult population in younger age brackets (e.g. 25-35 or 25-45), as found by Muellbauer and Williams (2011) for Australia. This age group would be expected to be saving for a housing deposit or to repay mortgage debt. For South Africa, unlike in Australia, there are no consistent time series data on the age structure of the population. We employ instead a weak proxy.[30] In the event, the coefficient is positive, which is inconsistent with our theoretical priors and so the proxy was omitted.

The stability of these estimates for samples 1974Q1 to 2005Q4 and for 1971Q2 to 1994Q1, omitting the 1990Q1 to 1991Q4 period, is demonstrated in columns 3 and 4. The LM tests for residual autocorrelation up to the fourth order are satisfactory.

We tested how much the interaction effects add to the fit of the system. The (three) interaction effects can be set to zero in the consumption and debt equations, plus relaxing two restrictions.[31] Though *CCI* remains highly significant, the log likelihood of the system drops by 17.5. Since twice the difference in the log likelihood follows an asymptotic chi-squared distribution, this is a highly significant rejection. Moreover the estimated 'housing wealth effect' then reverses sign (-0.06, t= -2.0). Speeds of adjustment are also somewhat lower. Two other radical differences in this 'no interaction effects' model are the lower contribution of $E_t \ln(yperm_t / y_t)$ with a coefficient of 0.49. The *CCI* from this model also falls after 1996, but it shows a sharper and somewhat implausible rise from 2003 to a level not far below its 1996 peak.

Co-integration analysis

The long-run properties of our credit-augmented life-cycle consumption function were examined in a cointegration analysis. The direct and interaction effects of the credit conditions index were combined into a single index, giving five variables that are integrated of order one, I(1). These are the log consumption to income ratio, net liquid assets to income ratio, illiquid assets to income ratio, the log permanent income to income ratio and the composite CCI effect. The composite CCI effect is defined as $COMPCCI_t = \alpha_{0c} \times CCI_t + \alpha_{3c} \times CCI_t E_t \ln(yperm_t / y_t)^* + \gamma_{3c} \times CCI_t (HA_{t-1} / y_t)^*$. The I(0)

[30] In the absence of reliable time series data on the age distribution of the population, we use the population growth rate as a proxy, since faster growth rates will be associated with a younger age structure. With interpolated annual data, the two-year change of the four-quarter moving average should smooth artificial jumps in the series.

[31] To be precise, α_{3c}, γ_{3c} and the corresponding interaction effect in the debt equation, φ_{1c}, are restricted to be zero. However, the coefficients α_3 and γ_3 are unrestricted in the 'no-interaction effects' specification, so that net only one restriction is being imposed compared to the 'with-interaction effects' model.

variables in the system are the real interest rate, the ratio of property to non-property income, the change in log income, the inflation rate, income uncertainty as measured by the adjusted change in log employment and the impulse dummies. In a VAR for the five I(1) variables, with the I(0) variables entering unrestrictedly, a lag-length of two is tested as acceptable against longer or shorter lags. There is one co-integrating vector with beta weights that are close to the long-run coefficients that were reported in Table 3. The alpha coefficients, measuring the adjustment of each of the I(1) variables to the co-integrating vector have clear implications: only the coefficient for the log consumption to income ratio is significant (with a t ratio of 7.5). The other four I(1) variables are thus weakly exogenous with respect to the log consumption to income ratio.[32]

The finding that consumption adjusts to the co-integration vector linking consumption with income, assets and other variables contradicts the conclusion of the influential paper by Lettau and Ludvigson (2001) that assets (to be precise, asset prices) rather than consumption do the adjusting. We attribute their finding to the omission of shifting credit conditions from the co-integrating vector.

5.2 The Debt Equation

The empirical results for the debt equation are discussed next. Table 4 provides estimates corresponding to columns 1-4 of the consumption estimates in Table 3. The speed of adjustment is high at 22 percent per quarter. For a mortgage debt equation, this would be implausibly high, but for total debt, the sum of flexible, unsecured debt and less flexible mortgage debt, this is not unreasonable. It confirms that there is a strong long-run solution. The coefficient on CCI is normalised at 1 to identify all the coefficients in the CCI spline function. The only significant interaction effect concerns housing and liquid assets. The restriction that the two effects are of equal and opposite magnitudes is easily accepted by a likelihood ratio test. Both nominal and real interest rate effects are significant and negative. The scale effect ($\delta_5 = \varphi_{1t} + \varphi_{2t} + \varphi_3 + \varphi_{3a}$) is estimated at around 1.41, very close to the corresponding U.K. and Australian estimates. However, the net effect of income is zero, which is a surprising result. No doubt financial assets and housing wealth are themselves driven partly by income so that income has an indirect effect. Before liberalization the

[32] We tested whether the current dated I(0) variables were weakly exogenous and found their reactions to the lagged co-integrating vector were insignificant. While it seems implausible that the current change in income should be weakly exogenous with respect to consumption alone, exogeneity with respect to the ratio of consumption to income, as found in the data, is completely plausible.

housing wealth effect was also zero, but becomes highly significant in interaction with CCI (t=5.3). The finding of no effect from directly-held financial assets, but a positive and significant pension asset effect, makes good sense in the South African context, discussed in section 4.

In the dynamics, the change in log employment is strongly significant, as in the consumption equation, and it has the same interpretation as a negative measure of increasing income uncertainty (or a positive one of confidence). Inflation has a negative effect as it does for consumption, with the same interpretation as an indicator of future rises in interest rates or signalling a short-term decline in real income, given sticky wages. But changes in income and interest rates are insignificant. Finally the population growth rate has a positive and strongly significant effect. This result accords with evidence in Fernandez-Corugedo and Muellbauer (2006) suggesting a positive effect on debt from the proportion of the adult population in younger age brackets.

Table 4 confirms that the parameter estimates are fairly stable over the different samples shown. LM tests for residual autocorrelation up to the fourth order are satisfactory. As for the consumption equation, the omission from the debt equation of the credit conditions index produces a far worse fit, with serially correlated residuals, a far lower speed of adjustment and implausible wealth coefficients.

5.3 The Income-forecasting Equation

The log ratio of permanent to current income $\log yperm/y$ was modelled[33] on quarterly data for 1968-2005, though with a restricted lag structure.[34] The included split time trends reflect a slowdown beyond 1984 stemming from the 1985 debt crisis, and faster growth after the release of Nelson Mandela in 1990Q1 and the democratic elections in 1994Q2 following which capital flows increased. In model selection, explanatory variables were retained if they satisfied sign priors as well as being significant: asset price and terms of trade price effects should be positive, real interest rate effects negative, the real exchange rate effect negative, the effect of domestic credit growth positive, and trade openness positive.

[33] Model selection for the equation for permanent income was performed on data from 1968.

[34] For lags longer than three, we restricted the dynamics to fourth differences or four-quarter moving averages, to prevent over-parameterisation.

Table 5 shows estimates of the resulting parsimonious equation and Figure 5 plots fitted and actual values of $\ln yperm / y$.[35] The figure shows a notable increase in the actual and fitted values of $\ln yperm / y$ from the early 1990s. The model has three long-run effects: log real gold prices, log real house prices and the real prime rate of interest. Similar results are obtained using the terms of trade in place of the real gold price. In the dynamics, only changes in log income, changes in nominal interest rates and their interaction with a dummy for prescribed liquidity ratios matter. There are reasons to think that the influence of house prices on future income rose with credit market liberalization. One reason is a general equilibrium argument. If credit liberalization increases the effect of housing wealth on consumption, then, since consumption is of the order of 70 percent of GDP, one might expect an effect on future income from the interaction of real house prices with CCI. Indeed, the interaction effect of log real house prices with CCI is more significant than log real house prices alone. The results for the other equations are robust to the inclusion of log real house prices instead of the interaction with *CCI*.

