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# PERMANENT INCOME HYPOTHESIS AND VARIABILITY OF CONSUMPTION*

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*This paper investigates the variability of Finnish consumption with a purpose to determine whether traditional permanent income hypothesis is consistent with Finnish consumption data, or is consumption excessively smooth as suggested in recent empirical studies. A spectral density based measure is used to determine the variability ratios for nondurables consumption and durables expenditures. Results show strong excess smoothness in durables expenditures, and slight excess smoothness in nondurables consumption. The issue of excess smoothness is also approached using cross spectral analysis. The role of features such as liquidity constraints, uncertainty and irreversibility of durables stock in causing excess smoothness is discussed. (JEL D12, C4)*

## 1. Introduction

The permanent income hypothesis (PIH) originally introduced by Friedman (1957) has become a widely accepted theoretical framework to formulate consumer behavior. The popularity of PIH is mainly due to its dynamic and forward looking nature which enables it to explain many observed features that appear in time series (e.g. that consumption is smoother than current income).

Since the original version the PIH has undergone a great deal of developement, probably the most significant study being Hall's (1978) paper in which he shows that under the life cycle-permanent income hypothesis consumption of nondurable goods should be a martingale process, i.e. that consumption changes should be unpredictable. Mankiw (1982) broadened Hall's framework by including durable goods and demonstrated that if PIH was to hold, durables expenditures should in general be ARMA(1,1) process.

In recent years the main interest in this field has been the rejection of the PIH on grounds of empirical data. For example, Campbell and Mankiw (1991) and Flavin (1981) found consumption changes to be excessively sensitive to the changes in current income, and could thus be predicted. This finding contradicts the martingale property of nondurables consumption implied by PIH. In Finland empirical tests (e.g. Koskela and Sullström, 1979, and Svento, 1990) have also received similar results suggesting rejection of the traditional permanent income model. Koskela and Virén (1985) studied the effect of labor rationing on consumption autoregression, and found employment innovations to be statistically significant in explaining consumption during periods of high excess supply of employment. Another

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major departure is the finding that consumption doesn't seem to respond fully to innovations in permanent income. E.g. Campbell and Deaton (1989) concluded that consumption appears to be smoother than PIH implies.

In measuring the excess smoothness of consumption the main difficulties in the traditional approaches have been found to lie in the handling of the underlying income term. If income is assumed to follow ARMA process one simultaneously makes quite restrictive and intuitively unappealing assumptions about consumers' information set. Traditional variability measures are also extremely sensitive to the actual transformation of the income process used as demonstrated in Deaton (1987).

One way to avoid this problem is to use a non-parametric method to estimate the variability measure directly from the existing consumption time series data by making use of the spectral time series theory. In this paper method developed by Galí (1991 and 1993) is applied on Finnish quarterly data of durables expenditures and nondurables consumption to find out whether any excess smoothness can be detected. Cross spectral method is then used to verify the results based on the variability statistics, and to pinpoint the differences between durables and nondurables consumption with respect to different lenghts of changes in disposable income.

The paper is organized as follows. Part two reviews some existing empirical evidence concerning the variability of consumption with respect to traditional PIH. In part three the Galí-type variability statistics for durables and nondurables are applied on Finnish quarterly data. The results of the estimations and coherence and phase diagrams based on cross spectral method are reported and analyzed. Part four provides some concluding remarks.

## 2. *Departures from PIH: excess sensitivity and excess smoothness of consumption*

One of the cornerstones of permanent income hypothesis is the assumption that consumers make their consumption decisions not only based on their current income but on the annuity value of their expected future income flow, which can be interpreted as their permanent income. For example, when a consumer experiences a rise in his current income he then can make some assumption of his new permanent income level and adjust his consumption accordingly:

$$(1) \quad \Delta c_t = \Delta y_t^p = \varepsilon_t, \qquad \varepsilon \sim N(0, \sigma^2).$$

This random walk result of consumption based on the martingale property of consumption introduced by Hall (1978) implies that consumption changes could not be predicted. In his paper Hall regressed consumption on lagged income and lagged consumption and found that lagged income terms were statistically insignificant. Although he ended up rejecting his model after finding that lagged stock market values seemed to be able to predict consumption changes, the main result of his paper was the orthogonality between lagged income terms and consumption.

