NIESR Discussion Paper No. 344

April 2009

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PROJECT ON CONSUMPTION AND SAVING FOR THE DWP

COMPARATIVE ANALYSIS OF CONSUMPTION AND SAVING IN THE UK AND US

Abstract. In this note we compare consumption behaviour in the US and the UK with a special focus on the scale of, and differences in, the impacts of changes in income, financial and housing wealth, both over time and between countries. It is common to claim that theory tells us housing wealth is not wealth, and hence it should not impact on consumption. We investigate these issues first by searching for patterns of cointegration and causality between consumption, income and wealth in the UK and the US. Using these results we investigate the effects of changes in asset prices on consumption in the UK and the US using the National Institute Global Model, NiGEM under different sets of assumptions. A temporary 10 percent fall in the price of houses will in both countries increase the savings ratio by around 1 percentage point, with the effect being marginally larger in the UK than the US. It is relatively clear from the data, but not from theory, that a permanent change in real house prices will have a similar effect on the saving ratio. Hence a 30 per cent fall in real house prices in either country would raise saving by around 1½ percentage points. The effects of a fall in equity prices of a similar magnitude would have about a sixth of the effects, as we would expect from estimated equations.

Introduction

In this note we compare consumption behaviour in the US and the UK with a special focus on the scale of, and differences in, the impacts of changes in income, financial and housing wealth, both over time and between countries. It is common to claim that theory tells us housing wealth is not wealth, and hence it should not impact on consumption. For a recent version of the theory see Buiter (2008) and for an attempt to validate it on micro data see Attanasio et al (2009). It is also common to follow Lettau and Ludwigson (2004) and presume that the difference between consumption and income drives asset prices. We investigate these issues first by searching for patterns of cointegration and causality between consumption, income and wealth in the UK and the US. We produce a minimalist explanation of the factors affecting consumption before we elaborate on the work in Barrell and Davis (2007) which looks in detail at these issues for the UK and the US by taking into account financial liberalisation. Our conclusion is that the standard equilibrium correction consumption equation presented in that paper remains a perfectly adequate workhorse for both forecasting and policy analysis. With that in mind we then investigate the effects of changes in asset prices on consumption in the UK and the US using the National Institute Global Model, NiGEM under different sets of assumptions.

Estimation and results

In this section we check the stationarity properties of the data, examine variables for the existence of the long–run relationships, construct dynamic equations with the long run cointegrating equations embedded in an error correction mechanism and discuss estimation results. Our analysis is based on a quarterly data from 1971q1 to 2007q4 for the UK and the US, and is essentially 'hands off', in order that we can investigate what the data suggest might be the case. Our time frame, set of variables and analytical approach are largely dictated by data availability for the two countries and by the existing empirical work on the determinants of consumption and specifically by Lettau and Ludvigson (2004) and Barrell and Davis (2007), both of which involve a 'hands on' approach where clear answers are expected of the data set before investigation starts.

Before determining whether long–run relationships exist among the variables, we test all series for stationarity. As can be seen from the tables 1 and 2, which present the resulting probabilities of unit root tests for the UK and the US, all variables can be considered as integrated of order (I). The exceptions are USPOPT (POPT: total population) which rejects the presence of a unit root in level and UKPOPT where the break in the series leads to the acceptance of a unit root in the first difference.

Table 1. Test for series stationary (UK)

Series	Level	1st Difference
LUKC	0.99	0.01
LUKLBIN	0.87	0.00
LUKPOPT	1.00	0.64
LUKRHW	0.92	0.00
LUKRLIABS	0.95	0.02
LUKRNW	0.91	0.00
LUKRLIABSRPDI	0.95	0.02
LUKRPDI	0.90	0.00
LUKRPH	0.91	0.00
LUKRTW	0.96	0.00
UKRR	0.30	0.00

note: Probabilities from ADF test with 4 lags and a constant

Table 2. Test for series stationary (US)

Series	Level	1st Difference
LUSC	0.94	0.02
LUSLBIN	0.93	0.01
LUSPOPT	0.00	-
LUSRHW	0.79	0.04
LUSRNW	0.96	0.00
LUSRPDI	0.83	0.00
LUSRPH	0.87	0.00
LUSRTW	0.97	0.00
USRR	0.13	0.00
LUSCP	0.92	0.00
LUSLBINP	0.88	0.00
LUSRPDIP	0.77	0.00
LUSRHWP	0.73	0.02
LUSRNWP	0.94	0.00
LUSRTWP	0.96	0.00

note: Probabilities from ADF test with 4 lags and a constant

Our variable list for both countries includes real consumption (C), real total wealth (RTW) and its two components, real housing (RHW) and real net financial wealth (RNW) where we use Consumers Expenditure Deflator(CED) to convert from Nominal to Real, real forward looking interest rates, RR which is the 3-month interbank rate less the expected inflation rate, real personal disposable income (RPDI) , real personal

disposable labour income (LBIN)[1] and total population (POPT). All variables are calculated in real terms and put in natural logarithms with L as a prefix (except for the real interest rate).

To ascertain the presence of a long-run relationship we run regressions including variables listed in the tables 3 (for the UK) and 4 (for the US) and test for the presence of a unit root in the residuals. The general forms of the cointegration regressions are as follows :

$$\ln C_t = a*\ln RPDI_t + b*\ln RNW_t + c*\ln RHW_t + d*RR_t + e*\ln POPT_t + \varepsilon_t$$

$$\ln C_t = a*\ln RPDI_t + b*\ln RTW_t + c*RR_t + d*\ln POPT_t + \varepsilon_t$$

$$\ln C_t = a*\ln LBIN_t + b*\ln RNW_t + c*\ln RHW_t + d*RR_t + e*\ln POPT_t + \varepsilon_t$$

$$\ln C_t = a*\ln LBIN_t + b*\ln RTW_t + c*RR_t + d*\ln POPT_t + \varepsilon_t$$

We run regressions first over the full sample period and then from 1987q1 to 2007q4, to check whether financial liberalization, which mainly took place in these countries before 1986 has an impact on our analysis of the long run. For the UK, first we check for the existence of a cointegrating relationship in the standard set of variables with labour income included following the work by Lettau and Ludvigson (2004). The results (table 3) do not suggest the existence of a structurally stable long run relationship when labour income is included into the specification.

Table 3a. Testing residuals for the presence of a unit root in UK cointegration regressions

	Full sample	1987-2007
variable set	Labour Income	Labour Income
	t-stat	t-stat
c hw nw popt rr	-2.462	-3.192
c hw nw rr	-2.335	-3.190
c hw nw popt	-2.688	-3.001
c hw nw	-1.993	-3.206
c tw popt rr	-2.452	-2.644
c tw popt	-2.015	-2.563
c tw rr	-2.396	-2.645
c tw	-2.141	-2.534

note: ADF test with 4 lags and a constant; bold indicates variables significant at 90% level; t-stats are compared against critical values by MacKinnon (1991)

[1] We assume that mixed income is split between labour and capital, and that the self employed pay themselves the same wage per person hour as the employed.

Table 3b. Testing residuals for the presence of a unit root in UK cointegration regressions

	Full sample	1987-2007
variable set	RPDI	RPDI
	t-stat	t-stat
c hw nw popt rr	-3.328	-3.422
c hw nw rr	-2.954	-2.971
c hw nw popt	-3.451	-3.575
c hw nw	-3.622	**-3.876**
c tw popt rr	-2.592	-3.264
c tw popt	-2.413	-3.320
c tw rr	-2.040	-3.667
c tw	-2.330	**-3.603**

note: ADF test with 4 lags and a constant; bold indicates variables significant at 90% level; t-stats are compared against critical values by MacKinnon (1991)

As a next step, we substitute labor income with the real disposable income as in Barrell and Davis (2007) and again check for the existence of a cointegrating relationship. With this specification, we discover two cases of possible cointegrating relationships for the UK. However, cointegration only appears in the reduced sample; we fail to find a cointegrating set of variables over the full sample period for the UK, as a result of a break in the series during the financial liberalization. Based on our estimation results, we note that housing wealth did not play a significant role in the determining of consumption prior to 1987 but is significant after 1986. It also exhibited almost three times larger effect on consumption compared to the financial wealth during 1987 2007, which may be an indication of the role that financial liberalisation played over this period.