5.4 The Credit Conditions Index

The method of constructing the CCI is explained in Appendix 1. In practice, 13 parameters were used to define the *CCI* in estimation from 1971Q2 to 2005Q4. Details of the *CCI* parameters are shown in Table 6. Figure 4 shows two versions of the estimated credit conditions index: they reveal a small fall from 1973, strong rises from the early 1980s until just before the debt crisis of 1985, then a temporary reversal, strong rises in 1987-89 and from 1994-95. Interestingly, there is no sign of further liberalization after 1996, when *CCI* has reached its peak value of 0.62 (or 0.68 on the alternative measure discussed further below). Indeed, estimated *CCI* declines from 1997 to 2003 and finally appears to rise slightly from 2004. These patterns are consistent with the evolving institutional picture painted earlier.

An obvious question is whether the estimated CCI partly captures other influences (apart from shifts in credit supply conditions), which, controlling for demand side influences, simultaneously increase household debt and the marginal propensity to spend out of housing wealth. This is not impossible. For example, an increased population share in the 25-45 age

[35] Given the overlapping nature of the dependent variable, the residuals of the equation, as expected, are autocorrelated, as the Durbin-Watson test and LM tests (not shown) confirm.

group for those with incomes high enough to qualify for a mortgage could increase mortgage demand. *Given liberal access to home equity loans*, it could also increase the rate of home equity withdrawal and raise the *mpc* out of housing wealth. To be consistent with the estimated *decline* in CCI after 1997, it is possible that a decline in the relevant population share could be a part explanation. The death rate among South African men aged 25 to 49 more than doubled between 1997 and 2004, while rates among women aged 25 to 39 more than trebled.[36] The AIDS epidemic was likely to have been the main cause. This could have contributed to a decline in the population share of this age group. It is also possible that increasing health risks over this period might also have caused households to become more risk averse and less keen to spend and take on debt.

If the AIDS epidemic was a factor in the decline in CCI after 1997, this would have different policy implications than a decline caused, for example, by tighter credit market regulation. However, the short run aggregate implications for transmission of monetary policy shocks via house prices and household debt are likely to be similar.

5. Conclusions

There is widespread disagreement about the role of housing wealth in explaining consumption. This paper has argued that the empirical literature could be strengthened by better controls for the common drivers of both house prices and consumption. In particular, it is important to control for the direct effect of credit liberalization in models of consumption. Otherwise the effect of housing wealth or collateral on consumption will be over-estimated in countries where easing of credit restrictions is correlated with rises in asset prices. The omission of income growth expectations can also bias estimates of the housing wealth or collateral effect, e.g. discussion by King and Pagano of Muellbauer and Murphy (1990).

This paper has proposed an empirical model, grounded in theory, to measure wealth effects on consumption. The empirical model has more complete controls than generally used in the literature, including controls for shifts in credit conditions and the forecast growth rate of income to proxy expectations. The model is applied to quarterly data for South Africa from 1971 to 2005, and uses wealth estimates on a market value basis (Aron and Muellbauer, 2006a). In the absence of data measuring credit availability, a credit conditions index for South Africa is captured through a spline function that is common to jointly estimated

[36] http://www.statssa.gov.za/publications/Report-03-09-05/Report-03-09-052004.pdf

consumption, household debt and income forecasting equations. The parameters of the spline function reflect qualitative information on the timing of key institutional changes in the credit markets. A major part of the rise of the consumption to income ratio from pre-1980 into the new millenium is explained by easier credit availability, even when offset[37] by rising real interest rates and by the increasing constraint of higher debt levels on spending.

Attempts to estimate a conventional life-cycle consumption function for South Africa fail: only by controlling for the shifts in credit market architecture can a stable long-run relationship be found. The same credit market shifts also induce large and significant parameter shifts in the debt equation. These findings suggest that standard, constant parameter models such as VARs would be unlikely to be robust in the case of South Africa.

Despite the very different macroeconomic histories, there are striking similarities in the consumptions functions found for South Africa and three Anglo-Saxon economies, the U.K., U.S. and Australia (Aron et al., 2011; Muellbauer and Williams, 2011). This is less surprising than it seems at first sight, given the similarities between the banking and financial sectors of these four economies, and the dominance of the formal economy for national accounts aggregates in South Africa. Credit market liberalization increases the average propensity to consume out of income in all four countries and its inclusion in the consumption models brings clear benefits in finding better determined long-run solutions, including negative real interest rate effects on consumption and plausible wealth and collateral effects. The interaction effects found for the other economies, where credit market liberalization increases the roles of expected income growth and of housing wealth on consumption, are also confirmed for South Africa. The marginal propensities to spend out of net liquid assets and illiquid financial assets are broadly in line with those in the other economies, marginally higher for illiquid assets. This may reflect a slight underestimate of such wealth. The time variations in wealth appear to be relatively well-measured, judging by the stability and significance of the coefficients in the consumption and debt equations. The evidence here supports the claim by Case et al. (2005) that housing wealth or collateral effects greatly exceed stock market wealth effects but with the qualification that this is only true after substantial credit market liberalization.

The estimated housing collateral effect after credit market liberalization for South Africa is estimated to be about twice or more as high as for the three Anglo-Saxon economies. The estimated effect is an average for a population with one of the highest levels

[37] Aron and Muellbauer (2000) discuss these and other general equilibrium effects, including a partial offset in higher corporate saving for lower household saving.

of income inequality in the world and necessarily reflects a diverse set of micro-responses, zero for most households. It is plausible that the segments of the population where the responses are largest have been increasing their share of income and consumption. The growth of a Black South African middle-class, with low saving deposits but improving employment opportunities and confident expectations in future income, has likely led to an increase in spending linked to easier credit and higher collateral values, accounting for the large collateral effect. However, as noted above, the AIDS epidemic may well have caused a partial reversal of these tendencies from the late 1990s.

The consumption model estimates also throw light on the monetary transmission mechanism in South Africa, showing that there are multiple channels for the effect of interest rates on consumption expenditure. This is highly relevant for policy making. A rise in short-term interest rates has negative direct effects on consumer spending, mainly through higher real rates, but there appear to be even larger *indirect* effects via asset prices and income expectations. In the absence of household balance sheet data for South Africa, these large asset effects have not previously been measured. Given the multiple possible influences on asset prices in small open economies - including foreign interest rates, terms of trade and foreign equity prices - to quantify the marginal effect of domestic interest rate changes alone requires separate models for the main asset prices of equities, bonds and housing, in addition to the consumption function and income forecasts. This remains an important task for future work.

Finally, the empirical results underline the need to improve national wealth accounts and to track changes in financial architecture in other emerging and developing countries. Better modeling of consumption and debt should improve stabilisation policy and reduce risks of future financial crises.

