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The Effects of Financial Deregulation on Consumption

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Abstract

This paper examines whether financial deregulation in the 1980s has reduced the importance of liquidity constraints in consumption patterns. Data for six industrialized countries are used to estimate a simple model incorporating liquidity constraints and forward looking behavior. It is concluded that the importance of liquidity constraints fell between the 1970s and the 1980s. This implies that forward looking models of consumer behavior fit the data better in the recent period.

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Summary

Recently there has been a substantial move toward financial deregulation on a national and international level in all the industrial countries. This paper examines whether this change has reduced the importance of liquidity constraints on consumption.

Data for six industrial countries are used to investigate the hypothesis that deregulation has had this effect. On the national level, the role of liquidity constraints is investigated by estimating a simple consumption model that incorporates both forward-looking behavior and liquidity constraints. The impact of financial deregulation is examined by comparing the results from estimation over the regulated 1970s with those from the (relatively) deregulated 1980s. A significant fall in the importance of liquidity constraints is found for four of the six countries studied.

On the international level, a similar framework is used to derive a system of cross-country equations under the assumption of perfect capital mobility. As with the work on individual countries, this system is estimated for the highly regulated 1970s and the relatively deregulated 1980s. The results indicate that liquidity constraints affect the pattern of consumption between countries and that financial deregulation has improved this pattern.

The analysis leads to the conclusions that financial deregulation has had important effects upon consumption in industrial countries and that the present pattern of consumption is close to the forward-looking model in most countries.

I. Introduction

The recent period has seen a substantial move towards financial deregulation throughout the industrialized countries, on both a national and international level. A question of interest to both policy makers and economic analysts is the degree to which this change has affected economic behavior. This paper explores on one particular effect, namely the possibility that financial deregulation has changed consumption behavior by reducing liquidity constraints. Data for six industrialized countries are used to investigate this hypothesis.

On the national level, the role of liquidity constraints in explaining the failure of the "random walk" type models of consumption is examined by estimating a simple consumption model that incorporates liquidity constraints. Comparisons among countries provide insights into whether departures from the permanent income/life cycle hypothesis are more pronounced in countries with a higher degree of financial regulation. For each country, the impact of financial deregulation is examined by comparing the results from estimating the model over the regulated 1970s with those from the (relatively) deregulated 1980s. The basic hypothesis is that financial integration reduced liquidity constraints faced by consumers, allowing a higher percentage of the population to smooth consumption.

On the international level, a similar framework is used to derive a system of cross country equations under the assumption of perfect capital mobility. As in the case of the analysis for individual countries, this system is estimated for two separate sample periods, the "highly regulated" 1970s and the relatively deregulated 1980s.

The results have important implications for both economic theory and macroeconomic policy. For the theory this research offers the prospect of improved models that reconcile the "utility maximization" framework with the empirical evidence by taking borrowing constraints explicitly into account. On the policy side, financial deregulation is considered from a normative perspective. The existence of liquidity constraints implies that observed consumption patterns may deviate from the "optimal" patterns predicted by the permanent income hypothesis; these deviations suggest that financial deregulations may result in welfare improvement.

The paper is organized as follows. Section II examines the relationship between consumption and borrowing constraints on the national level. Section III analyzes the impact of financial deregulation on international consumption patterns. Section IV applies a method for estimating the short-run dynamics of conventional consumption models on the basis of the Euler equation approach. Section V concludes with a summary of the key results. The Appendix contains algebraic derivations.

II. National Consumption Patterns

1. The estimating equation

Much of the recent empirical work on consumption has focused on the Euler equation characterization of optimal behavior. The Euler equation approach as formulated by Hall (1978) assumes that rational, forward-looking consumers maximize the expected value of lifetime utility, subject to an intertemporal budget constraint. 1/ The solution to the optimization problem yields the equation:

$$U'(C_t) = E_t\{\beta(1+R_t)U'(C_{t+1})\} \qquad (1.1)$$

where $U(C_t)$ is the one-period utility function, C_t is the consumption, E_t is the mathematical expectation conditional on the information available at t, β is a subjective discount factor and R_t is the real interest rate.

The Euler equation states that consumption should approximate a random walk; that is, the change in consumption should not be predictable. However, empirical work has shown that certain variables (e.g. current disposable income, stock prices) have enough predictive power to reject the hypothesis in formal statistical tests. 2/

The objective of this section is to investigate whether the failure of the "random walk" type models of consumption can be attributed to liquidity constraints, where "liquidity constraints" imply an inability or unwillingness to use capital markets to smooth consumption, and to examine whether these constraints have been reduced by the steps toward financial deregulation in the 1980s. 3/ To this end, the permanent income hypothesis is nested in a more general model in which a fraction λ of

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1/ Carroll and Summers (1989) argue that the observed correlation between consumption and income growth indicates that consumption smoothing takes place over periods of several years rather than over a lifetime. The relevance of the Euler equation approach, however, is not invalidated by this criticism.

2/ See for example Flavin (1981), Hall and Mishkin (1982), Hayashi (1982) and Hansen and Singleton (1982).

3/ Other work on liquidity constraints includes Zeldes (1986) and Hall and Mishkin (1982) on the micro-economic side, and Campbell and Mankiw (1987 and 1989) and Jappelli and Pagano (1988) on the macro-economic side. The other main explanation for the failure of the simple version of the forward-looking model is that consumption is not separable in the utility function. Works in this vein include Mankiw, Rottenberg and Summers (1985) and Eichenbaum, Hansen and Singleton (1987) on labor supply and Bernanke (1985) on durable goods and Aschauer (1985) on government purchases. The general results from this literature are not encouraging, and are not explored here.

consumption accrues to individuals who are liquidity constrained and thus unable to smooth their consumption path through borrowing, while $(1-\lambda)$ accrues to individuals who behave according to the permanent income hypothesis. 1/ For the liquidity-constrained group it is assumed that consumption expenditures are a constant fraction of current income, so that the expected rate of growth of aggregate consumption is equal to the expected rate of growth of real disposable income. Mathematically,

$$E_t\{C_{1t+1}/C_{1t} - Y_{t+1}/Y_t\} = 0 \tag{1.2}$$

where C_{1t} and Y_{1t} refer respectively to the consumption and real disposable income of the liquidity constrained consumers.

In contrast, the consumption of the group that is not liquidity constrained evolves according to the Euler equation:

$$E_t\{(1+R_t)\beta U'(C_{2t+1})/U'(C_{2t}) - 1\} = 0 \tag{1.3}$$

where C_{2t} denotes the current consumption of the forward looking consumers. Under the assumption that the utility function is of the form $U_t = C_t^{1-\alpha}$, the behavior of the second group of consumers can be approximated by the equation: 2/

$$E_t\{C_{2t+1}/C_{2t} - (\theta+((1+R_t)\beta)^{\sigma})\} = 0. \tag{1.4}$$

The coefficient σ in the above expression denotes the intertemporal elasticity of substitution of consumption, and is equal to $(1/\alpha)$. 3/

1/ The model formulation in this section builds on Campbell and Mankiw (1987). A similar approach is used by Jappelli and Pagano (1988) and Delong and Summers (1986).

2/ The Appendix contains a complete derivation of equation (1.4). A "drift" term has been included, to represent the growth in consumption over time caused by factors such as technological change. This type of effect is implicitly included in most tests of the theory, such as Hall (1978).

3/ Given the assumed utility function the coefficient σ can also be identified with the reciprocal of the coefficient of risk aversion (α). Less restrictive assumptions about preferences would break this correspondence. Since the equation deals with changes in consumption over time, the intertemporal elasticity appears a better characterization (Hall (1988)). For a discussion of a wider class of utility functions see Epstein and Zin (1987).