A little bit later quite different empirical evidence started to appear. Flavin (1981) constructed and estimated the following model:

$$(2) \quad \begin{aligned} & y_t = \mu_1 + \rho_1 y_{t-1} + \rho_2 y_{t-2} + \ldots + \rho_8 y_{t-8} + v_{1t} \\ & \text{and} \\ & \Delta c_t = \mu_2 + \beta_0 [(\rho_1 - 1) y_{t-1} + \rho_2 y_{t-2} + \ldots + \rho_8 y_{t-8}] + \\ & + \beta_1 \Delta y_{t-1} + \ldots + \beta_8 \Delta y_{t-8} + v_{2t} \end{aligned}$$

For comparison to Hall's model she also estimated a reduced form model:

$$(3) \quad \Delta c_t = \mu_2 + \pi_1 y_{t-1} + \ldots + \pi_8 y_{t-8} + v_{1t}$$

She found the β- parameters of the structural model, which she called the excess sensitivity parameters, to be statistically signifigant. Also half of the reduced model parameters received estimates signifigantly different from zero, thus contradicting Hall's results. A possible reason for this was that while Flavin restricted the coefficient of lagged consumption to unity by working with the difference of consumption, Hall estimated his model in the level form. Also the facts that Hall included only four lags in his model and had a different sample period could have contributed to the difference of their results.

Flavin's results have since received support from various studies. For example Deaton (1987) found strong evidence of sensitivity of consumption when estimating what he called a surprise consumption function. Working with a modified permanent income model, which they called $\lambda$- model Campbell and Mankiw (1991) reached results supporting those of Flavin's and Deaton's. They estimated the following model:

$$(4) \qquad \Delta c_t = \mu + \lambda \Delta y_t + \varepsilon_t,$$

where $\lambda$ is the measure of the effect of a change in current income on consumption. Their results indicated $\lambda$ to be significant in five out of the six countries they considered in their study[1].

The empirical evidence of predictability of consumption changes makes a strong argument in favor of rejecting the standard PIH. However, one has to be careful when interpreting these results of excess sensitivity. The significance of the sensitivity parameters implies that consumption changes can be predicted by perceived changes in income, but it *does not* imply that consumption is excessively sensitive to the innovations in permanent income, which correspond to the unpredictable consumption changes.

When attempting to measure the extent to which consumption responds to the innovations in permanent income traditional analysis starts with the well know result of PIH relating consumption change and labor income (see e.g. Flavin 1981):

$$(5) \qquad \Delta c_{t+1} = r \sum_{j=1}^{\infty} \frac{1}{(1+r)^j} (E_{t+1} - E_t) y_{t+j} \, .$$

Labor income is assumed to follow an ARMA process:

$$(6) \qquad \alpha(L) y_t = \beta(L) \varepsilon_t .$$

When calculating $(E_{t+1} - E_t)y_{t+1}$ from (6) and plugging it into (5) one can see that the magnitude of consumption response to income innovation depends on the actual ARMA process income is expected to follow. Deaton (1987) showed that if labor income is formulated as trend stationary, permanent income, and thus consumption appears to be smoother than measured income. However, if income process is assumed to be difference stationary permanent income should respond more than one for one to innovations in income, so when comparing the variability of actual consumption data to that warranted by the formulation above one detects strong excess smoothness of consumption when income process is assumed to contain a unit root. Another disadvantage of this approach is that it restricts the consumers' information set to consist only of information based on lagged and current income. This assumption seems intuitively somewhat questionable.

To avoid the problems discussed above Campbell and Deaton (1989) used an alternative non-parametric method in order to obtain a measure for consumption variability without making any restrictive and possibly biasing assumption about the stochastic income process. They suggested the following statistic:

$$(7) \quad V = \frac{\operatorname{var}\left\{ \sum_{j=0}^{\infty} \frac{1}{(1+r)^j} (E_{t+1} - E_t) \Delta Y_{t+j} \right\}}{\sigma^2},$$

where numerator is the variance of permanent income change and denominator the variance of measured income change.[2] $V$ can be estimated, since it is equivalent to the normalized spectral density of the income series at zero frequency.[3] The interpretation is as follows: if $V < 1$ permanent income is less variable than measured income like PIH predicts, but if $V > 1$ permanent income is actually more volatile than measured income, and since measured consumption is smoother than measured income we would have a case of excess smoothness of consumption.