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Table 1: Variable Definitions

Variable	*Definition*	*Mean*	*Standard deviation*
SA Consumption Equation (1971Q2-2005Q4)			
$\Delta \ln c_t$	Growth rate of real personal consumption (seas. adj.). Consumption is defined as consumption of durable, semi-durable and non-durable goods plus services (including imputed rents for owner-occupied housing).	0.003	0.015
CCI	Credit conditions index (see text for definition)	0.268	0.208
real interest rate $_t$	Real prime rate/100 (4 quart. MA); adjusted for inflation using the implicit final consumption expenditure deflator	0.079	0.047
$E \ln(yperm / y)_t$	Forecast deviation between discounted present value of future log income and current log income (see text for definition of permanent income)	0.025	0.069
$(y^{prop} / y)_t$	Ratio of property income to non-property income	0.320	0.096
Net liquid assets$_{t-1}$ / y $_t$	Ratio of real(liquid assets (eopp) – debt (eopp)) to annualised real income, y	0.137	0.258
Directly held illiquid financial assets$_{t-1}$ / y_t	Ratio of real directly-held securities (eopp) to annualised real income, y, 4 quart. Ma	1.159	0.216
Pension assets$_{t-1}$ / y_t	Ratio of real pension assets (eopp) to annualised real income, y, 4 quart. ma	1.323	0.549
CCI x housing wealth$_{t-1}$ /y $_t$	CCI interacted with ratio of real housing wealth (eopp) to annualized real income, y	0.045	0.231
ln y_t	Log real per capita non-property income	9.150	0.062
ln c_{t-1}	Log real per capita consumption	9.371	0.096
$\Delta_4 \ln employment_t$	Uncertainty indicator: the annual change in the log of employment	-0.036	0.022
Δ_2 ln pc$_t$	Inflation: the two-quarter change in the log of the implicit final consumption expenditure deflator	0.052	0.021
$\Delta \ln c_{t-1}$	Growth rate of real personal consumption (seas. adj.), lagged one quarter	0.003	0.015
Dummies	These are a pre-1976 seasonal to reflect mis-measured seasonal correction in the data before that date; an impulse dummy for an outlier in 1975Q1; and dummies taking values +1, -1 in successive quarters, reflecting shifting of expenditure in anticipation of increases in sales tax in Q2 and Q3 of 1978 and in 1984.	-	-
SA Debt Equation (1971Q2-2005Q4)			
Δln debt$_t$	Log change of household debt (eocp)	0.031	0.020
CCI		0.268	0.208

Variable	*Definition*	*Mean*	*Standard deviation*
real interest rate$_{t-1}$	Real prime rate/100 (8 quart. MA), lagged one quarter	0.047	0.044
ln (nominal interest rate $_t$)	The log of the prime rate/100	-1.927	0.296
ln (non-property income$_t$)	The log of real per capita non-property income	9.150	0.062
$(y^{prop} / y)_t$	Ratio of property income to non-property income	0.319	0.096
ln (liquid financial assets$_{t-1}$ /y $_t$)	Log ratio of liquid assets (eopp) to annualised real income, y	-0.229	0.203
CCI x [ln(housing wealth$_{t-1}$ /y $_t$) - ln (liquid financial assets$_{t-1}$ /y $_t$)]	CCI times [Log ratio of real housing wealth (eopp) to annualised real income, y,- Log ratio of liquid assets (eopp) to annualised real income, y]	0.052	0.05
ln(pension assets$_{t-1}$ /y $_t$)	Log ratio of real pension assets (eopp) to annualised real income, y, 4-quarter ma	0.185	0.448
Ln(real debt)$_{t-1}$	Log of real per capita household debt, lagged one quarter	8.748	0.160
$\Delta_4 \ln employment_t$	Income uncertainty (or confidence) indicator: the annual change in the log of employment minus 1980Q4 value	-0.036	0.022
Δ_3 ln pc$_t$	Inflation: the three-quarter change in the log of the implicit final consumption expenditure deflator	0.078	0.028
Δ_8 ln population $_{t-1}$	Two year log change in population (defined as a four quarter moving average)	0.043	0.012
Dummies	A seasonal dummy for quarter 4, indicating slightly higher end-of-year debt levels; temporary dummies taking values +1, -1 in successive quarters, reflecting shifting of debt between 1982Q1 and Q2, and between 1984Q4 and 1985Q1; an impulse dummy for an outlier in 1987Q1 and an impulse dummy for a 2002Q3 outlier associated with the failure of Sambou Bank.	-	-
SA Income Forecasting Equation (1971Q2-2005Q4)			
$E \ln(yperm / y)_t$	Forecast deviation between discounted present value of future log income and current log income (see text for definition of permanent income)	0.030	0.070
ln y $_t$	Log of real income (nppdi) per capita (seas. adj.); deflated by implicit final consumption expenditure deflator	9.150	0.062
Δ_4 ln y $_t$	Annual change in the above	0.007	0.034
Trend	Trend	-	-
split trend 1984 $_{t+2}$	split trend, zero before 1984 and 1 thereafter, leading by two quarters	29.46	30.27
split trend 1990 $_{t-1}$	split trend, zero before 1990 and 1 thereafter, lagged by one quarter	14.50	20.16
split trend 1994 $_{t-1}$	split trend, zero before 1994 and 1 thereafter, lagged by one quarter	8.12	13.87
ln (real $ gold price) $_t$	the log of the real gold price in dollars, deflated by the US WPI	1.351	0.324
CCI x ln (real house price	Log of house price index deflated by implicit consumer expenditure deflator,	-0.054	0.091

Variable	*Definition*	*Mean*	*Standard deviation*
$indexma_{t-1})$	lagged 4q moving average, interacted with the credit conditions index		
real interest rate $_{t-1}$	real prime rate/100 (4 quart. MA) and lagged one quarter; adjusted for annual inflation using the implicit final consumption expenditure deflator	0.047	0.047
real interest rate $_{t-5}$	as above, lagged five quarters		
Δ_4 nominal interest rate $_t$	annual change in the nominal prime rate/100	0.001	0.032
Δ_4 nominal interest rate $_{t-4}$	as above, lagged four quarters		
liquidity ratio dummy, LRD	liquidity ratio dummy based on actual liquidity ratios defined as follows: 1960:1 1983:2; LRD=0; 1983:3 1983:3; LRD =0.18; 1983:4 1983:4; LRD =0.42; 1984:1 1984:1; LRD =0.72; 1984:2 1985:1; LRD =0.87; 1985:2 1985:3; LRD =0.94; 1985:4 2006:2; LRD =1;	-	-
LRD x Δ_4 nominal interest rate $_t$	LRD interacted with the annual change in the nominal prime rate/100	-0.002	0.027
LRD x Δ_4 nominal interest rate $_{t-4}$	as above, lagged four quarters		

Notes: eopp is "end of previous period", eocp is "end of current period", ma is "moving average", nppdi is "non-property personal disposable income". Constructed asset data are not seasonally-adjusted. All variables potentially entering with CCI interaction effects have their end of 1980 values subtracted as denoted by the x_t^* notation in equations (7) and (8); thus, $x_t^* = (x_t - x_{1980Q4})$. All income and wealth data are on a per capita basis.