Weighing equations (1.2) and (1.4) by the assumed proportion of aggregate consumption in the two categories yields the following equation:

$$E_t\{C_{t+1}/C_t - (1-\lambda)(\theta+(\beta(1+R_t))^{\sigma}) - \lambda Y_{t+1}/Y_t\} = 0 \qquad (1.5)$$

Equation (1.5) is the expression used in the empirical work on national consumption behavior. The econometric approach involves estimating λ and testing the permanent income hypothesis ($\lambda=0$) against the alternative that consumers are liquidity constrained ($1>\lambda>0$). Compared to other available tests of the permanent income hypothesis, direct estimation of λ has the advantage of providing a useful measure of the economic importance of deviations from the theory. As Campbell and Mankiw (1989) observe, an estimate of λ close to zero can be interpreted as evidence in favor of the theory, even if it is statistically significant, while a large estimate of the same parameter points away from the permanent income hypothesis.

2. Econometric methodology

The estimation technique employed in this paper is the Generalized Method of Moments (GMM). This method seems appropriate, since the equation to be estimated involves non-linear terms and has the form of Euler equations with expected values of zero. GMM both produces robust estimates of the parameters and a test of the orthogonality conditions that are implied by the rational expectations hypothesis. 1/ This contrasts with traditional techniques where the estimation of the parameters and testing of the orthogonality conditions requires a two-stage procedure. 2/

All tests are performed using data for six different countries for which the appropriate data was available on a quarterly basis: the United States, Japan, Canada, United Kingdom, France and Sweden. Y_t is measured as per capita personal disposable income, C_t is per capita consumption of nondurables and services and R_t is the real interest rate, defined as the nominal rate adjusted by the rate of inflation of the implicit consumption deflator. The full sample period covers 1970:1 to 1988:1 (disaggregated consumption data for Japan, France and Sweden do not start until 1970, but longer data sets are available for the other three countries). 3/ All the data is seasonally adjusted.

1/ This test is constructed by exploiting instrumental variable techniques; the excess of instruments over parameters generates a set of overidentifying restrictions of the orthogonality conditions implied by the expectations operator. The instruments can be any predetermined variables; they do not have to be exogenous in the model.

2/ For a further discussion of the GMM estimation technique see Hansen and Singleton (1982).

3/ See note on data sources.

3. Empirical results

Equation (1.5) contains four parameters: the intertemporal elasticity of substitution σ, the fraction of liquidity constrained consumption λ, the subjective discount rate β, and the drift term θ. While free estimation of all four parameters was attempted, there were problems with the estimation of the discount rate β. This is a standard problem in these types of models. In the results that are reported β was imposed at 0.99 and the other parameters estimated freely; values of β between 0.98 and 0.995 produced similar results.

The set of instruments used in estimation were a constant, lags two through six of the real income growth (Y_t/Y_{t-1}), lags two through six of the consumption growth (C_t/C_{t-1}), the second lag of the ratio of consumption to current income and the second lag of the real interest rate. 1/

Experiments were undertaken with several other instrumental variables, e.g., different lags of the income and consumption growth and lagged changes of real stock prices. However, the results were less satisfactory than those based in the above approach. Share prices, in particular, have little predictive power. This finding is consistent with the results reported by Campbell and Mankiw (1989) who found that stock prices were not useful in predicting consumption or income growth. 2/

The results obtained from estimating equation (1.5) over the full sample period are reported in Table 1. The first column shows the estimate of λ, the parameter associated with liquidity constraints, the second the estimate of the intertemporal elasticity of substitution σ, the third the drift term θ, while the fourth shows the probability value associated with the orthogonality constraints implied by the expectations operator. The general picture that emerges is that the model fits the data; most of the parameter estimates appear to be reasonable while tests of the overidentifying restrictions do not reject the model. The liquidity constrained share of consumption, λ, obtains plausible values and is significantly different from zero in most regressions. Cross country comparisons are also reasonable; for example the proportion of consumption associated with liquidity constrains is lower in the U.S.

1/ First lags are inadmissable as instruments because consumption and income are measured as quarterly averages rather than at points in time. According to the permanent income hypothesis, consumption is a random walk; Working (1960) shows that averaging a random walk induces serial correlation between the contemporaneous value and the first lag, but not earlier lags, making first lags invalid instruments. See also Hall (1988) and Campbell and Mankiw (1987 and 1989).

2/ This finding contrasts with the positive results reported by Hall (1978), who found that stock price changes have explanatory power. However, he included first lags in his set of instruments.

Table 1. Estimation Results for the Basic Model

Estimating Equation: $E_t\{C_{t+1}/C_t-(1-\lambda)(\theta+(\beta(1+R_t))^{\sigma})-\lambda Y_{t+1}/Y_t\}=0$

	λ	σ	θ	Probability Value for Orthogonality Constraints
United States	0.27 (0.07)	0.03 (0.09)	0.004 (0.001)	0.77
Japan	0.51 (0.07)	-0.02 (0.03)	0.007 (0.001)	0.30
France	0.32 (0.14)	0.06 (0.14)	0.007 (0.001)	0.08
United Kingdom	0.04 (0.08)	0.10 (0.07)	0.006 (0.001)	0.12
Canada	0.18 (0.09)	-0.08 (0.11)	0.005 (0.001)	0.45
Sweden	0.33 (0.25)	-0.03 (0.19)	0.003 (0.002)	0.62

Notes: The sample period is 1971:3-1988:1. Standard errors are given in parentheses. Instruments were the second lag of the ratio of consumption to income, lags 2 to 6 of the rate of change of consumption, lags 2 to 6 of the rate of change of income and the second lag of the real interest rate.

(0.27) than in countries generally regarded as having had a higher degree of financial regulation, such as Japan (0.51). The main anomaly pertains to the results for the United Kingdom, where the coefficient is low, and insignificantly different from zero. This appears to be a feature of the data set; when the growth rate of consumption was regressed on income using ordinary least squares, similar estimated were obtained. It contrasts with the results in Japelli and Pagano (1988), who report a higher coefficient using annual data.

The estimates of the intertemporal elasticity of substitution, σ, reported in column 2 of the table, vary between -0.08 and 0.10. While three of these estimates have the wrong sign, the values are all small, insignificantly different from zero and have low standard errors. Of the six estimates, four are significantly different from 0.25 at conventional level, and all are significantly different from 0.4. These results agree with Hall (1988), who finds that the intertemporal elasticity of substitution is low using data for the United States.

The drift terms θ are small but significant. The pure version of the model, in which a representative consumer smooths consumption over an infinite horizon, is clearly rejected by the data. 1/

Finally, the probability values for the test of overidentifying restrictions, indicate that the model cannot be rejected at conventional significance levels for any of the countries, although the probability value is quite low for France. In summary, the evidence presented in Table 1 suggests that the basic model with liquidity constraints offers a good approximation of the data, and shows evidence of the existence and relevance of liquidity constraints.

4. Financial deregulation

This section uses the framework developed above to investigate the effect of financial deregulation on consumption. To the extent that financial deregulation has reduced the importance of liquidity constraints, this shift should be apparent when comparing estimates of liquidity constraints before financial deregulation with those after deregulation. This can also be seen as a test of the interpretation that the correlations between changes in consumption and (predictable) changes in disposable income are due to liquidity constraints. Other explanations, for example the possibility that income is correlated with labor supply and hence that the correlation of income and consumption is due to substitution between leisure and consumption, would be unaffected by financial deregulation. The identification of significant changes in the correlation between income and consumption over the period of

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1/ For a discussion on long-run trends in disposable income and consumption between countries, and their implications for permanent income/life cycle models see Caroll and Summers (1989).

financial deregulation would provide powerful evidence that this behavior reflects liquidity constraints.