For the US we first test for the long-run relationship using the Lettau and Ludvigson (2004) approach. We calculate our variables in per capita terms and include a labour income measure. The test results presented in table 4 show that we failed to find a cointegrating set based on the above specification, unlike the previous authors. This may reflect changes in data since their work was undertaken, or perhaps their data definitions which have been criticised. As a next step, we check the alternative, RPDI based, set of variables used in Barrell and Davis (2007) for a long-run relationship and found a single case of possible cointegrating relationship (table 5). Contrary to the UK, in the US long-run relationship exists over the full data range.

Tables 4. Testing residuals for the presence of a unit root in US cointegration regressions

	Full sample	1987-2007
variable set	Labour Income	Labour Income
	t-stat	t-stat
cp hwp nwp rr	-2.628	-3.018
cp hwp nwp	-2.570	-3.057
cp twp rr	-2.179	-2.220
cp twp	-2.143	-1.996

note: p denotes per head as in Lettau and Ludvigson (2004)

Table 5. Testing residuals for the presence of a unit root in US cointegration regressions

	Full sample	1987-2007
variable set	RPDI	RPDI
	t-stat	t-stat
c hw nw popt rr	**-4.483**	-3.359
c hw nw rr	-2.464	-2.740
c hw nw popt	-3.327	-3.378
c hw nw	-2.668	-2.373
c tw popt rr	-4.094	-3.053
c tw popt	-3.215	-3.058
c tw rr	-2.680	-2.794
c tw	-2.848	-2.197

note: ADF test with 4 lags and a constant; bold indicates variables significant at 90% level; t-stats are compared against critical values by MacKinnon (1991)

Long run cointegrating relationships tell us nothing about the direction of causation, and they can be renormalized with any coefficient set to one. We use Granger causality test with I(1) variables to establish the appropriate normalisation of the long-run relationship. Once a long-run relationship has been established, we use the Engle-Granger two-step method to capture the error-correction term in the dynamic equation. According to the Granger representation theorem, which states that for every cointegrating relationship there is an error correction representation, the coefficient on the error correction term should be significantly different from zero if variables cointegrate and Granger cause the dependent variable. Consequently for the relevant normalization of the cointegrating vector to be identified, we need to evaluate error correction representations for each dependant variable and check coefficients on the residual terms for significance.

We regress the first difference of each variable from the cointegrating set on the lagged value of the residual and four lags of first differences of all variables from the set, including the dependant variable. The general form of the equations is given by:

$$d\ln Y_t = a_t * resid_{t-1} + b_t * \sum_{m=1}^{4} d\ln Y_{t-m} + c_t * \sum_{n=0}^{4} d\ln X_{t-n} + \varepsilon_t$$

where $d\ln Y_t$ is a first-difference of the dependant variable, *resid* is a residual from the cointegrating regression and $d\ln X_t$ represents first-difference of regressors. Tables 6 and 7 list coefficients for the error correction terms and corresponding test statistics for each case in both countries.

Table 6. Error correction terms in the dynamic equations (UK)

		DLNC	DLRNW	DLRHW	DLRPDI	DLTW
error correction	coefficient	-0.094	0.376	0.169	0.162	-
	t-stat	-1.759	0.664	0.773	1.654	-
error correction	coefficient	-0.07	-	-	0.10	0.292
	t-stat	-1.63	-	-	1.35	1.467

note: estimation period 1987-2007

Table 7. Error correction terms in the dynamic equations (US)

		Dependent variable			
		DLNC	DLRNW	DLRHW	DLRPDI
error correction	coefficient	-0.17	0.701	0.087	0.41
	t-stat	-2.31	1.436	0.720	3.80

note: estimation period 1971-2007

There are two possible cointegrating structures for the UK and we test them in turn. Regressing consumption, real personal disposable income, real net wealth and real housing wealth on each other reveals one instance when the coefficient on the residual term was significant. Consumption is found to be Granger caused by real disposable income, real financial wealth and real housing wealth. This error correction term is significant at 10 % level and there is a strong possibility that the effects of financial

liberalisation depressed the impact from the long-run on consumption. We fail to uncover a clear long-run relationship among consumption, real personal disposable income and total wealth, even though the first stage of the analysis suggested the existence of a cointegrating relationship. In none of the cases the residual term was found significant. For the US, none of the wealth variables are found to be Granger caused by other variables, contrary to the results in Lettau and Ludwigson (2004), but there are two instances when the coefficients on residuals are significant. Both consumption and real disposable income appear to be simultaneously Granger caused.

In order to obtain a reduced form specification for the UK we use a general to specific approach, starting from the variables listed in the cointegrating set and eliminating the most insignificant ones at each stage. We stop the elimination process once all variables are significant at least at 5% level[2]. The final reduced form equation is given below, with c_1 representing a coefficient on the equilibrium or error correction term:

$$Dlnukc = a + c_{1*}resid + c_i*dynamics + error$$

Table 8. Reduced form dynamic equation (UK)

	Coefficient	t-stat
error correction	-0.106	-2.386
dlukc(-2)	0.422	4.594
dlukrpdi	0.226	4.369
dlukrnw(-3)	0.022	2.066
dlukrhw	0.131	4.216

note: Estimation period 1987q1-2007q4;

Coefficients from the resulting error correction equation for the UK are given in table 8. All variables listed in the final specification are significant and have coefficients that we would have expected. Dynamic effects of both financial and housing wealth are present, with housing wealth having a larger and more immediate impact on consumption as compared to financial wealth. Real disposable income has the largest effect on consumption. Changes in financial wealth and in consumption enter the equation with a

[2] In case of the US, we use the same approach, but as real disposable income variable is endogenous it should be instrumented.

lag which is not surprising given quarterly frequency of the underlying data. Consumption patterns do not change abruptly from one quarter to another and as for financial wealth its specific composition (which we discuss later) may be the determinant of the lag structure.,

Table 9. Reduced form dynamic equation (US)

	Coefficient	t-stat
error correction	-0.253	-5.025
dlusrpdi	0.302	5.713
dlusrnw	0.030	2.263
dlusrhw	0.103	2.821

note: Estimation period 1971q1-2007q4

Table 9 presents results for the US where similar pattern is observed, with the short-run effect of housing wealth being three times larger than the net wealth effect. The impacts of short-run changes in real financial wealth and real personal disposable income on consumption in the UK and US are of similar magnitude, but the speed of equilibrium correction to the long run when out of equilibrium in the US is twice that in the UK.

There are a number of studies of consumption, wealth and saving using a micro data. A good example is Attanasio et al (2009) who investigate a synthetic micro panel of household income and expenditure. They are not in a position to correct for the growing discrepancy between consumption as recorded in these surveys and in the national accounts. This discrepancy may reflect the difficulty in using surveys to record expenditure on financial products, which have been becoming more important over time, especially to older groups (see Weale, 2009). Attanasio et al (2009) suggest that over much of the past 25 years, house price and consumption growth have been closely synchronized. They suggest that there are three main hypotheses for this have been proposed: increases in house prices raise household wealth and so their consumption; house price growth reduces credit constraints by increasing the collateral available to homeowners; and house prices and consumption are together influenced by common factors. Using microeconomic data, they find that the relationship between house prices and consumption is stronger for younger than older households. Despite their claim to the contrary this does not contradict the wealth channel as young people both own houses (albeit on mortgages) and expect to inherit their parents housing wealth. In a forward

looking world they would react now to an increase in their actual and in their expected wealth. Attanasio et al (2009) suggest that common causality has been the most important factor linking house prices and consumption, but they present no evidence to suggest that this is the case. Their suggestion is contradicted by the Granger causality tests above, as in this case income and wealth would not Granger cause consumption.

The discussion above involves the relatively mechanical production of an equilibrium correction consumption equation. This form is more carefully analysed in Barrell and Davis (2007), taking account of financial liberalisation and its impacts on the dynamics and adjustment parameters of the consumption relationship. The workhorse model is also used in the Institute NiGEM model, and can be evaluated with forward and backward looking consumers. We discuss these in turn.

The Barrell Davis Methodology

Barrell and Davis (2007) assess the effects of financial liberalisation on consumption in seven major industrial economies. They use a dynamic error correction model with both tangible and financial wealth included, and study short and long-run liberalization impacts on the determinants of the consumption. Liberalisation started at dates determined by OECD studies, and proceeded for 5 year as if following a cumulative normal distribution. Liberalisation started in 1980 in the UK and the US, and hence was complete by the start of the short data period discussed above. They detected a noticeable shift in the consumers' expenditure behaviour as a result of the financial liberalisation in most countries in the sample, including UK and the US.