[1] *Their study included UK, US, Canada, France, Sweden and Japan. For Japan $\lambda$ was not identified because based on Japanese data the hypothesis of current income and permanent income being equal could not be rejected. See Campbell and Mankiw (1991) for details.*

[2] *Campbell and Deaton worked with a logarithmic transformation, but the interpretation doesn't change.*

[3] *See Cochrane (1988) for proof.*

Depending on the lag window size in the estimator resulting $V$:s varied around 2 suggesting consumption to be notably smoother than permanent income. However this approach, as good as it looks, suffers from one flaw: When formulated as (5) the $V$-ratios are correct only when PIH holds, so they can be used only to test permanent income hypothesis itself, but are of no use when attempting to measure the extent of the possible excess smoothness/variability of consumption.

Galí (1991) developed spectral approach further and demonstrated that one needs only consumer's lifetime budget constraint to hold to be able to achieve a consistent variability ratio for consumption.[4] An advantage of this method is that it requires no assumptions of how consumers are to forecast their future income level, nor does it require PIH itself to hold to produce consistent estimates. This in turn means that the estimates of consumption variability are consistent and thus interpretable also outside PIH null, so we are able to determine the magnitude of excess smoothness when it exists. The variability ratios were defined as follows:

$$(8) \qquad \varphi_c = \frac{\hat{\sigma}(\Delta c)}{\sigma(\Delta c)} \quad \text{and} \quad \varphi_d = \frac{\hat{\sigma}(\Delta d)}{\sigma(\Delta d)}.$$

Where ($\hat{\sigma}(\Delta c)$ is the standard deviation of the first difference of actual consumption series and $\sigma(\Delta c)$ is the standard deviation of the corresponding series as implied by PIH. ($\hat{\sigma}(\Delta d)$ and $\sigma(\Delta d)$ are the corresponding values for durables expenditures. The interpretation of these statistics is even more straightforward than Campbell's and Deaton's $V$. If the values are greater than one we have a case of excess variability, and equivalently values less than one can be taken as evidence of excess smoothness.

Again, we can turn to spectral time series theory and show that we can use the zero frequency spectral density of these consumption series to estimate the variability measures[5]:

$$(9) \qquad \hat{\varphi}_c = \frac{1}{\sqrt{2\pi \hat{f}_c(0)}}$$

$$(10) \qquad \hat{\varphi}_d = \frac{\Psi(\delta)}{\sqrt{2\pi \hat{f}_d(0)}}$$

where $\psi(\delta) = \delta/\sqrt{1 + (1-\delta)^2}$, and $\delta$ is the depreciation rate of durables stock. $\hat{f}_c$ (0) and $\hat{f}_d$ (0) are the estimators for normalized zero frequency spectral density of nondurables consumption and durables expenditures, respectively. Galí (1993) estimated these variability ratios for six OECD countries, namely US, UK, Canada, Japan, Italy and France, and found mild excess smoothness for nondurables in all countries with the exception of France, and strong excess smoothness in all countries for durables.

These empirical findings of excess sensitivity and excess smoothness, although sounding contradictory, are in fact very much in line with each other, since they can be seen as two different forms of manifestations of the same phenomenon: If consumers for some reason are reluctant to adjust their consumption fully according to changes in permanent income it would be reasonable to expect their consumption revision to be completed on the basis of perceived changes in their current income. Thus the finding of excess smoothness of consumption to permanent income innovations implies the existence of excess sensitivity of consumption to lagged income changes.

Different possible features have been suggested to be the reason for this failure of PIH. Quah (1990) found consumers to have superior information unobservable to econometricians to cause excess smoothness of consumption. Also West (1988) and Campbell and Deaton (1989) concluded the answer to lie in the information set of the consumers. Campbell and Mankiw (1991) found excess sensitivity to be caused by liquidity constraints due to undeveloped credit markets.