A problem that arises in empirical work on financial deregulation is the fact that measures toward financial integration often have been piecemeal. 1/ Furthermore, in many cases actual bank behavior preceded legal changes, as in the case of the introduction of NOW accounts in the United States. This makes it difficult to identify specific regime shifts. Hence, instead of looking for specific changes in different countries, a more general approach was adopted. The sample period was divided into two halves, with results from the "regulated" 1970s compared to those from the relatively deregulated 1980s. In addition to allowing easier comparison across countries, this has an econometric advantage. Since 1980 is approximately in the middle of the full sample period (1970-1988), the chosen sub-periods have similar lengths, which minimizes possible small sample biases.

The basic model was modified by adding a dummy variable, which takes the value 0 in the 1970s and 1 in the 1980s. Including the dummy in the estimating equation yields the expression:

$$E_t\{C_{t+1}/C_t - (1-\lambda+\lambda_1*\text{dummy})(\theta+(\beta(1+R_t))^{\sigma}) - (\lambda-\lambda_1*\text{dummy})Y_{t+1}/Y_t\} = 0. \qquad (1.6)$$

The coefficient λ has now to be reinterpreted as the liquidity constrained consumption in the 1970s while λ_1 represents the decline in the coefficient during the 1980s.

The estimation results are shown in Table 2. They clearly show a significant change in liquidity constraints for most countries. The coefficient λ_1, representing the change in proportion of consumption associated with liquidity constraints, is significant at conventional levels in four of the six countries, namely for the United States, Japan, France and Canada. The results for Sweden also show a fall in the coefficient; however, this fall is not significant at conventional levels. Given that financial liberalization occurred somewhat later in Sweden than in the other countries being considered, the lack of precision in estimating this parameter is not surprising. 2/ On the other hand, the results for the United Kingdom are somewhat disappointing. The sign of

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1/ For a survey of such reforms see OECD (1989).

2/ Another possible reason for this lack of precision is that different seasonal adjustment procedures were used on the consumption and disposable income data. While the consumption data was seasonally adjusted, the income data was not and was seasonally adjusted by the authors.

Table 2. Estimation Results When a Dummy Variable is Included in the Basic Model

Estimating Equation: $E_t\{C_{t+1}/C_t-(1-\lambda+\lambda_1.\text{dummy})(\theta+(\beta(1+R_t))^{\sigma})-(\lambda-\lambda_1.\text{dummy})Y_{t+1}/Y_t\}=0$

	λ	λ_1	σ	θ	Probability Value for Orthogonality Constraints
United States	0.44 (0.08)	0.31 (0.12)	0.01 (0.08)	0.004 (0.001)	0.70
Japan	0.66 (0.06)	0.29 (0.09)	0.00 (0.01)	0.006 (0.000)	0.31
France	0.59 (0.12)	0.52 (0.16)	0.05 (0.06)	0.005 (0.001)	0.72
United Kingdom	0.01 (0.08)	-0.14 (0.11)	0.11 (0.04)	0.007 (0.001)	0.25
Canada	0.28 (0.07)	0.24 (0.11)	0.06 (0.07)	0.005 (0.001)	0.28
Sweden	0.36 (0.27)	0.37 (0.34)	0.02 (0.09)	0.002 (0.001)	0.29

Notes: The sample period is 1971:3-1988:1. Dummy is equal to zero in the 1970s and 1 in the 1980s. Standard errors are given in parentheses. Instruments were the second lag of the ratio of consumption to income, lags 2 to 6 of the rate of change of consumption, lags 2 to 6 of the rate of change of income and the second lag of the real interest rate.

the parameter λ_1 is incorrect, although not significant. 1/ Turning to the intertemporal elasticity of substitution, all the estimates are correctly signed, another sign that this model is a superior description of the data. To test the robustness of the results reported in Table 2, experiments were carried out using a different specification, in which the real interest rate is assumed to be constant and the second lag of the nominal interest rate replaces the second lag of the real interest rate as an instrument. These regressions (not reported) produced similar results.

Table 3 shows estimates of the proportion of consumption subject to liquidity constraints for the 1970s and 1980s based upon the results in Table 2 above. These estimates appear reasonable, both in terms of cross-country comparisons and movements over time. For example, for the 1970s the shares of consumption associated with liquidity constraint are large in both France and Japan, which were relatively highly regulated, and lower in less regulated economies such as the United States and Canada. Turning to the 1980s, liquidity constraints appear to be an important factor only in Japan, where national financial deregulation has not been particularly strong.

As a further check, the model was estimated over the 1970s and the 1980s separately. These results--reported in Table 4--show a similar pattern to those in Table 3, except in the cases of the United States and Sweden. For the United States, there is little reduction in the parameter associated with liquidity constraints in the 1980s; however, the estimate of the intertemporal elasticity of substitution (σ) is implausibly large for the 1970s and changes considerably between the two sub-periods. If this effect is eliminated by estimating the model with a constant real interest rate, the results again indicate a large fall. The Swedish data in Table 4 also show a more modest fall in the coefficient associated with liquidity constraints than is shown in Table 3. This underlines the lack of precision of the Swedish results found earlier.

It is possible that the fall in the importance of liquidity constraints merely reflects a long term decline in this coefficient, associated, for example, with rising living standards. To investigate this question rolling regressions were carried out on data for the United States. 2/ The rolling regressions involve estimation of the basic model over ten year periods starting with 1963:1-1972:4 and ending with 1979:1-1988:4. The estimates of the liquidity constrained consumption λ obtained by this method are plotted in Figure 1. They clearly show that at least for the United States, the drop of the coefficient λ in later years does represent a change from the historical path.

1/ Alternative instrument sets produced both correctly and incorrectly signed estimates, none of which were significant.

2/ The regressions were performed every two years. The estimating model assumes real interest rates to be constant.

Table 3. Estimates of Parameters Associated with Liquidity Constraints for the 1970s and 1980s

	1970s	1980s
United States	0.44	0.13
Japan	0.66	0.37
France	0.59	0.07
United Kingdom	0.01	0.15
Canada	0.28	0.04
Sweden	0.36	-0.01

Notes: The parameters are derived from Table 2.