Barrell and Davis (2007) is based on a life-cycle model approach, where consumption is considered to be a function of human and non-human wealth. Non-stationary variables such as consumption, income and real net wealth measures form a cointegrating vector in log levels and are appended by the differences of the same variables in order to capture the dynamics. Inclusion of dynamics opens the channels for the adjustments to innovations in the economy. Splitting real net wealth into real tangible and real financial wealth allows them to distinguish the roots through which financial liberalization affects consumption. Real interest rates are seen as a determinant of the consumption decision, reflecting the inter-temporal elasticity of substitution for those who are not borrowing constrained. Hence there should be an effect of financial liberalization on the coefficient on real forward looking interest rates.

Financial liberalization can impact consumption in different ways. Whether it is through reduced credit constraints, lower deposit requirements or wider availability of collateral-backed loans for households, the resulting effect is a decreased reliance on fluctuating current income. Increased and easier borrowing possibilities allow consumers to be less firmly tied to current income and smooth their consumption. As a result the relative importance of financial and tangible wealth may change in pre and post liberalization periods. For borrowing constrained consumers the most liquid assets are expected to have the largest impact on consumption, while less liquid assets (specifically housing wealth) have a reduced role. With financial deregulation, softening of credit constraints opens the possibility of consuming out of wealth, by using the illiquid assets as collateral, especially if the value of illiquid assets increases. Increase in nonhuman wealth on one hand may lead to the increase in consumption, but at the same time at least temporarily it can cause the reduction in savings as well, because of the higher consumption out of the current income.

The coefficient on changes in real personal disposable income in this form of equation is often described as a measure of the proportion of consumption in borrowing constrained households. Financial liberalisation should reduce this coefficient, and increase the coefficient on the error correction component as household are more able to reach the long run quickly when they are not borrowing constrained. In an equation of the form below the error correction parameter rises by 40 to 50 per cent in both countries as the number of borrowing constrained individuals falls to a third to a quarter of its 1980 value by 2001, at around 0.12 percent in the US and 0.13 in the UK.

$$dlnC_t = a+ECM*(lnC_{t-1}-b_1*lnRPDI_{t-1}-(1-b)*lnTW_{t-1}) \\ +c_1dlnRPDI_t+c_2dlnRNW_t+c_3dlnRHW_t$$

Borrowing constraints may change in the current financial crisis, as they appear to have done in Japan in the 1990s, as Barrell and Davis show. Constraints rose over the longer term in this country after its crises, and we can expect the same in the UK and US.

The equations in NiGEM are based on the same formulation, but the parameters are not time varying, reflecting the sample average more closely. They are derived from Barrell and Davis (2005), and their forecasting properties are good.

NiGEM simulations

We model the consumption function in National Institute Global Model (NiGEM) in line with the methodology and empirical analysis discussed above and equations are from Barrell and Davis (2005). This enables us to conduct different simulation scenarios replicating the developments in the economy in general and specifically in financial markets and assess their effects on macro variables. As changes in the economy can affect consumption through different channels, we exploit this possibility and run different exercises in order to monitor how some of recent developments in financial markets affect consumption. First we run simulations for the UK and US and compare the results, and then assess the changes in response to altering the assumptions on consumers behaviour; i.e backward looking behaviour in consumers vs forward looking one.

$$\ln(ukc) = \ln(ukc(-1)) - 0.019459 - 0.085532*(\ln(ukc(-1)) - 0.92847* \ln(ukrpdi(-1))$$
$$(2.0) \qquad (2.8) \qquad (28.16)$$
$$- (1.-0.92847)* \ln(uktw(-1)/(.01*ukced(-1))))$$
$$+ 0.17056* \ln(ukrpdi/ukrpdi(-1))$$
$$(3.7)$$
$$+ 0.029047* \ln((uknw(-1)/(.01*ukced(-1))) /(uknw(-2)/(.01*ukced(-2))))$$
$$(2.9)$$
$$+ 0.16003* \ln((ukhw(-1)/(.01*ukced(-1)))/(ukhw(-2)/(.01*ukced(-2))))$$
$$(5.9)$$

$$\ln(usc) = \ln(usc(-1)) - 0.038046 - 0.12750*(\ln(usc(-1)) - 0.80624* \ln(usrpdi(-1))$$
$$(1.71) \qquad (2.61) \qquad (18.39)$$
$$-(1.-0.80624)* \ln(dustw1/(.01*usced(-1)))) + 0.15489* \ln(usrpdi/usrpdi(-1))$$
$$(2.55)$$
$$+ 0.033974* \ln((usnw(-1) /(.01*usced(-1)))$$
$$(2.32)$$
$$+0.15375* \ln((ushw(-1)/(.01*usced(-1))) /(ushw(-2)/(.01*usced(-2))))$$
$$(2.64)$$

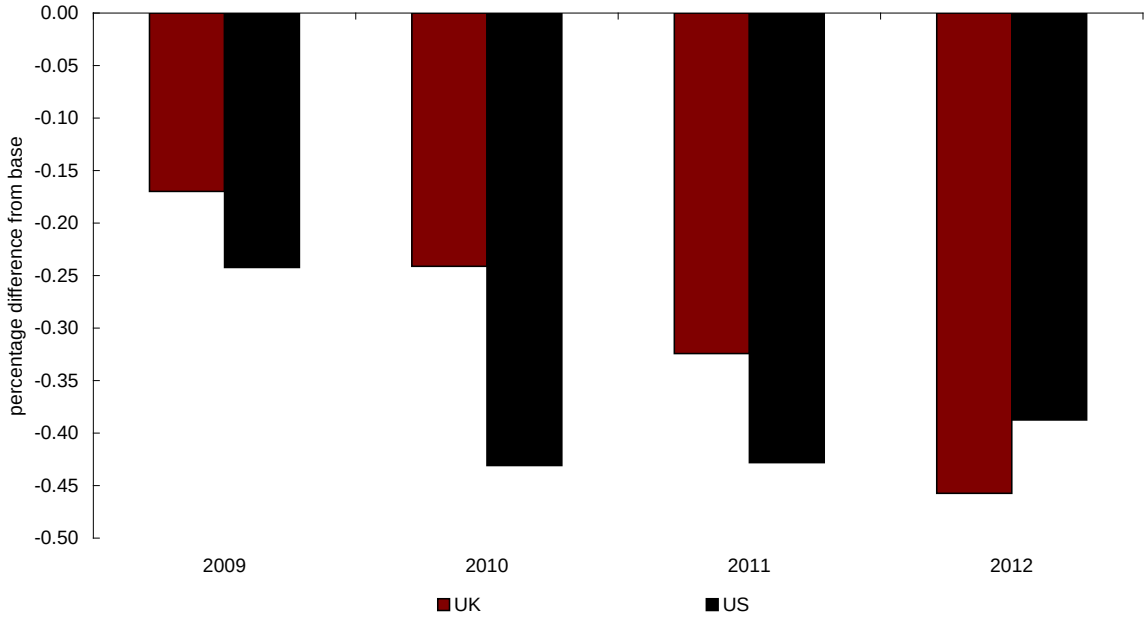
All the mnemonics in the equation coincide with the variable description used above in the empirical section. When we model forward looking behaviour for consumption we substitute [b*ln(RPDI) - (1-b)*ln((NW/CED) + (HW/CED)] in the equation with the permanent income variable (ln(PERMI)). This is defined as the income flow from the net present value of future post-tax incomes, where the discount factor includes a small myopia premium.

As discussed above, the estimated coefficients on the change in housing wealth are four to five times larger than those on financial wealth. This reflects the much more immediate perception of the impact of house prices on wealth. Financial wealth, especially in the UK is mainly held indirectly through pension and mutual funds, and owners do not always read a signal into changes in equity prices as they are unaware of the implications. The same in not true of owner occupied housing, where changes in price have an immediate signal for the owner, and changes in wealth are directly and immediately observed.

In times of financial uncertainties, share prices may decline in response to the increased nervousness concerning future company performances and resulting increase in risk premium which investors demand in order to cover themselves against future possible losses. Decreases in share prices will affect consumers through their wealth, but the magnitude of the impact will depend on the share of financial wealth in consumers' total wealth and on the marginal propensity to consume out of this wealth. Equity prices in NiGEM are determined by discounted future expected profits, with the discount factor being a combination of a long real interest rates and equity premium. We first reduce equity prices by increasing the equity premium and then we change equity prices exogenously by the same amount and evaluate the effect on consumption.

In the first scenario we increase the equity premium exogenously by 100 percentage points for 4 years and compare the impact on consumption for the UK and US. Figure 1 illustrates results of our simulations and plots the percentage difference for consumption from the baseline projection for the five year period.