Table 2: Consumption Function Estimates Excluding Credit Conditions

Dependent Variable = $\Delta \ln c_t$	*Symbol*	**(1)** 1971Q2-2005Q4		**(2)** 1971Q2-1994Q1		**(3)** 1971Q2-2005Q4		**(4)** 1971Q2-1994Q1	
		coefficient	*t- ratio*	*Coefficient*	*t- ratio*	*coefficient*	*t- ratio*	*coefficient*	*t- ratio*
Long-run coefficients									
speed of adjustment	λ	0.027	1.23	0.069	1.96	0.096	2.54	0.234	3.26
Constant	α_0	0.220	0.44	0.078	0.34	0.264	1.81	0.188	2.28
real interest rate $_t$	α_1	-3.76	-1.00	-2.69	-1.72	-0.96	-1.78	-0.66	-2.09
forecast income growth: E $\ln(yperm / y)_t$	α_3	-1.40	-0.92	-1.41	-1.81	0.11	0.35	-0.08	-0.39
$(y^{prop} / y)_t$	α_4	2.34	1.46	1.08	2.40	0.49	1.88	0.22	1.84
net worth$_{t-1}$/y_t	γ	0.159	1.17	0.091	1.52	-	-	-	-
net liquid assets$_{t-1}$ / y_t	γ_1	-	-	-	-	-0.160	-1.24	-0.227	-2.67
directly held illiquid financial+pension assets$_{t-1}$ / y_t	γ_2	-	-	-	-	0.063	1.52	0.027	1.30
housing wealth$_{t-1}$ /y_t	γ_{3c}	-	-	-	-	0.007	0.12	0.044	0.82
ln y_t –lnc_{t-1}		1		1		1		1	
Short-run coefficients									
uncertainty: $\Delta_4 \ln employment_t$	β_3	0.239	4.59	0.185	2.37	0.236	4.64	0.195	2.54
inflation: Δ_2 ln pc $_t$	β_4	-0.219	-3.47	-0.385	-4.61	-0.300	-4.59	-0.308	-3.39
$\Delta \ln c_{t-1}$	β_5	-0.328	-5.55	-0.263	-3.47	-0.182	-2.82	-0.161	-1.94
Diagnostics									
Standard error		0.00895		0.01043		0.00873		0.01002	
Adjusted R^2		0.647		0.674		0.665		0.699	
LM het. Test (p-value)		0.926		0.133		0.463		0.102	
Durbin Watson		1.82		1.84		1.86		1.91	

LM AR4, MA4 Test (p-value)		0.084		0.256		0.109		0.403
Log likelihood		435.98		268.64		440.41		273.18
Number of observations		132		85		132		85

Table 3: Consumption Function Estimates Including Credit Conditions

Dependent Variable = $\Delta \ln c_t$	***Symbol***	**(1)** 1971Q2-2005Q4		**(2)** 1971Q2-2005Q4		**(3)** 1971Q2-1994Q1		**(4)** 1974Q1-2005Q4	
		coefficient	***t- ratio***	***Coefficient***	***t- ratio***	***coefficient***	***t- ratio***	***coefficient***	***t- ratio***
Long-run coefficients									
speed of adjustment	λ	0.453	10.92	0.442	10.55	0.493	9.15	0.442	10.34
Constant	α_0	0.0269	0.79	0.0382	1.11	0.0167	0.317	0.0498	1.40
credit conditions index: *CCI*	α_{0c}	0.553	9.04	0.482	7.76	0.654	6.07	0.546	7.94
real interest rate $_t$	α_1	-0.473	-4.23	-0.487	-4.18	-0.550	-3.55	-0.431	-3.71
forecast future income growth: $E \ln(yperm / y)_t$	α_{3c}	1.112	7.85	0.657	4.97	1.021	6.07	1.060	6.81
$(y^{prop} / y)_t$	α_4	0.136	3.82	0.140	3.81	0.129	3.22	0.110	2.96
net liquid assets$_{t-1}$ / y $_t$	γ_1	0.167	3.43	0.155	3.19	0.193	2.60	0.127	2.55
directly held illiquid financial+pension assets$_{t-1}$ / y$_t$	γ_2	0.0250	3.24	0.0226	2.86	0.0283	2.63	0.0222	2.54
CCI x housing wealth$_{t-1}$ /y $_t$	γ_{3c}	0.248	3.52	0.158	2.60	0.222	1.39	0.296	3.25
ln y_t – ln c_{t-1}		1		1		1		1	
Short-run coefficients									
uncertainty: $\Delta_4 \ln employment_t$	β_3	0.204	4.42	0.210	4.55	0.216	2.94	0.204	4.30
inflation: Δ_2 ln pc $_t$	β_4	-0.154	-3.33	-0.156	-3.31	-0.177	-3.14	-0.145	-3.07

$\Delta \ln c_{t-1}$	β_5	-0.283	-6.19	-0.287	-6.21	-0.352	-5.79	-0.230	-4.77
Diagnostics									
Standard error		0.00603		0.00614		0.00692		0.00583	
Adjusted R^2		0.839		0.833		0.855		0.846	
LM het. Test (p-value)		0.478		0.494		0.358		0.986	
Durbin Watson		2.34		2.28		2.40		2.33	
LM AR4, MA4 Test (p-value)		0.83		0.90		0.55		0.60	
Log likelihood for system		1349.2		1347.89		880.25		1239.81	
Number of observations		132		132		85		121	

Notes:

i. The results for column 2 impose a peak coefficient in the consumption function of 0.75 on log permanent income at t+1, and 0.95 in the remaining columns.

ii. Estimates for the dummies are not reported. Coefficients correspond to the equation below which is based on the theory equation (7). All interaction terms are in the form of $CCI_t \times (x_t^*)$ where $x_t^* = x_t - x_{1980Q4}$.

iii. The form of the equation is:

$$
\begin{aligned}
\Delta \ln c_t = \lambda[&(\alpha_0 + \alpha_{0c} CCI_t) + (\alpha_1 + \alpha_{1c} \times CCI_t) rma_t^* \\
&+(\alpha_3 + \alpha_{3c} \times CCI_t) E_t \ln(yperm_t / y_t)^* + \alpha_4 (y^{prop} / y)_t \\
&+\gamma_1 NLA_{t-1} / y_t + \gamma_2 DHIFAma_{t-1} / y_t + \gamma_2 PAma_{t-1} / y_t \\
&+(\gamma_3 + \gamma_{3c} \times CCI_t)(HA_{t-1} / y_t)^* \\
&+\ln y_t - \ln c_{t-1}] \\
&+(\beta_1 + \beta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\beta_2 + \beta_{2c} \times CCI_t)(\Delta_4 nr_t \times debt_{t-1} / y_t)^* \\
&+(\beta_3 + \beta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\
&+\beta_4 \Delta_2 \ln pc_t + \beta_5 \Delta \ln c_{t-1} + dummies + \varepsilon_{1t}
\end{aligned}
$$

Note that the following parameters were not significant and set to zero: $\alpha_{1c}, \beta_1, \beta_{1c}, \beta_2, \beta_{2c}$, and β_{3c}.

Table 4: Household Debt Equation Estimates

Dependent Variable = $\Delta\ln debt_t$	*Symbol*	(1) 1971Q2-2005Q4		(2) 1971Q2-2005Q4		(3) 1971Q2-1994Q1		(4) 1974Q1-2005Q4	
		coefficient	***t- ratio***	***Coefficient***	***t- ratio***	***coefficient***	***t- ratio***	***coefficient***	***t- ratio***
Long-run coefficients									
Speed of adjustment	δ	0.217	7.43	0.213	7.07	0.229	6.08	0.198	6.49
Constant	δ_0	-4.444	-3.16	-4.443	-2.94	-2.811	-1.76	-6.232	-3.37
real interest $rate_{t-1}$	δ_1	-0.735	-2.84	-0.915	-3.18	-0.631	-2.20	-0.876	-2.85
Nominal interest $rate_t$	δ_2	-0.105	-3.21	-0.122	-3.33	-0.058	-1.21	-0.0949	-2.54
ln (real non-property income)	δ_5	1.408		1.400		1.248		1.597	
ln (liquid financial $assets_{t-1}$ $/y_t$)	φ_2	0.359	6.77	0.344	6.15	0.348	5.82	0.440	6.16
ln (pension $assets_{t-1}$ $/y_t$)	φ_{3a}	1.049	9.83	1.056	9.05	0.900	6.84	1.157	8.51
$(y^{prop}/y)_t$	δ_6	0.184	1.97	0.200	2.06	0.182	2.02	0.251	2.20
CCI x [ln (housing $wealth_{t-1}$ $/y_t$)-ln (liquid financial $assets_{t-1}$ $/y_t$)]	φ_{1c}	1.432	5.31	1.166	4.68	0.812	1.13	1.625	4.51
ln (real $debt)_{t-1}$		-1		-1		-1		-1	
Short-run coefficients									
uncertainty: $\Delta_4 \ln employment_t$	η_3	0.879	2.89	0.842	2.86	0.915	2.49	0.703	2.30
inflation: $\Delta_3 \ln pc_t$	η_5	-0.119	-2.44	-0.106	-2.13	-0.169	-2.59	-0.117	-2.25
$\Delta_8 \ln population_{t-1}$	η_6	1.166	5.04	1.401	5.81	0.661	1.18	1.393	5.66
Diagnostics									
Standard error		0.00837		0.00841		0.00839		0.00856	
Adjusted R^2		0.823		0.822		0.828		0.823	