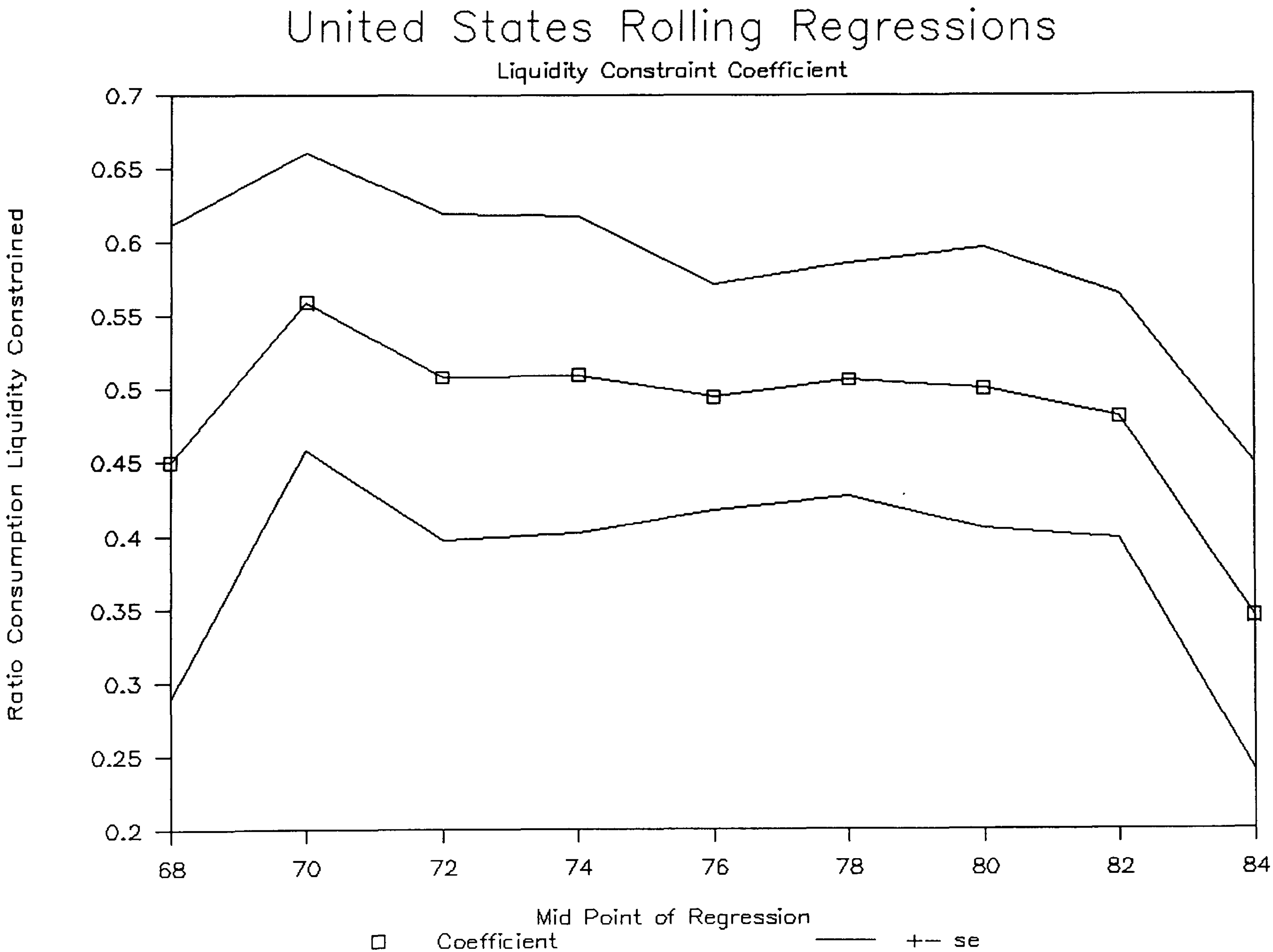
Table 4. Estimates of the Model over the 1970s and 1980s

Estimating Equation: $E_t\{C_{t+1}/C_t-(1-\lambda)(\theta+(\beta(1+R_t))^{\sigma})-\lambda Y_{t+1}/Y_t\}=0$

		λ	σ	θ	Probability Value for Orthogonality Constraints
United States	1970s	0.27 (0.08)	1.04 (0.27)	0.018 (0.003)	0.30
	1980s	0.24 (0.10)	0.26 (0.17)	0.004 (0.001)	0.41
Japan	1970s	0.52 (0.07)	-0.02 (0.04)	0.010 (0.001)	0.30
	1980s	0.18 (0.06)	0.01 (0.01)	0.005 (0.000)	0.12
France	1970s	0.49 (0.17)	0.32 (0.49)	0.012 (0.007)	0.62
	1980s	-0.01 (0.12)	0.03 (0.10)	0.005 (0.001)	0.30
United Kingdom	1970s	-0.04 (0.66)	0.21 (0.62)	0.10 (0.002)	0.66
	1980s	0.11 (0.14)	0.05 (0.06)	0.007 (0.002)	0.21
Canada	1970s	0.18 (0.09)	-0.19 (0.16)	0.002 (0.003)	0.21
	1980s	0.03 (0.08)	-0.01 (0.18)	0.005 (0.001)	0.62
Sweden	1970s	0.39 (0.19)	0.49 (0.23)	0.012 (0.005)	0.93
	1980s	0.30 (0.32)	0.12 (0.19)	0.001 (0.002)	0.23

Notes: The sample period over the 1970s is 1970:1-1979:4, for the 1980s it is 1980:1-1988:4. Standard errors are given in parentheses. The instruments used were the second lag of the ratio of consumption to income, lags 2 to 6 of the rate of change of consumption, lags 2 to 6 of the rate of chamge of same, and the second lag of the real interest rate.

Figure 1



United States Rolling Regressions
Liquidity Constraint Coefficient
Ratio Consumption Liquidity Constrained
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
68
70
72
74
76
78
80
82
84
Mid Point of Regression
Coefficient
+– se

The estimation results lead to the conclusion that the fraction of consumption that is liquidity constrained declined in the 1980s; this decline appears to reflect the financial deregulation observed in that decade rather than a long term decline in the importance of liquidity constraints. Financial integration in the 1980s affected the national consumption paths, bringing them closer to the "optimal" ones predicted by the permanent income hypothesis.

III. International Consumption Patterns

1. The estimating equations

This section examines the implications of Euler equations such as equation (1.1) for the path of consumption across countries. Obstfeld (1987) noted that if economies are financially integrated, in the sense that consumers have access to both home and foreign capital markets, then home consumers face not only the home real interest rate, $(1+i_t)(p_t/p_{t+1})$, but also the foreign real interest rate $(1+i^*_t)(p_t x_{t+1}/p_{t+1} x_t)$, where asterisks represent foreign country data and x is the exchange rate, valued in terms of the home currency. Similarly, for any foreign country Euler equations can be defined based on their home interest rate and upon their foreign interest rates. Since the current interest rate is part of the information set at time t, the following set of equations can be derived:

$$1/(1+i_t) = E_t\{(U'(c_{t+1})/U'(c_t))(p_t/p_{t+1})\beta\}$$
$$= E_t\{(U'(c^*_{t+1})/U'(c^*_t))(p^*_t x_t/p^*_{t+1} x_{t+1})\beta^*\} \qquad (2.1a)$$

$$1/(1+i^*_t) = E_t\{(U'(c_{t+1})/U'(c_t))((p_t/x_t)/(p_{t+1}/x_{t+1}))\beta\}$$
$$= E_t\{(U'(c^*_{t+1})/U'(c^*_t))(p^*_t/p^*_{t+1})\beta^*\} \qquad (2.1b)$$

Assuming that the utility function is of the form $U(c_t) = c_t^{1-\alpha}$, these estimable equations follow:

$$E_t\{(\beta/\beta^*)(c_t/c_{t+1})^{1/\sigma}(p_t/p_{t+1}) - (c^*_t/c^*_{t+1})^{1/\sigma^*}((p^*_t x_t)/(p^*_{t+1} x_{t+1}))\} = 0 \qquad (2.2a)$$

$$E_t\{(\beta/\beta^*)(c_t/c_{t+1})^{1/\sigma}((p_t/x_t)/(p_{t+1}/x_{t+1})) - (c^*_t/c^*_{t+1})^{1/\sigma^*}(p^*_t/p^*_{t+1})\} = 0. \qquad (2.2b)$$

Equation (2.2a) is the expression used in the empirical work reported below. It states that the rate of growth of consumption is different countries depends upon differences in rates of time preference, 1/ intertemporal substitution and real interest rates, where the elasticity of intertemporal substitution, σ, is equal to $1/\alpha$. As with the national Euler equations, past changes in variables, in particular income, should have no effect upon the path of consumption. This property of the equation is used to test how well the theory fits the data. Equation (2.2b) is the same, except that the foreign interest rate is used to calculate the rate of return.