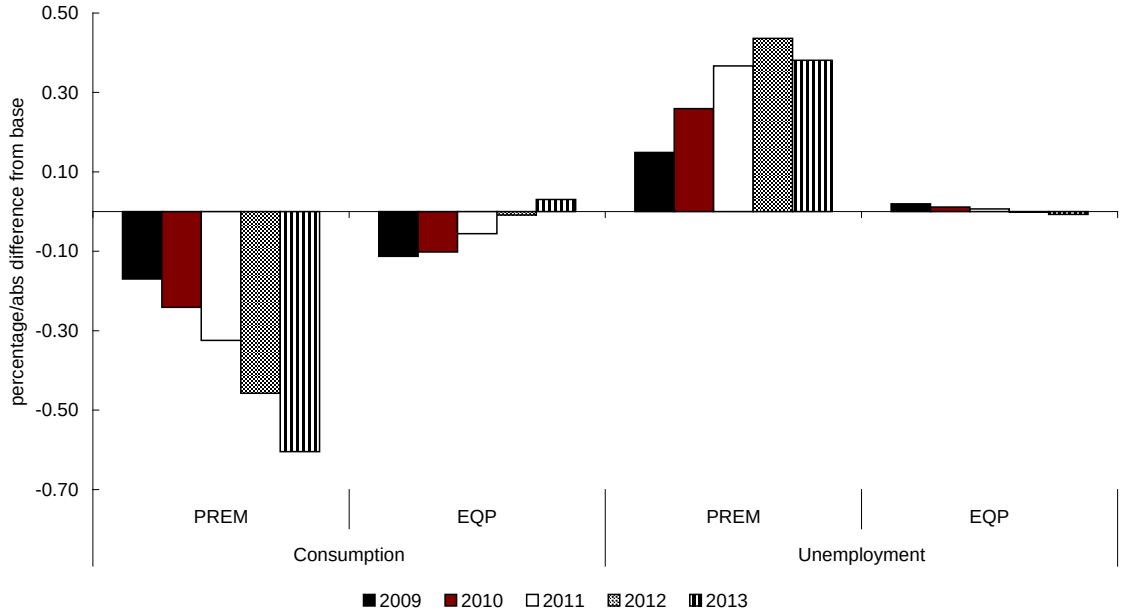
Figure 1. Effect of 100 percentage point temporary increase in equity premium on consumption



The initial effect of an increased equity premium on consumption is smaller in the UK than in the US and remains smaller for the first three years of the shock. While the effect of the shock is stronger in the US, it fades away more rapidly. The differences in the response to the shock in the countries may be an indicator of the sensitivity to the channels through which equity premium affects the economies. Changes in the equity premium play an important role in firms' investment decisions. A higher premium raises the user cost of capital for firms, leading to the heavier discounted future profits and possible cut backs or even complete abandonment of investment decisions. Reduction in investment contributes negatively to the output growth of the economy and hence to the consumption.

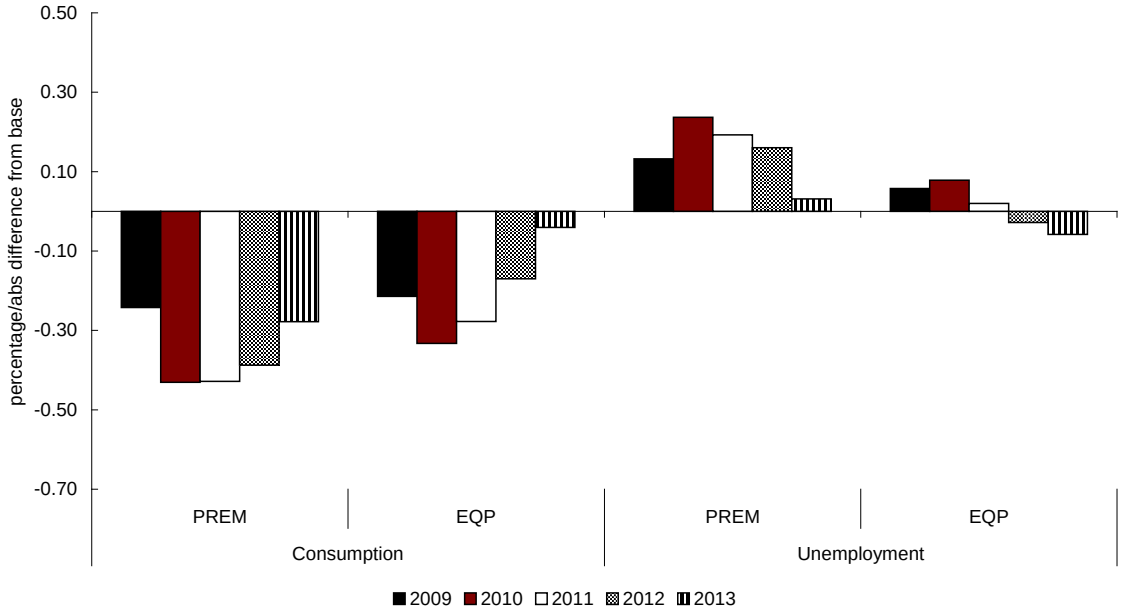
To differentiate between the channels mentioned above, we ran another set of simulations where equity prices are reduced by 10% in the first year. In order to get comparable results with the previous set of analysis, we extract the path of equity prices from the simulations with an increased equity premium and impose them in a new set of simulations. This allows us to separate wealth effect from the user cost of capital impact on consumption. Figures 2 and 3 illustrate simulation results and compare effects of equity premium increase to reduction in equity prices on consumption and unemployment for the UK and US.

Figure 2. Temporary increase in equity premium vs decrease in equity prices (UK)



note: PREM – equity premium, EQP – equity prices

Figure 3 Temporary increase in equity premium vs decrease in equity prices (US)

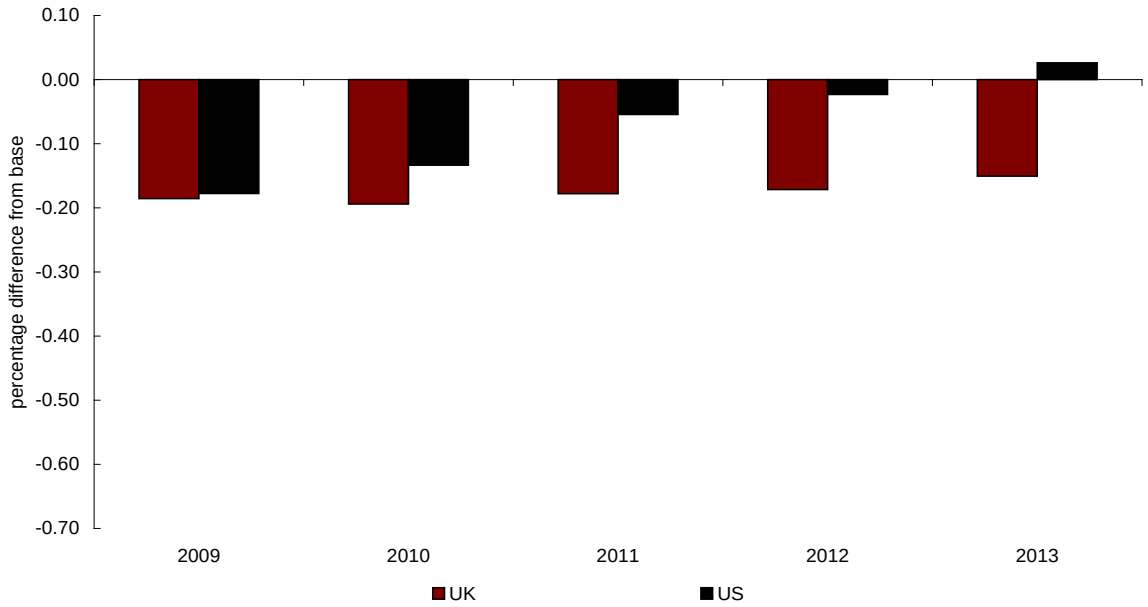


note: PREM – equity premium, EQP – equity prices

Comparing simulation results in the above figures shows an interesting insight to the differences in the response to the same type shocks between countries. In the UK the effect of the reduction in equity prices yields a negligible reduction in the consumption compared to the US, suggesting a more significant financial wealth effect in the US compared to the UK and larger impact from the user cost of capital in the UK than in the US. Increasing the equity premium in both countries results in rising unemployment (compared to the baseline scenario), with unemployment increasing initially more in the US compared to the UK, but returning to the pre-shock levels faster in the US.