LM het. Test (p-value)		0.893		0.718		0.814		0.776	
Durbin Watson		2.20		2.19		1.92		2.23	
LM AR4, MA4 Test (p-value)		0.14		0.24		0.35		0.14	
Log likelihood		1349.2		1347.89		880.25		1239.81	
Number of observations		132		132		85		121	

Notes:

i. The results for column 2 impose a peak coefficient in the consumption function of 0.75 on log permanent income at t+1, and 0.95 in the remaining columns.

ii. Estimates for the dummies are not reported. Coefficients correspond to the equation below which is based on the theory equation (8). All interaction terms are in the form of $CCI_t \times (x_t^*)$ where $x_t^* = x_t - x_{1980Q4}$.

iii. The form of the equation is:

$$\begin{aligned}
\Delta \ln debt_t = \delta[&(\delta_0 + \delta_{0c} \times CCI_t) + (\delta_1 + \delta_{1c} \times CCI_t)(rma8_{t-1})^* \\
&(\delta_2 + \delta_{2c} \times CCI_t)(\ln nr_t)^* + (\delta_4 + \delta_{4c} \times CCI_t) E_t \ln(yperm_t / y_t)^* \\
&+\delta_5 \ln y_t + \delta_6 (y^{prop} / y)_t + \varphi_1 \ln(HA_{t-1} / y_t) + \varphi_2 \ln(LA_{t-1} / y_t) \\
&+(\varphi_{1c} \times CCI_t)(\ln(HA_{t-1} / y_t)^* - \ln(LA_{t-1} / y_t)^*) \\
&+\varphi_3 \ln(DIFAma_{t-1} / y_t) + \varphi_{3a} \ln(PAma_{t-1} / y_t) - \ln rdebt_{t-1}] \\
&+(\eta_1 + \eta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\eta_2 + \eta_{2c} \times CCI_t)(\Delta \ln nr_t)^* \\
&+(\eta_3 + \eta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\
&+\eta_4 \Delta_3 \ln pc_t + \eta_5 \Delta \ln debt_{t-1} \\
&+\eta_6 \Delta_8 \ln(popma_t) + dummies + \varepsilon_{2t}
\end{aligned}$$

Note that the following parameters were insignificant and set to zero: $\delta_{1c}, \delta_{2c}, \delta_4, \delta_{4c}, \varphi_1, \varphi_3, \eta_1, \eta_{1c}, \eta_2, \eta_{2c}, \eta_{3c}$, and η_4. Also $\delta_5 = \varphi_2 + \varphi_{3a}$.

Table 5: Income Forecasting Equation Estimates

Dependent Variable = $E\ln(yperm/y)_t$	**(1)** 1971Q2-2005Q4		**(2)** 1971Q2-2005Q4		**(3)** 1971Q2-1994Q1		**(4)** 1974Q1-2005Q4	
	coefficient	***t- ratio***	***Coefficient***	***t- ratio***	***Coefficient***	***t- ratio***	***coefficient***	***t- ratio***
constant	8.675	22.47	8.843	22.59	10.807	26.72	9.221	22.14
current income growth: $\Delta_4 \ln y_t$	-0.110	-2.21	-0.104	-2.10	0.0197	0.41	-0.0260	-0.46
$\ln y_t$	-0.952	-21.95	-0.970	-22.08	-1.194	-26.17	-1.010	-21.71
Trend	0.000411	1.87	0.000468	2.13	1.94E-03	8.14	0.000360	1.59
split trend 1984_{t+2}	-0.00425	-10.79	-0.00436	-11.09	-7.30E-03	-16.96	-0.00407	-10.17
split trend 1990_{t-1}	0.00626	12.15	0.00628	12.37	6.02E-03	13.75	0.00596	11.67
split trend 1994_{t-1}	0.00368	6.84	0.00373	7.13	3.65E-03	0.00	0.00365	6.84
ln (real \$ gold price)$_t$	0.0352	5.80	0.0355	5.92	0.0203	3.86	0.0301	4.59
CCI x ln (real house price indexma)$_{t-1}$	0.152	5.18	0.138	5.27	0	0	0.207	5.58
real interest rate $_{t-1}$	-0.166	-3.29	-0.171	-3.43	-0.168	-3.21	-0.163	-3.26
real interest rate $_{t-5}$	-0.287	-6.30	-0.282	-6.27	-0.288	-5.18	-0.243	-5.25
Δ_4 nominal interest rate $_t$	-0.223	-3.28	-0.203	-3.01	-0.0884	-1.45	-0.198	-2.96
Δ_4 nominal interest rate $_{t-4}$	-0.325	-4.39	-0.313	-4.26	-0.276	-4.13	-0.243	-3.19
liquidity ratio dummy x Δ_4 nominal interest rate $_t$	0.0968	1.38	0.0810	1.17	-0.0173	-0.27	0.0929	1.35
liquidity ratio dummy x Δ_4 nominal interest rate $_{t-4}$	0.416	5.54	0.408	5.49	0.491	7.37	0.350	4.66
Diagnostics								
Standard error	0.00887		0.00878		0.00677		0.00865	
Adjusted R^2	0.984		0.984		0.984		0.985	
LM het. Test (p-value)	0.106		0.102		0.290		.041	
Durbin Watson	0.286		0.281		0.379		0.232	
Log likelihood	1349.2		1347.89		880.245		1239.81	
Number of observations	132		132		85		121	