Equation (2.2a) takes no account of the effect of liquidity constraints upon the behavior of consumers. The results using national data reported above, however, indicate that liquidity constraints are an important part of the explanation of consumption behavior. Clearly, if consumers are liquidity constrained in national financial markets they cannot arbitrage freely in international markets. This effect can be taken into account by adjusting the consumption data to take out the proportion that is liquidity constrained. The following expression represents the growth of non-liquidity constrained consumption:

$$((c_t/c_{t+1}) - \lambda(y_t/y_{t+1}))/(1-\lambda), \qquad (2.3)$$

where y_t is real disposable income and λ is the percentage of consumption associated with liquidity constraints. This expression can be substituted for the consumption terms in equation (2.2a) in order to compare the paths of non-liquidity constrained consumption across countries.

Equation (2.2a) assumes that international financial integration allows consumers in different countries equal access to the same nominal interest rates, but that real interest rates can differ across countries. An alternative is to assume that real interest rates are equalized across countries. As a positive proposition, this implies that purchasing power parity holds across countries, which appears not to be the case. 2/ However, it has considerable interest as a normative statement, since the resulting Euler equation can be seen as defining an optimal consumption path across countries; as such it is an interesting benchmark against which to test the actual data. When real interest rates are equated, the following Euler equation can be derived:

1/ Carroll and Summers (1989) note that, in the long run, the rate of growth of consumption in different economies is closely linked to the rate of growth of disposable income. They argue that permanent income should be thought of as a medium term concept. Using this interpretation the ratio of discount rates can be seen as a drift term, similar in function to the constant in the 'random walk' theory of consumption.

2/ For evidence that real interest rates are not equated across countries in the floating rate period, see Mishkin (1984).

$$E_t\{(\beta^*/\beta)^{\sigma}(c_t/c_{t+1}) - (c^*_t/c^*_{t+1})\} = 0, \qquad (2.4)$$

which is a "random walk" type result for relative consumption growth rates; the equation can also be derived under the assumption that the intertemporal elasticity of assumption is zero. Given that equation (2.4) is probably best regarded as a normative equation, it follows that the consumption terms should not be adjusted for liquidity constraints, since the data is being tested against this 'ideal' path.

The empirical approach taken in this section is similar to that used earlier for national data. The models are estimated over the full data period (1970 to 1988), to see how well they fit the data, and then re-estimated over the 1970s and the 1980s samples separately, to investigate whether the move to greater international financial integration has had a perceptible effect upon the behavior of consumption.

2. Results

Equations (2.2a) and (2.4) are in the form of Euler equations, which can be estimated using the Generalized Method of Moments estimator (GMM). Since there are data for six different countries, there are five cross country equations with the United States as "home" country and the other countries as "foreign" (the first comparing the consumption of the United States with that of Japan, the second the United States with France, etc.). When equations involving data from countries other than the United States are included, there are a total of fifteen equations. All of these equations involve a number of cross equation parameter restrictions, since (say) the parameter σ_{US} should be the same across different equations. Indeed, although fifteen equations can be derived, there are only eleven parameters (six values of σ, and five ratios (β/β^*)). Hence it is useful to estimate these equations as a system, with the appropriate cross equation restrictions imposed. This gives a general test of whether the model holds across all countries. 1/

The results from running systems estimation on equation (2.2a) over the full sample period are shown in Table 5. They refer to systems estimation using the five equations involving data for the United States. Work was carried out using all fifteen equations; however, there were problems with estimation over some sub-periods. 2/ Since the results using fifteen equations were similar to those using five equations, only the five equation results are reported. The instruments used were a

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1/ Single equation estimation was also carried out. These results give useful insights as to whether equation (2.2a) holds between specific countries, however they are not reported for the sake of brevity.

2/ Attempts to estimate the national and international equations as a system were also unsuccessful.

Table 5. Estimation Results from International Equations

$$E_t\{(\beta/\beta^*)(c_t/c_{t+1})^{1/\sigma}(P_t/P_{t+1}) - (c^*_t/c^*_{t+1})^{1/\sigma^*}((p^*_t x_t)/(p^*_{t+1}x_{t+1}))\} = 0$$

Parameter	Free Estimation	Intertemporal Elasticity Imposed at One Fifth
$(1/\sigma_{US})$	5.16 (4.61)	5
$(1/\sigma_{JP})$	-4.26 (6.06)	5
$(1/\sigma_{FR})$	-2.22 (4.54)	5
$(1/\sigma_{UK})$	-1.55 (4.06)	5
$(1/\sigma_{CA})$	0.77 (2.76)	5
$(1/\sigma_{SW})$	-1.88 (4.91)	5
(β_{US}/β_{JA})	1.04 (0.05)	0.98 (0.01)
(β_{US}/β_{FR})	1.03 (0.04)	0.98 (0.01)
(β_{US}/β_{UK})	1.02 (0.02)	1.00 (0.01)
(β_{US}/β_{CA})	1.02 (0.03)	0.99 (0.00)
(β_{US}/β_{SW})	1.02 (0.03)	1.00 (0.01)
Test statistic for orthogonality conditions (degrees of freedom chi squared)	3.59 (9)	23.88 (15)
Probability value for orthogonality conditions	0.93	0.07

Notes: Sample period 1970:4 - 1988:1. Instruments were a constant, the second lag of the ratio of consumption and the second and third lags of the ratio of income between the two countries.

constant, the second lag of the ratio of consumption between the two countries, and the second and third lags of the ratio of real disposable income between the two countries. As explained above, first lags of the instruments were not used since the data represent averages over the quarter. Experiments were carried out with other sets of instruments, which gave similar results.

Column 1 shows the results when the (reciprocal of the) elasticities of intertemporal substitution (the σ's) were estimated freely. These results are disappointing; four of the six estimates have the wrong sign. The associated standard errors are large, with none of the estimates being significantly different from zero. Rather surprisingly, the ratios of the discount rates are quite well estimated, with values close to, and insignificantly different from, unity. The test of the orthogonality conditions indicate that they cannot be rejected. However, given the unsatisfactory nature of the parameter estimates this test is not very useful. The results from running the regressions over the sub-periods are broadly similar to those for the full data period, and are not reported.

In view of the unsatisfactory nature of the results when the elasticities of intertemporal substitution were freely estimated, the regressions were repeated with these parameters fixed at the "reasonable" values of one fifth. The results from these regressions are reported in the second column of Table 5. The estimates of the ratios of discount rates are now estimated somewhat more accurately, and are still close to, and largely insignificantly different from, unity. The big change, however, is in the significance of the orthogonality conditions. For the period as a whole the model is rejected at the 7 percent significance level, in spite of the fact that the reduction in the number of estimated coefficients raises the degree of freedom for the test of the orthogonality conditions from nine to fifteen. In order to investigate whether there has been a significant change in behavior between the 1970s and the 1980s, the model was re-estimated for these two sub-periods. The probability values for the associated orthogonality conditions were almost identical for the sub-periods; hence there is no evidence that financial deregulation in the 1980s has improved the explanatory power of the model. Similar results were obtained using values of the intertemporal elasticity of substitution of 1, 0.5, 0.33, 0.1 and 0.05, which cover the plausible values for this coefficient. Overall, it appears that the model without liquidity constraints can be rejected as a description of the data. This contrasts with the results in Obstfeld (1987), who concluded that the model could not be rejected for the floating rate period.