If consumers are forward looking and adjust their consumption in accordance with anticipated changes in income and wealth, then the medium to longer term effects on consumption of a temporary increase in the equity premium will be absent and we should observe a smaller reduction in consumption compared to one in case of backward looking consumers. Results of the simulations with forward looking consumers for the UK and the US are presented in figure 4. It is clear that not only the impact of the shock is smaller in both countries, but also consumption returns to its base line scenario much faster.

Figure 4. Effect of 100 percentage point temporary increase in equity premium on consumption with forward looking consumers



We also ran a scenario where equity prices alone are reduced but with forward looking consumers equity premium shock. Again the impact on consumption is reduced. Even more importantly, anticipation of the end of the temporary shock together with the monetary measures countering the negative impact on the economy starts to have a positive effect on the consumption towards the end of the shock period. The effects of equity prices alone remain larger in the US than the UK, reflecting the composition of financial wealth, which is significantly more biased toward equity holdings, and especially directly held equities, than is wealth in the UK. This latter effect helps explain why the coefficient on net financial wealth in our model equations is larger in the US than the UK, as a change in equity prices contains more immediate signal in that country. In the UK more equity is held indirectly in pension funds. In the US a 10 per cent fall in equity prices produces a 3.8 per cent fall in real net financial wealth, whilst in the UK a similar sized fall in equity prices process a fall in real net financial wealth of 2.8 per cent. Simulation results are presented in Figures 5 and 6.

Figure 5. Increase in equity premium vs decrease in equity prices in case of forward looking consumers(UK)

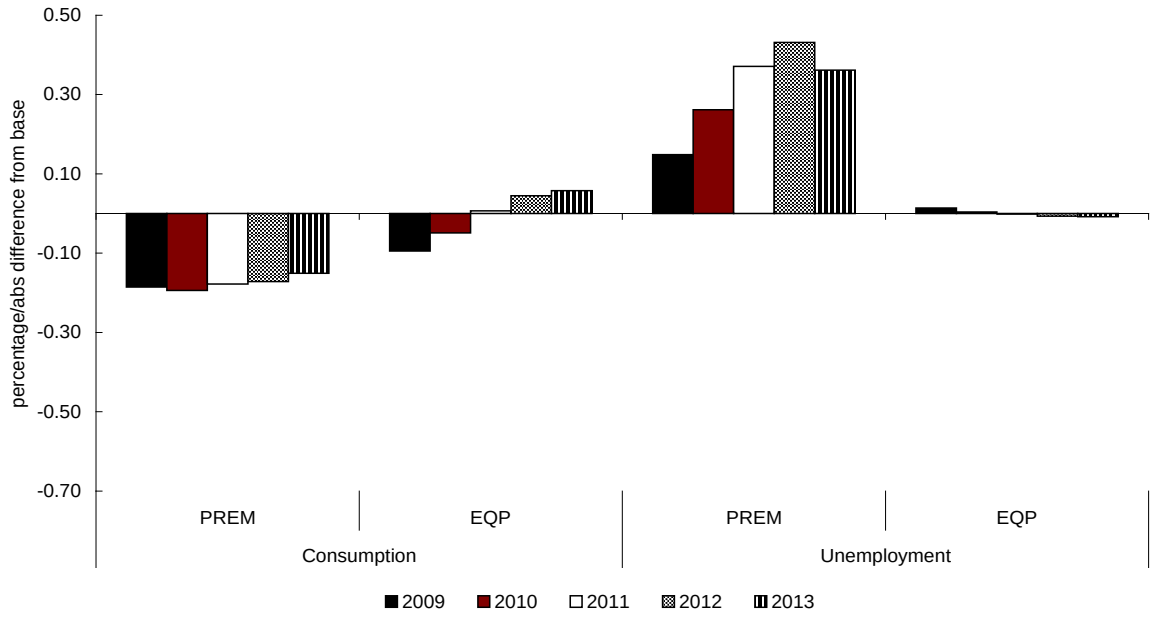
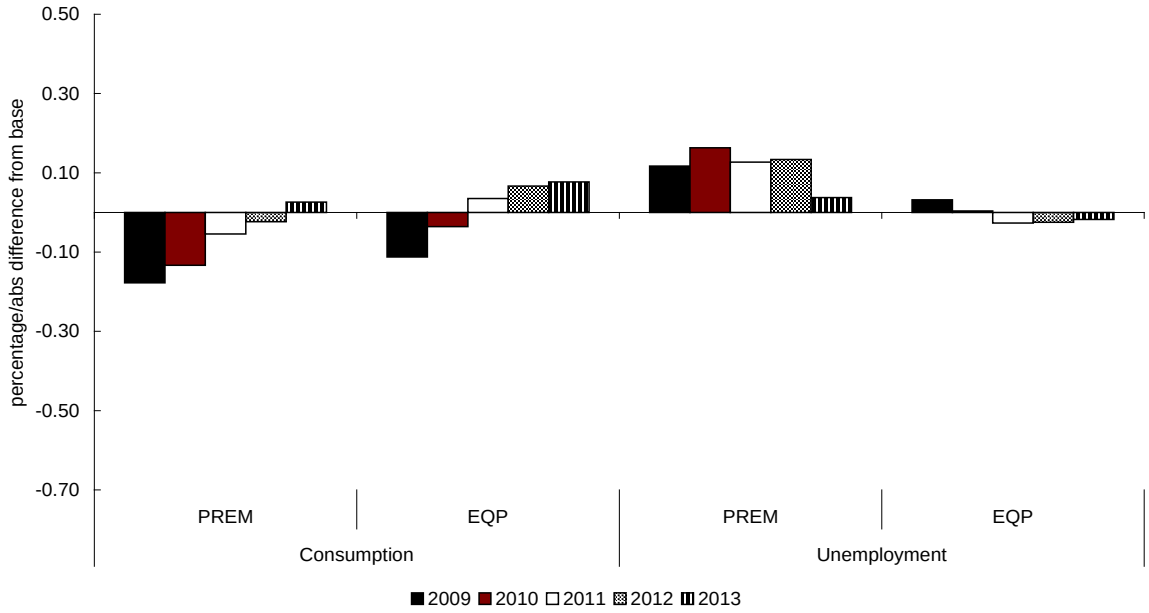
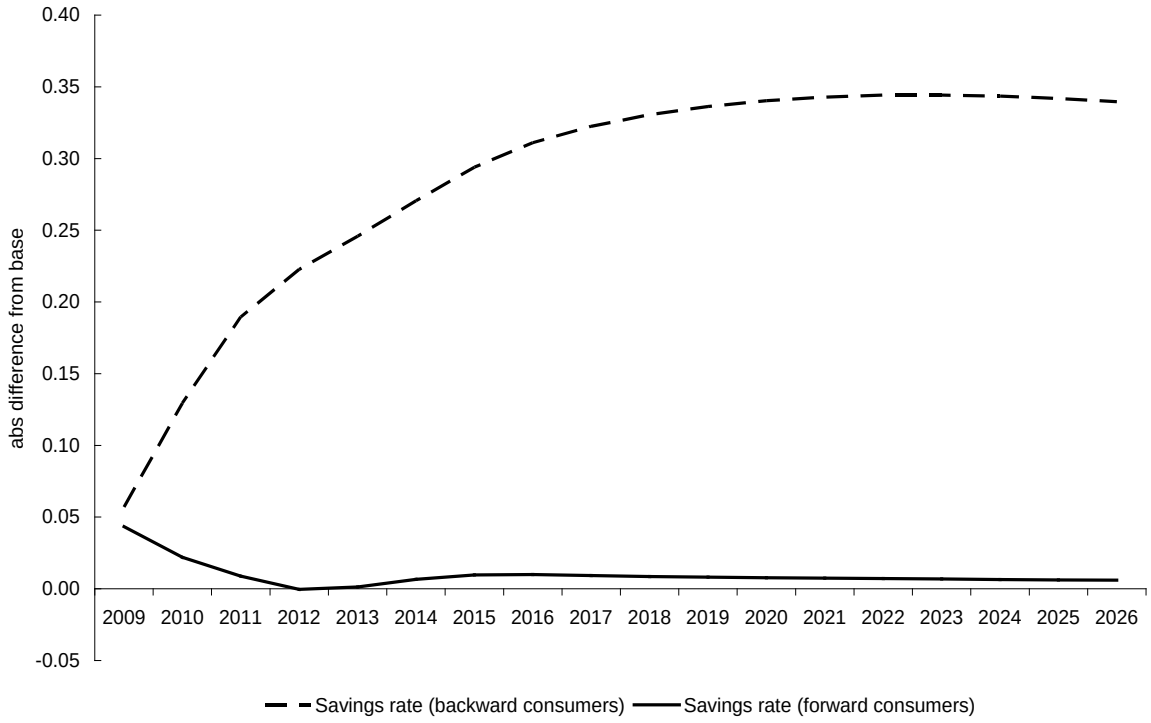