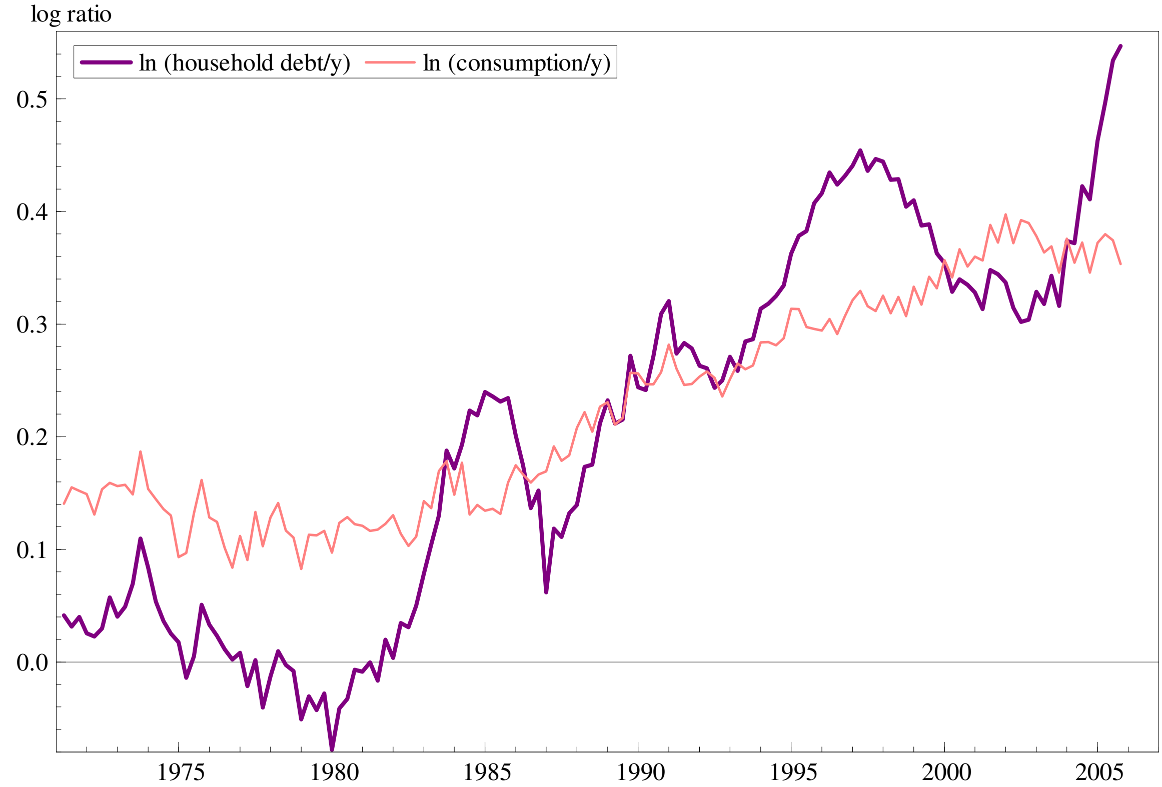
Notes: The results for column 2 impose a peak coefficient in the consumption function of 0.75 on log permanent income at t+1, and 0.95 in the remaining columns.

Table 6: Estimates of the smoothed year dummies for the Credit Conditions Index (*CCI),* corresponding to Tables 3 to 5

Spline dummies	*coefficient*	*t- ratio*
D73	-0.0184	-1.81
D81	0.1433	7.52
D83	0.0775	4.09
D85	-0.0469	-1.56
D87	0.1050	3.74
D88	0.1604	5.42
D94	0.0842	4.06
D95	0.0939	3.99
D97	-0.0722	-3.83
D99	-0.0639	-2.68
D100	-0.0901	-4.01
D102	-0.0361	-2.53
D104	0.0267	1.22

Notes: These values stem from the consumption-debt-income forecast system with regressions as reported in Column 1 of Tables 3, 4 and 5.

Figure 1: South African personal consumption and household debt relative to personal disposable non-property income



Note: 0.6 is added to the debt ratio for scaling purposes.

Figure 2: South African debt, liquid and illiquid assets relative to personal disposable non-property income

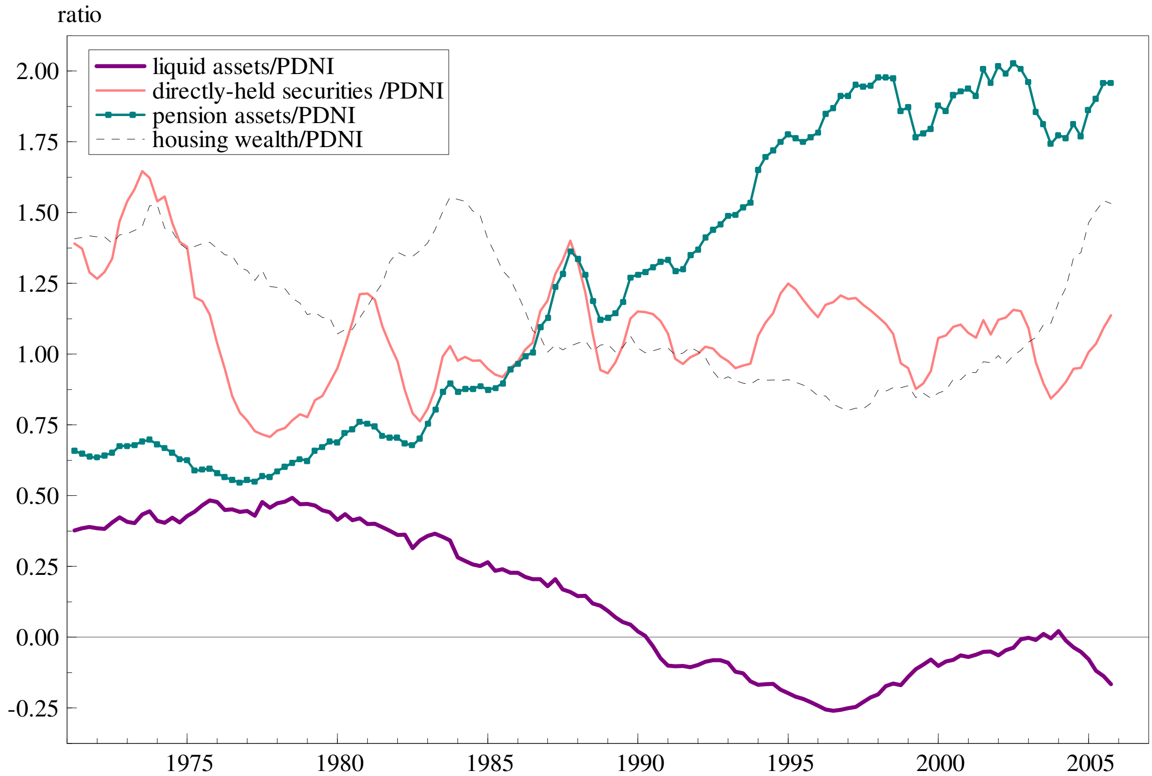


Figure 3a: Contribution of regressors to explaining the consumption to income ratio