As noted above, the results in Table 5 are derived from a model which assumes that consumers are not liquidity constrained. Taking account of liquidity constraints involves substituting the expression in equation (2.3) for consumption in equation (2.2a). This procedure requires values of λ, the proportion of consumption associated with liquidity constraints, to be chosen. Three different methods for choosing these values were applied: direct estimation; imposing the values estimated in the national equations reported above; and imposing a uniform value across the equations, based upon the approximate mean of the national estimates. For each case estimation was carried out both including the intertemporal elasticity of substitution freely estimated, and with this parameter imposed at plausible values.

Table 6 shows the results when the liquidity constraint parameter, λ, is imposed uniformly across countries; the chosen values were 0.30 for the entire period, 0.40 for the 1970s and 0.15 for the 1980s. Results using the values of the liquidity constraint estimated in the national equations were similar, while attempts to estimate the liquidity constraint coefficients freely were unsuccessful. The first column shows the results for the full period when the intertemporal elasticities of substitution were freely estimated. As with the model without liquidity constraints, the results are unsatisfactory, with three of the estimates having the wrong sign. Estimates for the two sub-periods were similar, and are not reported.

Columns two to four in Table 6 shows the results when the intertemporal elasticities of substitution were imposed at one fifth. The estimates are for the entire period (1970:4 to 1988:1), the 1970s and the 1980s. For the entire period, the test of the orthogonality conditions does not reject the model. As with the national data, liquidity constraints appear to be important in explaining the path of consumption. Comparing the results for the 1970s and the 1980s shows that the model is accepted in both periods. Similar results are obtained with values for the intertemporal elasticity of substitution of 1, 0.5, 0.33, 0.1 and 0.05. Hence, there does not seem to be evidence that international deregulation has affected consumption behavior over and above the effects from the decline in liquidity constraints. This result may be due to the fact that the test being used focuses upon intertemporal effects; the work on national data sets indicates that the intertemporal elasticity of substitution is small, making these effects difficult to identify.

Finally, the optimal path of consumption associated with equation (2.4) was estimated. Liquidity constraints were not taken, into account since the object was to compare the actual consumption path with the optimal path. The intertemporal elasticity of substitution was set at one fifth. The results are shown in Table 7. The model is rejected at the ten percent level for the entire period, and for the 1970s, where the probability value associated with the orthogonality conditions is eight percent. For the 1980s, this value rises to sixteen percent. Hence there is some evidence that financial deregulation has made the international path of consumption more optimal, in the sense that the data follow the path described by equation (2.4) more closely.

Table 6. International Results When Liquidity Constraints are Taken into Account

	Free Estimation		Intertemporal Elasticity Imposed at One Fifth: Entire Sample		1970s		1980s	
$(1/\sigma_{US})$	3.50	(6.19)	5		5		5	
$(1/\sigma_{JP})$	0.56	(5.46)	5		5		5	
$(1/\sigma_{FR})$	-10.52	(20.83)	5		5		5	
$(1/\sigma_{UK})$	-0.87	(3.09)	5		5		5	
$(1/\sigma_{CA})$	-1.35	(7.12)	5		5		5	
$(1/\sigma_{SW})$	3.59	(6.97)	5		5		5	
(β_{US}/β_{JP})	1.00	(0.06)	0.97	(0.01)	0.97	(0.01)	0.98	(0.01)
(β_{US}/β_{FR})	1.09	(0.18)	0.98	(0.01)	0.98	(0.01)	0.99	(0.01)
(β_{US}/β_{UK})	1.02	(0.04)	0.99	(0.01)	0.99	(0.01)	0.99	(0.01)
(β_{US}/β_{CA})	1.02	(0.04)	0.99	(0.01)	1.01	(0.01)	0.99	(0.01)
(β_{US}/β_{SW})	1.01	(0.03)	1.00	(0.01)	1.01	(0.01)	1.01	(0.01)
Test statistic for orthogonality conditions (degrees of freedom chi squared)	1.25	(9)	14.05	(15)	16.26	(15)	19.84	(15)
Probability value for orthogonality conditions	0.99		0.52		0.36		0.18	

Notes: The sample period is 1970:4 - 1988:1 for the full period, 1970:4 - 1979:4 for the 1970s, and 1980:1 - 1988:1 for the 1980s. Standard errors are given in parentheses. Instruments were a constant, the second lag of the ratio of consumption and the second and third lags of the ratio of income between the two countries.

Table 7. International Results for the Optimal Consumption Path

Estimating Equation: $E_t\{(\beta/\beta^*)^{\sigma}(c_{t+1}/c_t) - (c^*_{t+1}/c^*_t)\} = 0$

	Intertemporal Elasticity Imposed at One Fifth					
	Entire Sample		1970s		1980s	
$(\beta_{US}/\beta_{JP})^{\sigma}$	0.999	(0.001)	0.999	(0.001)	0.999	(0.000)
$(\beta_{US}/\beta_{FR})^{\sigma}$	0.998	(0.001)	0.995	(0.001)	1.000	(0.001)
$(\beta_{US}/\beta_{UK})^{\sigma}$	1.000	(0.001)	1.001	(0.001)	0.999	(0.001)
$(\beta_{US}/\beta_{CA})^{\sigma}$	0.999	(0.001)	0.999	(0.001)	1.000	(0.001)
$(\beta_{US}/\beta_{SW})\sigma$	1.003	(0.001)	1.003	(0.002)	1.001	(0.002)
Test statistic for orthogonality conditions (degrees of freedom chi squared)	22.76	(15)	23.39	(15)	20.25	(15)
Probability value for othogonality conditions	0.09		0.08		0.16	

Notes: The sample period is 1970:4-1988:1 for the full period, 1970:4-1979-4 for the 1970s, and 1980:1-1988:1 for the 1980s. Standard errors are given in parentheses. Instruments were a constant, the second lag of the ratio of consumption and the second and third lags of the ratio of income between the two countries.

IV. Using Euler Equations to Estimate Conventional Consumption Functions

The estimation of Euler equations throws light on the very short-term behavior of consumption. However, it contains little information about long run behavior and the associated dynamics. In particular, Euler equation type models do not provide conventional forecasting equations. An alternative approach is to estimate a more traditional type of consumption function using lagged variables. In particular, there has been a considerable amount of work carried out, principally in the United Kingdom, based on the "error correction" model. This section links the earlier results from the estimated Euler equations to these more traditional models. A theoretically consistent method of estimating the short-run dynamics of these models based upon an Euler equation type approach is implemented, and shown to generally fit the data. 1/

The error correction framework, as applied to the consumption function, has two main elements. A long-run elasticity of unity between consumption and real disposable income is imposed upon the model. 2/ The short-run dynamics are then estimated freely from a general specification based upon the data coherence of the overall model. The justification for this statistical approach to estimation of the dynamics of the model is that theory has little to say about dynamic processes. 3/ However, Euler equations are very much based upon the short-run dynamics of consumption; indeed the "random walk" theory of consumption (Hall 1978) has no implications about long-run behavior, since the variance of a random walk tends to infinity as the forecast horizon is extended. Instead, Euler equations concentrate on the short-run dynamics of consumption; this property is exploited in order to estimate the dynamics of consumption in a conventional framework.

This section tests the coefficient restrictions implied by estimating two regressions using typical error correction model variables. In the

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1/ This approach was mentioned in Campbell and Mankiw (1987) but no results were reported.