Figure 6. Increase in equity premium vs decrease in equity prices in case of forward looking consumers(US)



Given the large impact on consumption from the change in equity prices in the US we run one more simulation where equity prices are allowed to fall by 10% but this time permanently and again we compare scenarios with forward and backward looking consumers. Figure 7 depicts the effect on the savings rate (absolute difference from the base line projection) from our analysis. It can be seen, that although initial response to the shock is very similar in two scenarios, the resulting equilibrium levels of saving are different. In the backward looking case consumption continues to adjust for a sustained period. Consumers are faced with the reduced financial wealth and cut down their consumption. As a result the savings rate is increased in both short and long run and we end up with a permanent shift in the equilibrium level. In contrast in the forward looking case consumption drops only initially as consumption is set in relation only to income in the long run. Consumption and savings rate returns to the equilibrium level fairly quickly, and there is no shift in the long run as in case of backward looking consumers.

Figure 7. Effect of a permanent 10% reduction in equity prices in the US on savings rate, comparing results with forward and backward looking consumers

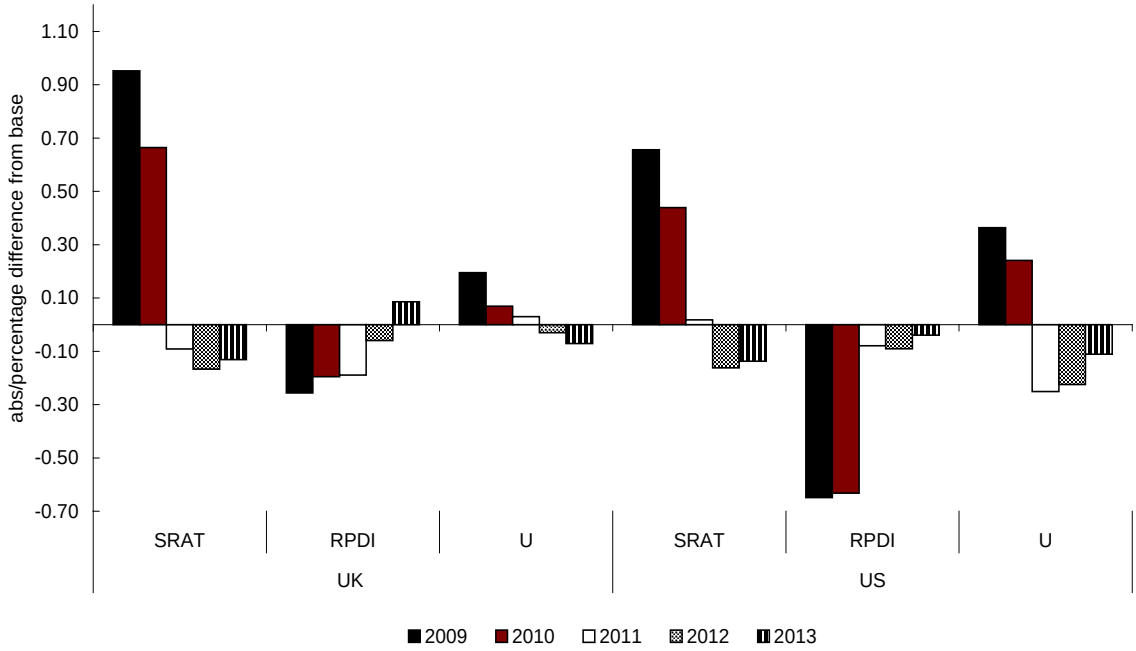


Having found a significant role for housing wealth in the consumption equation for the UK both in the long and short run, we investigate the effect of a house price reduction on consumers' savings decision, their disposable income and unemployment. We run two types of simulations. In the first case house prices are reduced exogenously by 10 per cent in the first year compared to our base line scenario and then they gradually return to the pre shock scenario in 2014. In the second scenario, house prices are decreased again by 10% in the first year, but unlike previous case, this time feedback from the changes occurring in the economy are allowed to affect house price movements starting from the second year of the shock. In both cases, for comparison purposes we run exactly the same simulations for the US as well.

Figure 8 illustrates simulation results from the first scenario. A negative shock to house prices reduces housing wealth and initially results in an increase in the savings rate, as the reduction in real personal income is more than matched by the decrease in consumption. In addition to this, if consumers consider an increase in housing wealth as a substitute to their savings, then the reduction in housing wealth may induce them to start saving more. In that case, short and long term wealth effects reinforce each-other causing savings rate

to increase significantly. Comparing the effects of a house price reduction on the unemployment and real personal disposable income between UK and US show that unemployment and income are affected more by changes in house prices in the US than in the UK despite the fact that the coefficient on the change in real housing wealth are similar in the two countries, .

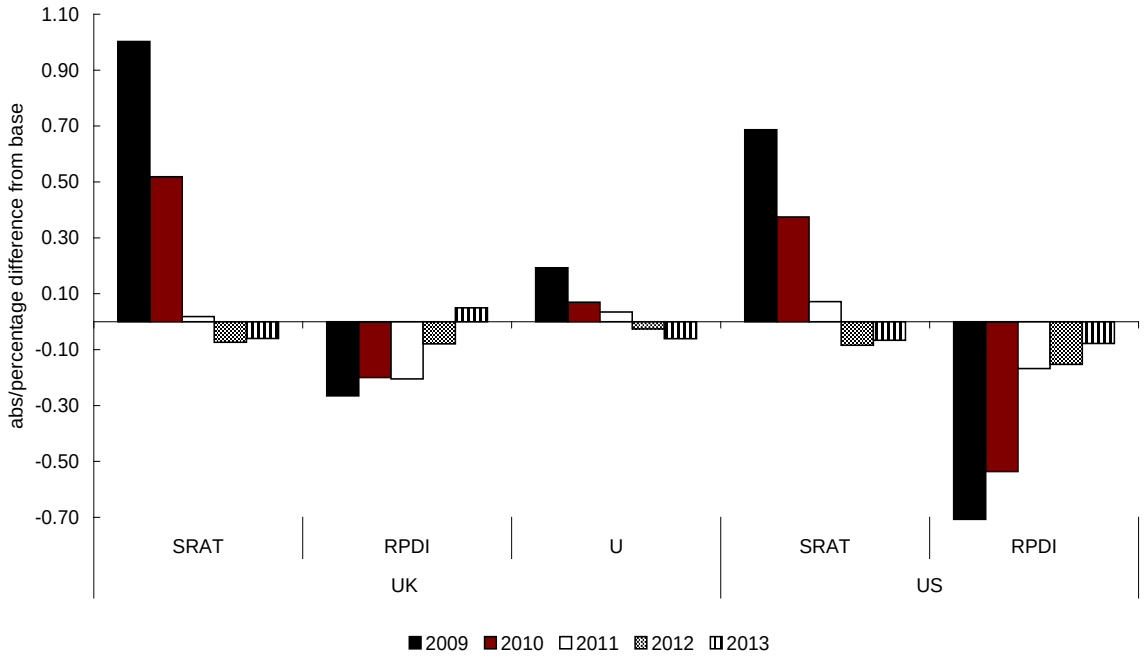
Figure 8. Effect of a temporary exogenous 10% decrease in house prices



note: SRAT –savings rate, RPDI – real personal disposable income, U- unemployment

When the feedback mechanism is allowed to operate and house prices respond to changes in the economy, the effect of a house price decrease fades away more quickly and the economy returns to its equilibrium level more rapidly. Comparing simulation results in figure 8 and figure 9 illustrates this point. Although in the first year, the response to the shock from all the variables is very similar in two cases, differences start to occur from the second period. In the second scenario the changes in all variables from the base line projections are smaller.

Figure 9. Effect of a temporary endogenous 10%decrease in house prices



Allowing house prices to drop endogenously by approximately 10% permanently supports our previous findings. Figures 10-11 below illustrate simulation results for both US and the UK. In both countries the short run effect of the reduction in house price on savings rates is comparable with the impact we have observed in case of temporary house price drop. We do not repeat results for forward looking consumers as effects are short lived. With backward looking consumers a permanent fall in house prices has much more prolonged positive impact on savings rate. Increased saving, especially in the US decreases long term interest rates and thus makes investment more attractive. An increase in investment activity has a positive effect on the whole economy and GDP slowly starts to return to a higher equilibrium level.