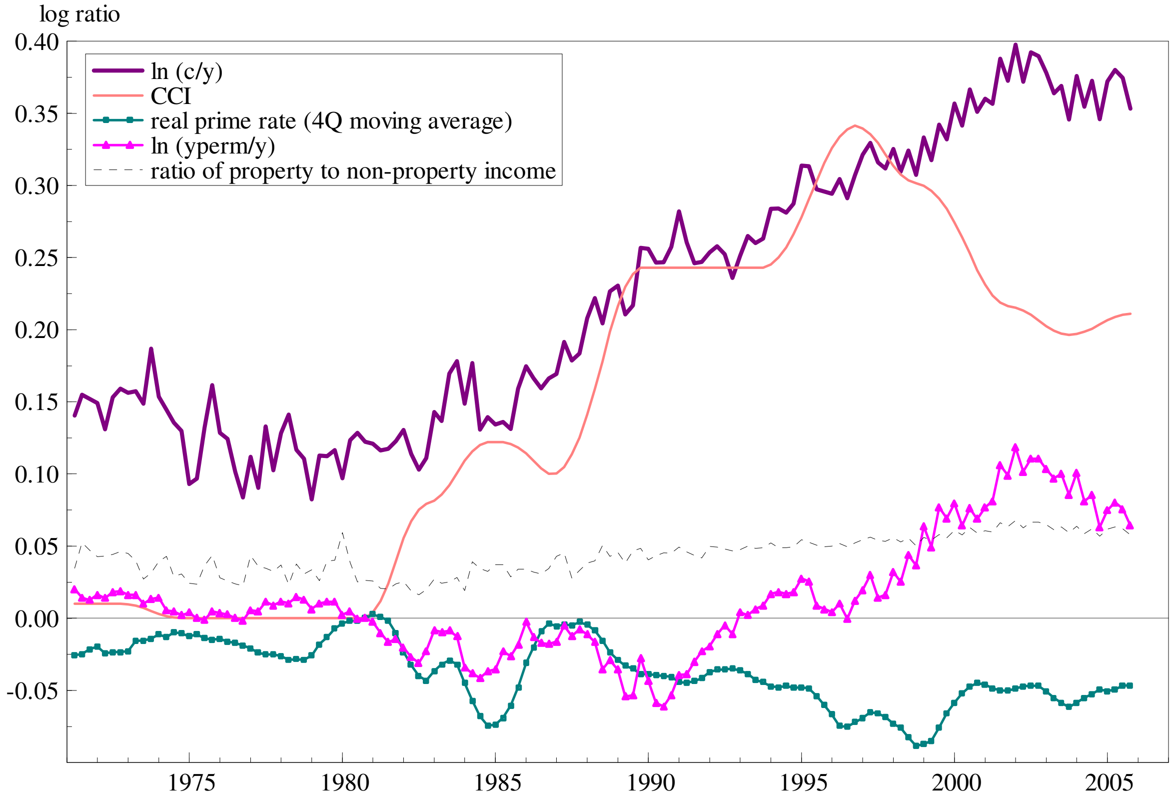


Figure 3b: Contribution of further regressors to explaining the consumption to income ratio