2/ This is often represented as a theoretical restriction. However, Carroll and Summers (1989) point out that this empirical regularity across countries in fact represents a rejection of the model in which life-time consumption is smoothed.

3/ Davidson et al (1978), the seminal piece in this literature, states "Unfortunately, much existing economic analysis ... leaves many important decisions in formulating an operational model to ad hoc considerations (e.g., functional form, dynamic specification, error structure, treatment of seasonality, etc.) Nevertheless, economic theory does furnish some helpful postulates about behavior in steady state environments..." (see Davidson et al, 1978, page 662). This piece was written before the adoption of Euler equations in consumption research. However later papers in the same tradition (Hendry (1982)) have a similar flavor.

contemporaneous change in real disposable income in an Euler equation, which incorporates liquidity constraints; this regression is then compared with a more conventional regression in which the same variables are estimated freely. The instrumental variables procedure implies a set of linear restrictions on the coefficients that can be tested using a standard F-test. To the extent that these restrictions are acceptable to the data this procedure represents a method of estimating the dynamics of a conventional consumption function based upon a theoretical model, rather than simple data coherence.

More specifically, the following log-linear version of the national equations was estimated using two stage least squares:

$$\Delta c_t = \alpha + \lambda \ \Delta y_t + \epsilon_t \tag{3.1}$$

where c_t is the log of the real non-durable and service consumption, and y_t is the log of real disposable income. 1/ The instruments used were a constant, the second lag of the ratio of consumption to real disposable income, the second and third lags of the rate of change of income, the second lag of the change in consumption and the second lag of both the level and rate of change of the nominal interest rate. First lags were not used for the reasons discussed above. These instruments represent the variables which would go into a conventional error correction model using lags of real disposable income, interest rates, and consumption, except for the exclusion of first lags. The typical error correction model would probably use a larger set of variables and longer lags as a starting point; however, it was important to chose a set of instruments which both have some explanatory power and avoid using too many explanatory variables in estimation. 2/

The two stage procedure involves first regressing the explanatory variables upon the instruments, and then substituting the fitted values from this regression in order to estimate the coefficients in the second stage regression. Since the set of instruments includes a constant, this comes down to estimating the following regression:

$$\Delta c_t = \alpha + \lambda \ \beta_I{}'X_t + \epsilon_t, \tag{3.2}$$

1/ This model assumes that the real interest rate is constant. It is the main version of the model estimated by Campbell and Mankiw (1989). The empirical work in this section uses data on total consumption and income, rather than per capita data, since this appears more appropriate for forecasting equations.

2/ Tests using different sets of instruments generally gave similar results.

where β_I is the vector of coefficients from regressing Δy_t on the instruments X_t. This procedure involves the estimation of only two parameters, namely α and λ. The implied set of coefficient restrictions can then be compared to the results from estimating the model without any constraints upon the coefficients on X_t, namely:

$$\Delta c_t = \alpha + \beta' X_t + \epsilon_t. \tag{3.3}$$

The significance of these coefficient restrictions were then tested using a conventional F-test, with five degrees of freedom in the numerator.

The results from this procedure, shown in Table 8 below, are encouraging. 1/ The probability values show that the restrictions were generally acceptable at conventional significance levels. Four of the six regressions accept the constraints at the five percent significance level (indeed at the twenty percent level), although the constraints fail for two of the countries, Japan and Canada. This success is in spite of the fact that free estimation produces quite precise coefficient estimates. 2/ In many cases the two procedures, free estimation and instrumental variables, give surprisingly similar estimates. For example, Table 9 shows the coefficients produced by free estimation and those implied by the instrumental variables procedure for the United States data set. The restricted coefficients are close to those produced by free estimation; the two set of parameters always have the same sign, and are never more that one standard error apart. As a further check on the adequacy of the instrumental variables procedure the auto-correlograms for the residuals from these regressions were examined, since statistical misspecification often produces positive autocorrelation in models. None of the six equations show evidence of significant positive autocorrelation, although the French and Swedish models did exhibit significant negative first order autocorrelation.

The evidence indicates that it is generally possible to estimate the short-run dynamics of a conventional type of consumption function using an Euler equation based on a well specified theoretical model in which some consumers face liquidity constraints. This more structural estimation procedure is generally preferable to simply testing down a general model using data coherence. It also shows that Euler equations can be used to derive more conventional types of forecasting equations.

1/ The sample was 1971:1-1988:1; evidence of a shift in the liquidity parameter over this period was discussed above. The long sample was chosen because of the number of regressors/instruments (seven). The earlier results also indicate that the model fits the data quite well even over the full sample.

2/ If first lags of the instruments are included, the restrictions are rejected for all countries. Since the instruments are inappropriate, the importance of this result is difficult to determine.

Table 8. Test of the Parameter Restrictions of Two-Stage Procedure Against the Error Correction Mechanism Formulation

Country	F-Statistic	Probability Value F(5,62)
United States	0.50	0.78
Japan	2.48	0.04
France	1.50	0.20
United Kingdom	1.38	0.24
Canada	3.80	0.00
Sweden	0.34	0.89

Notes: The sample period is 1971:1-1988:1.

Table 9. The Coefficients for the United States Produced by Free Estimation and Instrumental Variables

Variable	Free Estimation	Implied Coefficient From Instrumental Variables
$(C/Y)_{-2}$	0.10 (0.06)	0.16
ΔY_{-2}	0.03 (0.07)	0.07
ΔY_{-3}	0.12 (0.05)	0.12
ΔC_{-2}	-0.12 (0.17)	-0.16
i_{-2}	-0.06 (0.02)	-0.04
Δi_{-2}	-0.08 (0.06)	-0.04

Notes: Standard errors are in parentheses. The sample period is 1971:1-1988:1

V. Conclusions

This paper has looked at the relationship between liquidity constraints, consumption and financial innovation for six different countries, at both the national and international level. At the national level, a simple equation incorporating both forward looking consumers and liquidity constraints was derived and shown to generally fit the data. Next, estimates of the proportion of consumption associated with liquidity constraints was compared between the (regulated) 1970s and the (deregulated) 1980s. The parameter estimates were shown to have generally fallen between these periods, indicating that financial deregulation has had a significant effect in reducing liquidity constraints faced by consumers.

The international work utilized the standard forward looking model of consumption, plus the assumption of complete international financial integration. When no account was taken of liquidity constraints, the model was rejected by the data. When liquidity constraints were taken into account the model was accepted, again indicating that these constraints have had a significant effect on the behavior of consumption. Some weak evidence that the path of consumption between countries has become more optimal over time was also presented. Finally, a procedure for estimating traditional forecasting type consumption functions based upon the liquidity constraint model was proposed. The results were generally satisfactory.

The conclusion that financial integration has had significant effects upon the behavior of consumption both within and among countries has a series of important implications both for research and policy making analysis. The results in this study indicate that financial deregulation tends to improve the aggregate consumption path, in the sense that the observed path moves closer to the optimal one. While second best considerations must be kept in mind, there is a presumption that this raises welfare. 1/

The finding that financial deregulation appears to move consumption closer to the forward looking paradigm used in many theoretical models also has implications for the conduct of policy. For example, reductions in liquidity constraints will influence the effects of changes in government debt and, hence, the role of fiscal policy. As more consumers become forward looking, Ricardian effects may become larger and the effective incidence of taxation may change. In a similar vein, a reduction in the correlation of consumption with the predictable element of disposable income may reduce the ability of authorities to stabilize

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1/ It calls into question arguments that rules of thumb, such as consuming current disposable income, are used by many consumers because the utility losses associated with such rules are small (Cochrane (1989)). This hypothesis implies that financial deregulation should make little difference to consumption patterns.

demand through fiscal policy. On the other hand, an increase in the degree to which consumers act in a forward looking manner may make interest rates a more effective tool of demand management. Any country considering deregulating their financial markets should take these effects into account in the formulation of macro policies.