Figure 10. Effect of a permanent 10% reduction in house prices in the US on long real interest rates, savings rates and real output.

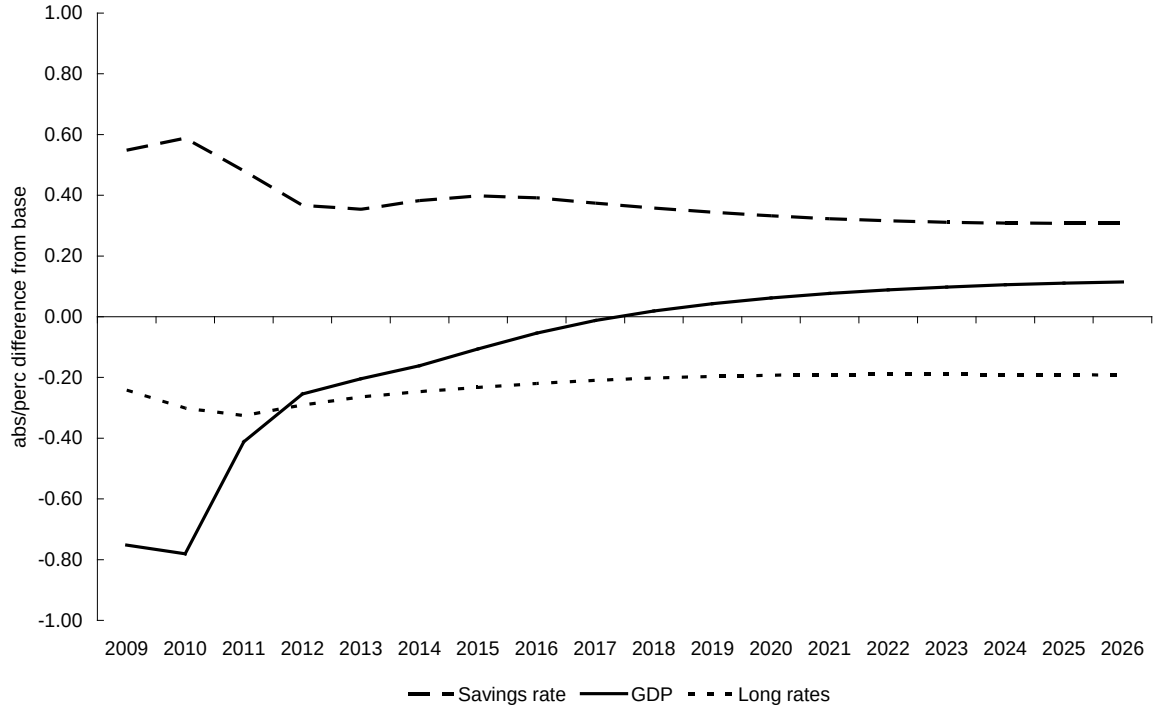
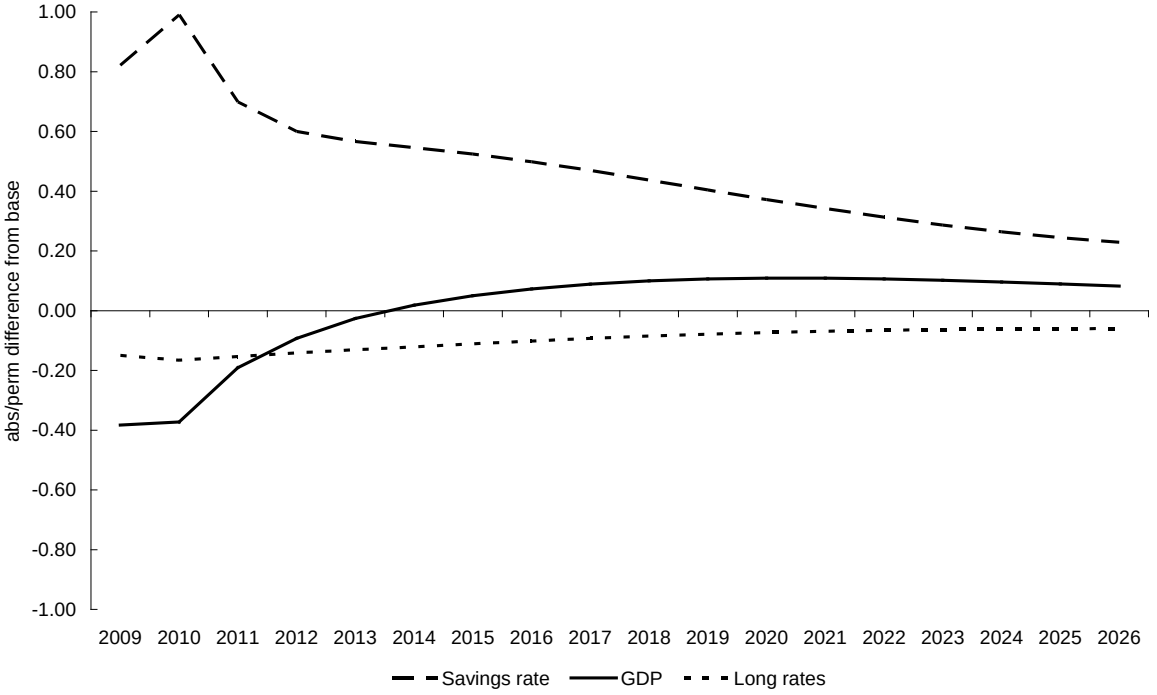


Figure 11. Effect of a permanent 10% reduction in house prices in the UK on long real interest rates, savings rates and real output.



Conclusions

The body of evidence on the relationship between house prices and consumption, and equity prices and consumption, in the UK is not as broad as in the US, and some of the links, especially in the long run, are disputed. However, our analysis of time series data suggest that consumption in the UK and the US are caused in a similar way by income and wealth, with significant effects from changes in real housing wealth, and smaller effects from changes in real financial wealth. These effects are generally larger than in other countries, and help explain the very low savings rates we have seen in these two countries whilst house prices were rising in the last decade. A temporary 10 percent fall in the price of houses will in both countries increase the savings ratio by around 1 percentage point, with the effect being marginally larger in the UK than the US. It is relatively clear from the data, but not from theory, that a permanent change in real house prices will have a similar effect on the saving ratio. Hence a 30 per cent fall in real house prices in either country would raise saving by around 1 ½ percentage points in the long-run.

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Appendix 1 The Structure and Use of the NiGEM Model

For a macroeconometric model to be useful for policy analyses, particular attention must be paid to its long-term equilibrium properties. At the same time, we need to ensure that short-term dynamic properties and underlying estimated properties are consistent with data and well-determined. As far as possible the same long run theoretical structure of NiGEM has been adopted for each of the major industrial countries, except where clear institutional or other factors prevent this. As a result, variations in the properties of each country model reflect genuine differences in data ratios and estimated parameters, rather than different theoretical approaches. The model has been in use at the National Institute since 1987, but it has developed and changed over that time. Some of its development was initially financed by the ESRC, but since 1995 it has been funded by its user community of public sector policy institutions. These currently include the Bank of England, the ECB, the IMF, the Bank of France, the Bank of Italy and the Bundesbank as well as most other central banks in Europe along with research institutes and finance ministries throughout Europe and eleswhere.

Each quarter since 1987 the model group has produced a forecast baseline that has been published in eth Institute *Review* and used by the subscribers as a starting point for their own forecasts. The forecast is currently constructed and used out to beyond 2031 each quarter, although the projection beyond 2015 is a stylized use of the long run properties of the model. Since 1998 the model has also been used by the EFN Euroframe group to produce forecasts for the European Commission. Forecasts are produced w based on assumptions and they do not always use forward looking behaviour. In policy analyses the model can be switched between forward, rational expectations mode and adaptive learning for consumers, firms, labour and financial markets. Policy environments are very flexible, allowing a number of monetary and fiscal policy responses. The model has been extensively used in projects for the European Commission, UK government departments and government bodies throughout the world. It has also contributed to a number of Institute ESRC projects.