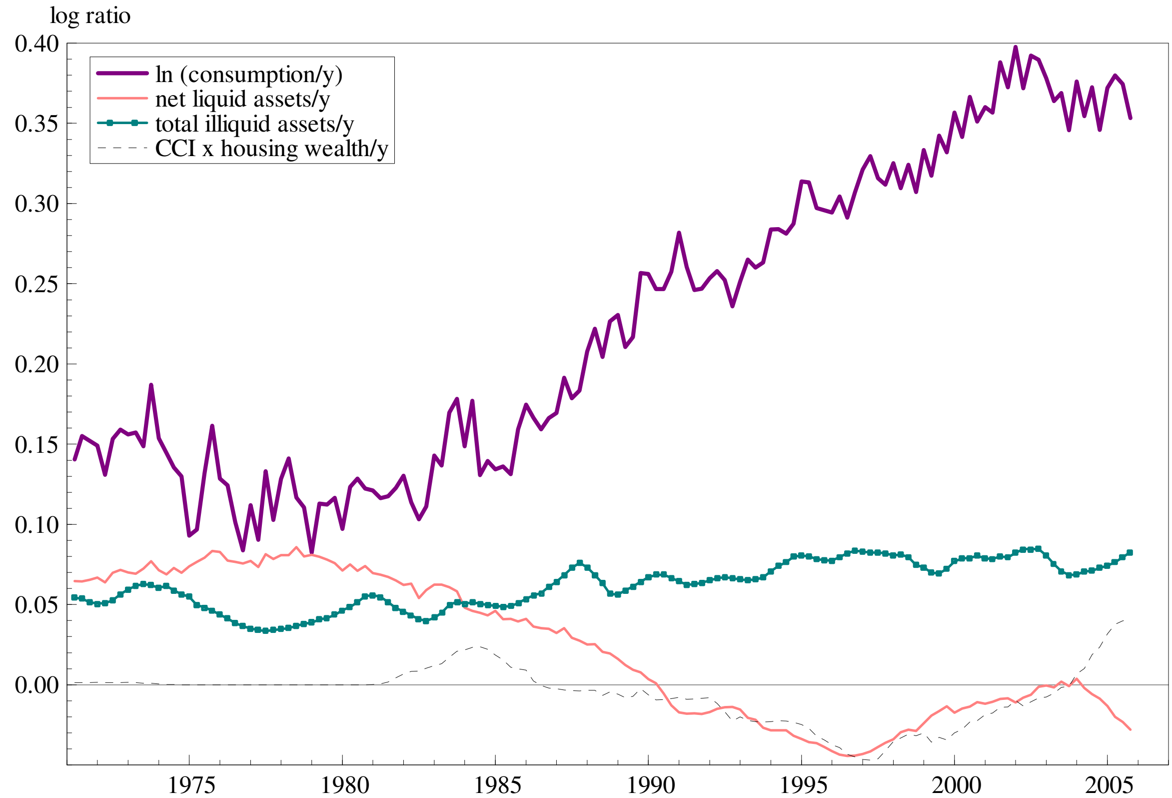


Figure 4: Credit conditions index for South Africa and the real interest rate

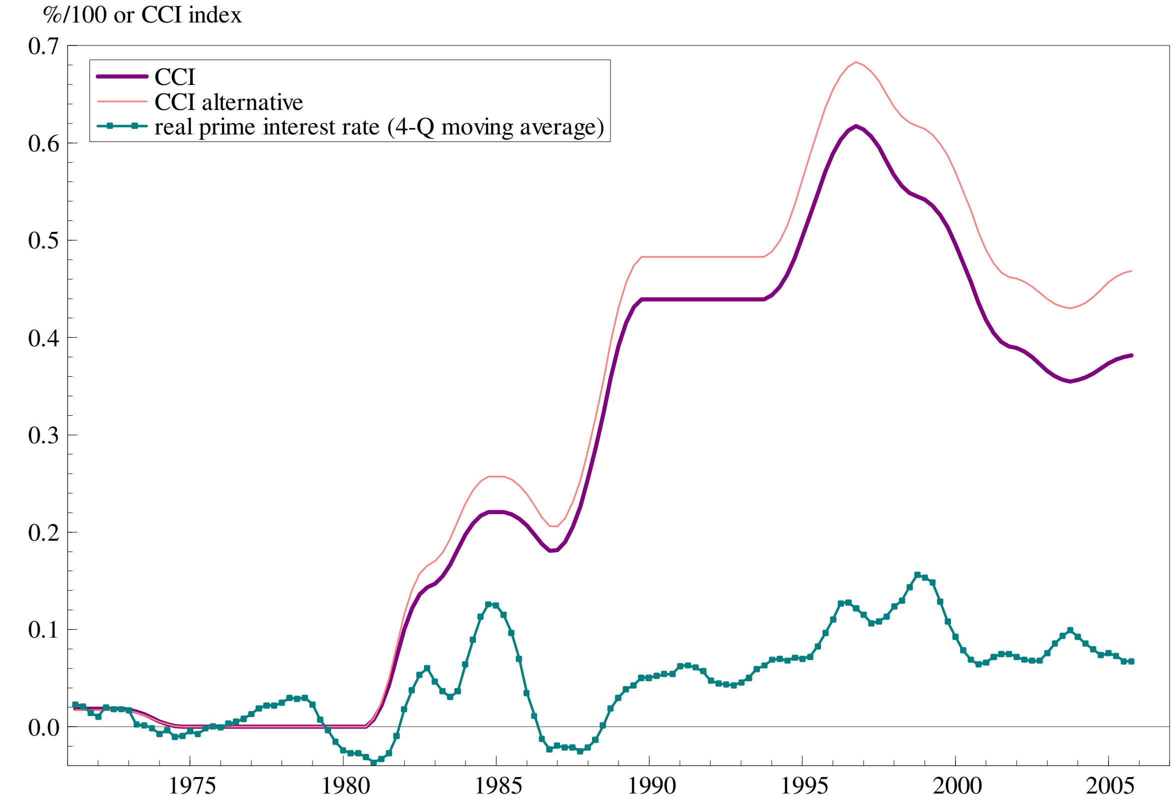
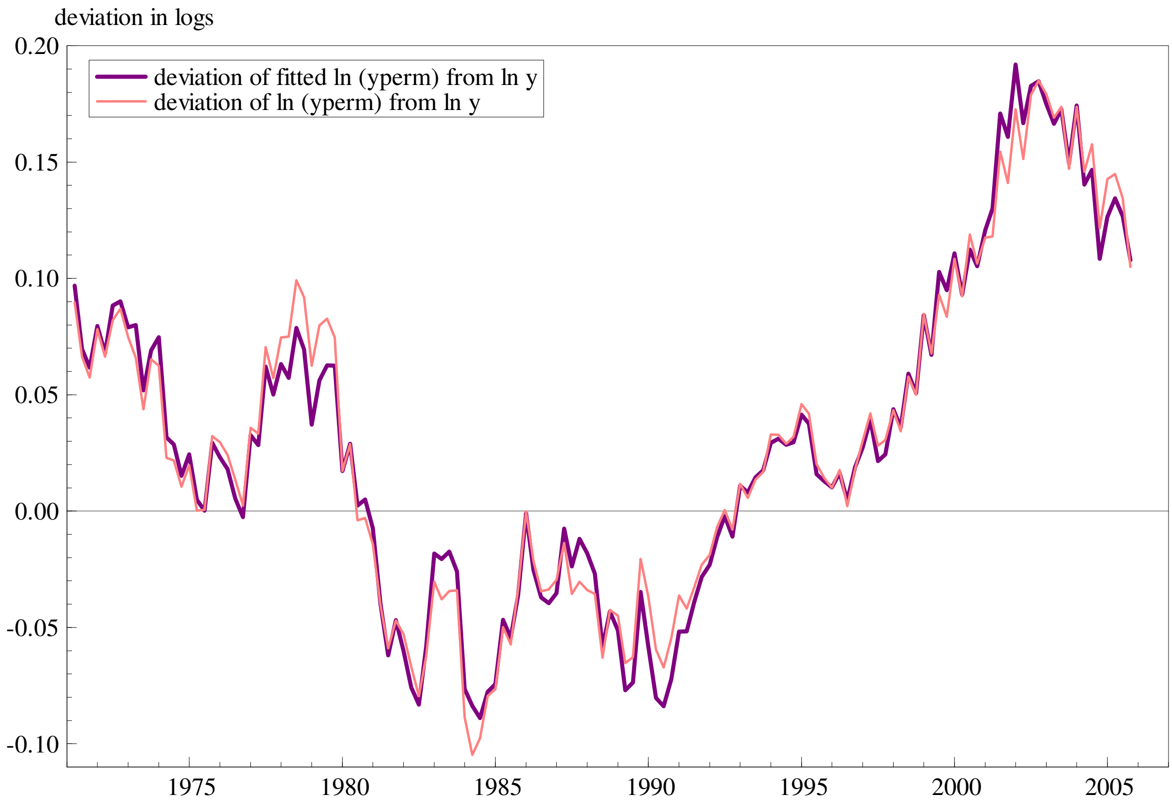


Figure 5: Forecast and actual log "permanent" income/current income



Appendix 1

Although the implications of credit liberalization have aroused interest, controversy, and a growing literature, there are few satisfactory applied analyses of these implications in the consumption literature. One major difficulty has been to find an indicator of credit market deregulation, *CCI,* with which to model the direct and interaction effects of credit liberalization. Proxying *CCI* by the ratio of debt to income, as in Bayoumi (1993a, 1993b) and Sarno and Taylor (1998), is not ideal because this ratio is endogenous and responds with a lag to deregulation and depends too on income expectations, asset levels, uncertainty, and interest rates. Bandiera et al. (2000) propose the technique of principal components to summarize the composite information in a set of dummy variables reflecting different facets of credit liberalization. However, the weights do not reflect the *behavioural* impact of credit liberalization. A flexible technique linking institutional information with behavioural responses is needed.

Our innovation is to treat credit liberalization as a 'latent variable', an unobservable indicator entering household debt, consumption and income forecasting equations. The indicator, *CCI*, is proxied by a non-linear spline function whose parameters are estimated jointly in the three equations.

The qualitative portrait presented in Section 3 about credit market liberalisation in South Africa has implications for our univariate measure of credit liberalization, *CCI*. The first is of a mainly monotonic rise in the indicator until around 1997, with plausible exceptions of a temporary decline after the debt crisis in 1985 and in the early 1970s when the decline in real interest rates led to increased rationing of credit.[38] The second is for particularly strong rises in 1981-84, and after 1986, some consolidation in the early 1990s, and a renewed rise after 1994, followed by a possible contraction in 1997 and the early 2000s. Unfortunately, available information on institutional changes does not permit further quantitative or qualitative implications to be drawn.

We define *CCI* using a non-linear spline function. A spline function, easy to apply and interpret, can be constructed from a set of smoothed step dummies. Define a step-dummy, *D81*, which is zero up to 1980Q4 and is 1 from 1981Q1. The 4-quarter moving

[38] In other countries such as the U.S., U.K. and Australia there was a decline in credit availability in around 1991-2 linked with new Basel regulations and bad loans in the banking industry. It is questionable whether South Africa would have experienced anything similar as it was still exposed to financial sanctions, though after the release of Nelson Mandela in February 1990 the international climate softened. Nevertheless, the possibility of a small contraction in the early 1990s was tested for.

average of this dummy, *D81M*, will have the values: 0.25, 0.5, 0.75 and 1 for the 4 quarters of 1981, and the value 1 thereafter. Taking a 5-quarter moving average of *D81M*, denoted *D81MM*, gives a smoothed step dummy that makes an S-shaped transition from zero to one over the two year period of 1980Q4 to 1982Q4.

The same method was used to generate smoothed step dummies for all the years from 1973 to 2004. A linear combination of these smoothed step dummies defines the potential *CCI* function as a spline function:

$$CCI = d73 \times D73MM + d74 \times D74MM + ... + d04 \times D04MM - d73 \qquad \text{(A.1)}$$

where up to 32 parameters (i.e. d73 to d04) could be estimated. By subtracting d73, CCI is normalised to be zero in the years following 1973-4. The linear combination of smoothed step dummies covering overlapping two year periods can potentially capture slowly implemented rules or institutional change.

The CCI function has the property that if the parameter *dT* for year T in equation (A.1) is positive (negative), then *CCI* increases (decreases) for the next seven quarters. This property makes it straightforward to impose the constraint (where relevant) that the parameters be non-negative. For South Africa we expect no reversal in financial liberalization, except in the early 1970s, in 1985-86, and from 1997. Where these institutional priors were violated, the *dT* coefficients were set to zero. In the process of reduction of the whole system to a parsimonious form, insignificant values were sequentially set to zero, which left 12 non-zero parameters. At the final stage, a likelihood ratio test of this restricted model against the unrestricted 32-parameter version of the CCI function was easily passed.

In some applications it can be desirable to impose additional smoothness on the spline function. For example, instead of using smoothed dummies for every year, one might decide to introduce dummies only for odd numbered years. This halves the number of coefficients to be estimated in the general formulation of the CCI function. In the current application, it would have resulted in a marginally worse overall fit but with substantive conclusions unchanged.