Derivation of Equation (1.5)

The liquidity constrained consumers consume a constant fraction of their current income. Hence, their expected rate of growth of aggregate consumption equals the expected rate of growth of real income:

$$E_t\{C_{1t+1}/C_{1t} - Y_{t+1}/Y_t\} = 0 \qquad \text{(A 1)}$$

For the forward looking consumers the Euler equation holds:

$$E_t\{(1+R_t)\beta(C_{2t}/C_{2t+1})^{\alpha} - 1\} = 0 \qquad \text{(A 2)}$$

Through some simple algebraic manipulations equation (A 2) can be transformed into the following expression:

$$E_t\{(C_{2t+1}/C_{2t})^{\alpha} - (1+R_t)\beta\} = 0 \qquad \text{(A 3)}$$

It should be noted, that the step from equation (A 2) to (A 3) is not mathematically rigorous. In particular, this transformation violates Jensen's inequality. However, (A 3) represents a reasonable approximation, and provides the intermediate link to an estimable expression.

By the same reasoning (A 3) can be approximated by the expression:

$$E_t\{C_{2t+1}/C_{2t} - (\theta+(1+R_t)\beta)^{\sigma}\} = 0, \qquad \text{(A 4)}$$

where a drift term (θ) has been included in the equation, to represent the long run rise in aggregate consumption. The parameter σ, which is equal to $1/\alpha$, is the intertemporal elasticity of substitution. This expression is the same as equation (1.4) in the main text.

Multiplying equations (A 1) and (A 4) by the fractions λ and $1-\lambda$ respectively and adding them together yields an expression which approximately describes the behavior of aggregate consumption:

$$E_t\{C_{t+1}/C_t - (1-\lambda)(\theta+\beta(1+R_t)^{\sigma}) - \lambda Y_{t+1}/Y_t\} = 0. \qquad \text{(A 5)}$$

The above equation is equation (1.5) in the main text.

If the real interest rate is assumed constant, or the elasticity of substitution (σ) is zero, equation (A 5) simplifies to the following expression,

$$E_t\{C_{t+1}/C_t - \Gamma - \lambda Y_{t+1}/Y_t\} = 0. \qquad \text{(A 6)}$$

This version of the model was also estimated.

Data Sources

The data on real and nominal consumption came from OECD Quarterly National Accounts (QNA). Disposable income data were obtained from national sources; the U.S. and Canadian data came from the DRI data tape, the Japanese data came from the Nikkei Telecom Japan News and Retrieval Service tape, the French and U.K. data from quarterly national accounts tapes while the Swedish data was obtained from the authorities. For Japan, France, Canada and Sweden the data was only obtainable in nominal terms; it was deflated using the implicit deflator for total consumption from the OECD QNA. The consumption data for Japan, and the disposable income data for both Japan and Sweden were seasonally unadjusted, and were adjusted using the smooth command in RATS with options exponential trend and multiplicative seasonals.

Interest rates and real share prices were obtained from the International Finance Statistics tape. The Treasury Bill rate (line 60c) was used for all countries except Japan and France, where the data did not exist so the money market rate (line 60b) was used. Real interest rates were obtained using the implied deflator for non-durable and service consumption. Nominal share prices were obtained from IFS, line 62, and deflated by the consumer price index, line 64. Population figures were also obtained from the IFS tape, line 99z. The mid-year values were linearly interpolated to give a quarterly series.

References

Aschauer, D., "Fiscal Policy and Aggregate Demand," American Economic Review, No. 75 (March 1985), pp. 117-27.

Bernanke, B., "Adjustment Costs, Durables and Aggregate Consumption," Journal of Monetary Economics, No. 15 (January 1985), pp. 41-68.

Campbell, J., and G. Mankiw, "Permanent Income, Current Income and Consumption," National Bureau of Economic Research Working Paper No. 2436 (November 1987).

_____, "Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence," National Bureau of Economic Research Working Paper No. 2924 (April 1989).

Carroll, C., and L. Summers, "Consumption Growth Parallels Income Growth: Some New Evidence", unpublished, July 1989.

Cochrane, J., "The Sensitivity of Tests of the Intertemporal Allocation of Consumption to Near-Rational Alternatives," The American Economic Review, Vol. 79, No. 3 (June 1989), pp. 319-37.

DeLong, J.B., and L. Summers, "The Changing Cyclical Variability of Economic Activity in the United States," in R.J. Gorden (ed.), The American Business Cycle: Continuity and Change (Chicago: University of Chicago Press, 1986).

Davidson, J., D. Hendry, F. Srba, and S. Yeo, "Econometric Modeling of the Aggregate Time Series Relationship between Consumers' Expenditure and Income in the United Kingdom," The Economic Journal, No. 88 (December 1978), pp. 661-92.

Eichenbaum, M., L. Hansen, and K. Singleton, "A Time Series Analysis of Representative Agent Models of Consumption and Leisure Choice Under Uncertainty," National Bureau of Economic Research Working Paper No. 1981 (1986).

Epstein, L., and S. Zin, "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns. I: A Theoretical Framework," Working Paper No. 8715 (Toronto: University of Toronto, 1987).

Flavin, M., "The Adjustment of Consumption to Changing Expectations About Future Income," Journal of Political Economy 89 (October 1981), pp. 978-1009.

Hall, R., "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence," Journal of Political Economy, No. 86 (October 1978), pp. 971-87.

_____, "International Substitution in Consumption," Journal of Political Economy, No. 96 (April 1988), pp. 339-57.

Hall, R., and F.S. Mishkin, "The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households," Econometrica, No. 50 (1982), pp. 461-81.

Hansen, L., and K. Singleton, "Stochastic Consumption, Risk Aversion and the Temporary Behavior of Asset Returns," Journal of Political Economy, No. 91 (April 1983), pp. 249-65.

_____, "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectation Models," Econometrica, No. 50 (1982) pp. 1269-86.

Hayashi, F., "The Permanent Income Hypothesis: Estimation and Testing by Instrumental Variables," Journal of Political Economy, No. 90 (October 1982), pp. 895-16.

Hendry, D., "Econometric Modeling: The Consumption Function in Retrospect," Scottish Journal of the Political Economy, No. 30 (November 1983), pp. 193-20.

Jappelli, T., and M. Pagano, "Consumption and Capital Market Imperfections: An International Comparison," CEPR Discussion Paper No. 244, June 1988.

Mankiw, G., J. Rottenberg, and L. Summers, "Intertemporal Substitution in Macroeconomies," Quarterly Journal of Economics, No. 100 (February 1985), pp. 225-51.

Mishkin, F.S., "The Real Interest Rate: A Multi-Country Empirical Study," Canadian Journal of Economics, No. 17 (May 1984), pp. 283-311.

Obstfeld, M., "How Integrated are World Capital Markets? Some New Tests," National Bureau of Economic Research WP No. 2075 (November 1986).

Organization for Economic Cooperation and Development, Structural Adjustment and Economic Performance, OECD Paris, France, 1987.

Working, H., "Note on the Correlation of First Differences of Averages of A Random Chain," Econometrica, No. 28 (1960), pp. 916-18.

Zeldes, S., "Consumption and Liquidity Constraints: An Empirical Investigation," Journal of Political Economy, Vol. 97 (1989), pp. 305-46.