Production and price setting
The major country models rely on an underlying constant-returns-to-scale CES production function with labour-augmenting technical progress.

$$Q = \gamma\left[s(K)^{-\rho} + (1-s)(Le^{\lambda t})^{-\rho}\right]^{-1/\rho} \qquad (1)$$

where Q is real output, K is the total capital stock, L is total hours worked and t is an index of labour-augmenting technical progress. This constitutes the theoretical background for the specifications of the factor demand equations, forms the basis for unit total costs and provides a measure of capacity utilization, which then feed into the price system. Barrell and Pain (1997) show that the elasticity of substitution is estimated from the labour demand equation, and in general it is around 0.5. Demand for labour and capital are determined by profit maximisation of firms, implying that the long-run labour-output ratio depends on real wage costs and technical progress, while the long-run capital output ratio depends on the real user cost of capital

$$Ln(L) = \left[\sigma \ln\{\beta(1-s)\} - (1-\sigma)\ln(\gamma)\right] + \ln(Q) - (1-\sigma)\lambda t - \sigma \ln(w/p) \qquad (2)$$

$$Ln(K) = \left[\sigma \ln(\beta s) - (1-\sigma)\ln(\gamma)\right] + \ln(Q) - \sigma \ln(c/p) \qquad (3)$$

where w/p is the real wage and c/p is the real user cost of capital. The user cost of capital is influenced by corporate taxes and depreciation and is a weighted average of the cost of equity finance and the margin adjusted long real rate, with weights that vary with the size of equity markets as compared to the private sector capital stock. Business investment is determined by the error correction based relationship between actual and equilibrium capital stocks. Government investment depends upon trend output and the real interest rate in the long run. Prices are determined as a constant mark-up over marginal costs in the long term.

Labour market

NiGEM assumes that employers have a right to manage, and hence the bargain in the labour market is over the real wage. Real wages, therefore, depend on the level of trend labour productivity as well as the rate of unemployment. Labour markets embody rational expectations and that wage bargainers use model consistent expectations. The dynamics of the wage market depend upon the error correction term in the equation and on the split between lagged inflation and forward inflation as well as on the impact of unemployment on the wage bargain (Anderton and Barrell 1995). There is no explicit equation for sustainable employment in the model, but as the wage and price system is complete the model delivers equilibrium levels of employment and unemployment. An estimate of the NAIRU can be obtained by substituting the mark-up adjusted unit total cost equation into the wage equation and solving for the unemployment rate. Labour supply is determined by demographics, migration and the participation rate.

Consumption, personal income and wealth

Consumption decisions are presumed to depend on real disposable income and real wealth in the long run, and follow the pattern discussed in Barrell and Davis (2007). Total wealth is composed of both financial wealth and tangible (housing) wealth where the latter data is available.

$$\ln(C) = \alpha + \beta \ln(RPDI) + (1-\beta)\ln(RFN + RTW) \qquad (4)$$

where *C* is real consumption, *RPDI* is real personal disposable income, *RFN* is real net financial wealth and *RTW* is real tangible wealth. The dynamics of adjustment to the long run are largely data based, and differ between countries to take account of differences in the relative importance of types of wealth and of liquidity constraints. As Barrell and Davis (2007) show, changes in financial (dlnNW) and especially housing wealth (dlnHW) will affect consumption, with the impact of changes in housing wealth having five times the impact of changes in financial wealth in the short run. They also show that adjustment to the long run equilibrium shows some inertia as well.

$$dlnC_t = \lambda(lnC_{t-1} - lnPI_{t-1}) + b_1 dlnRPDI_t + b_2 dlnNW_t + b_3 dlnHW_t \qquad (5)$$

Al Eyd and Barrell (2005) discuss borrowing constraints, and investigate the role of changes in the number of borrowing constrained households. It is common to associate the severity of borrowing constraints with the coefficient on changes in current income (dlnRPDI) in the equilibrium correction equation for consumption, where d is the change operator and ln is natural log,

Financial markets

We generally assume that exchange rates are forward looking, and 'jump' when there is news. The size of the jump depends on the expected future path of interest rates and risk premia, solving an uncovered interest parity condition, and these, in turn, are determined by policy rules adopted by monetary authorities as discussed in Barrell, Hall and Hurst (2006):

$$RX(t) = RX(t+1)[(1+rh)/(1+ra)](1+rprx) \qquad (6)$$

where *RX* is the exchange rate, *rh* is the home interest rate set in line with a policy rule, *ra* is the interest rate abroad and *rprx* is the risk premium. . Nominal short term interest rates are set in relation to a standard forward looking feedback rule. Forward looking long rates should be related to expected future short term rates

$$(1+LR_t) = \Pi^{T}_{j=1},\ (1+SR_{t+j})^{1/T} \qquad (7)$$

We assume that bond and equity markets are also forward looking, and long-term interest rates are a forward convolution of expected short-term interest rates. Forward looking equity prices are determined by the discounted present value of expected profits

Public sector

We model corporate (CTAX) and personal (TAX) direct taxes and indirect taxes (ITAX) on spending, along with government spending on investment and on current consumption, and separately identify transfers and government interest payments. Each source of taxes has an equation applying a tax rate (?TAXR) to a tax base (profits, personal incomes or consumption). As a default we have government spending on investment (GI) and consumption (GC) rising in line with trend output in the long run, with delayed adjustment to changes in the trend. They are re-valued in line with the consumers' expenditure deflator (CED). Government interest payments (GIP) are driven by a perpetual inventory of accumulated debts. Transfers (TRAN) to individual are composed of three elements, with those for the inactive of working age and the retired depending upon observed replacement rates. Spending minus receipts give us the budget deficit (BUD, and this flows onto the debt stock.

$$BUD = CED*(GC+GI)+TRAN+GIP-TAX-CTAX-MTAX \qquad (8)$$

The text above discussed how the government deficit (BUD) is financed.

External trade

International linkages come from patterns of trade, the influence of trade prices on domestic price, the impacts of exchange rates and patterns of asset holding and associated income flows. The volumes of exports and imports of goods and services are determined by foreign or domestic demand, respectively, and by competitiveness as measured by relative prices or relative costs. The estimated relationships also include measures to capture globalization and European integration and sector-specific developments. It is assumed that exporters compete against others who export to the same market as well as domestic producers via relative prices; and demand is given by a share of imports in the markets to which the country has previously exported. Imports depend upon import prices relative to domestic prices and on domestic total final expenditure. As exports depend on imports, they will rise together in the model. The overall current balance depends upon the trade balance and net property income form abroad which comprised flows of income on gross foreign assets and outgoings on gross foreign liabilities. Gross National Product (GNP) is gross Domestic Product (GDP) plus net factor income from foreigners.

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Appendix 2 Marginal Propensities to Consume (MPC)

In an equation of the form

$$Dln(C) = a + b_1\, dln(RPDI) + b_2\, dln(RNW) + b_3\, dln(RHW) + c\,(ln(C_{-1}) - d\, ln(RPDI_{-1}) - (1-d)\, ln(TW_{-1}))$$

The marginal propensities to consume out of income and wealth are

	Short Run	Long Run
MPC (income)	(C /RPDI) b_1	(C/RPDI) d
MPC (financial wealth)	(C/RNW) b_2	(C/RTW) RNW/RTW (1-d)
MPC (housing wealth)	(C/RHW) b_3	(C/RTW) RHW/RTW (1-d)

The MPC will vary over time, depending upon the ratios of consumption to income and the components of wealth. It will also increase over time from its initial impact effect to its long run effect. The table below gives UK and US MPC out of income (RPDI), net financial wealth (RNW) and real housing wealth (RHW). The first two blocks are the impact MPCs at different points in history. The second two blocks give the first year and twelfth year MPCs using 2006 consumption to income or wealth ratios. In both countries there is clear evidence of short run spending from housing wealth exceeding the long run impacts. US consumers appear to react more to a one dollar change in housing wealth in the short run, and have a stronger wealth effect in the long run

MPCs in the UK and the US

	ukrpdi	ukrnw	ukrhw
2006Q4	0.1714	0.0025	0.0092
2008Q4	0.1665	0.0032	0.0098
2009Q4	0.1589	0.0029	0.0113

	usrpdi	usrnw	usrhw
2006Q4	0.1535	0.0023	0.0148
2008Q4	0.1498	0.0032	0.0186
2009Q4	0.1392	0.0030	0.0208

	ukrpdi	ukrnw	ukrhw
Year 1	0.2602	0.0102	0.0351
Year 12	0.9077	0.0120	0.0125

	usrpdi	usrnw	usrhw
Year 1	0.266423	0.013294	0.053712
Year 12	0.79658	0.031154	0.031254