## 3. *Empirical evidence of excess smoothness*

If indeed excess sensitivity and thus excess smoothness is caused by liquidity constraints

[4] *In his 1991 study he worked with nondurables consumption only, and extended his method by inclusion of durables consumption in 1993.*

[5] See Galí (1993) for derivation of the estimators.

there is a good reason to expect Finnish data to show strong excess smoothness, since financial deregulation didn't take place in Finland until during the latter half of the 1980's. Although substantial amount of the data is from the period after deregulation, Campbell and Mankiw found no evidence that credit market evolution within the sample period would decrease the degree of excess sensitivity. They suggested that increase in unemployment in countries they studied could have offset the possible effect of deregulation. If so, there is even more reason to expect Finnish consumption to show strong excess smoothness.

In this study the Galí -type variability measure is applied on Finnish time series data to find out to which extent excess smoothness can be detected. Data used in the estimations are Bank of Finland's quarterly data of households' disposable income, nondurables consumption and durables expenditures from 1979(1) to 1992(3). The estimator for the normalized spectral density used in this study is the Parzen estimator[6]:

$$\text{(11)} \quad \hat{f}_j(\lambda) = \frac{1}{2\pi} \sum_{v=-n+1}^{n-1} w_v r_j(v) \cos(v\lambda) \qquad 0 \le \lambda \le \pi$$

$$j = c, d$$

where $r_j(v)$ is the estimator for the autocorrelation function of the series in question. The weight function $w_v$ defines the lag window, which in the case of Parzen estimator takes the form:

$$\text{(12)} \quad w_v = \begin{cases} \left[1 - 6\left(\frac{|v|}{M}\right)^2 + 6\left(\frac{|v|}{M}\right)^3\right]\left(1 - \frac{|v|}{n}\right), & |v| < \frac{M}{2} \\ 2\left(1 - \frac{|v|}{M}\right)^3\left(1 - \frac{|v|}{n}\right), & \frac{M}{2} \le |v| \le M, \\ 0, & |v| > M. \end{cases}$$

Parameter M controls the size of the lag window and the corresponding spectral window; the greater M, the wider the lag window and narrower the spectral window. Also when M gets larger the spectrum becomes less smooth, while estimation bias diminishes. Consequently the variability results are calculated using different sizes of M to verify the robustness of the results

The underlying assumptions in the Galí -type variability ratios are the unit roots of both nondurables consumption and durables expenditures processes and cointegration between the two. Although these assumptions have been widely tested with different consumption data from various countries, they were both tested using Finnish quarterly data for the ground of further analysis. Both unit root and cointegration tests are reported in table 1. Unit root assumption was tested with Dickey-Fuller and Augmented Dickey-Fuller tests. DF t- statistic was obtained by regressing each variable on its own lag and an intercept, and ADF(1) t- statistic by adding each variable's own lagged first difference to the regression. The critical values of the tests are based on MacKinnon's (1991) response surfaces. The results seemed to verify the unit root assumption. Both tests fail to reject the unit root null when applied on the levels of c and d quite clearly. Furthermore, when applied on the first differences DF tests and ADF test on durables imply strong rejection of the null, while ADF test on nondurables first difference rejects the null on 5% level.

Cointegration of consumption and durables expenditures is also tested with two different test statistics. We apply ADF test on the residuals from regressing c on d and an intercept, reported as ADF1 (or d on c, ADF2). Again, ADF t- values were obtained by regressing residuals on their own lags and their lagged first

Table 1. Unit root and cointegration tests.

| | **Unit root tests** | |
|---|---|---|
| | **DF** | **ADF(1)** |
| **Nondur. levels** | -1.1841 | -1.198 |
| **Dur. levels** | 0.4833 | -0.008 |
| **Nondur. first diff.** | -4.484** | -3.079* |
| **Dur. first diff** | -4.506** | -4.137** |
| critical values | 5%: -2.92 1%:-3.565 | |
| | **Cointegration tests** | |
| **ADF1** | -2.037* | |
| **ADF2** | -1.896 | |
| critical values | 5%: -1.947 1%: -2.608 | |

** = significant at the 1% level
* = significant at the 5% level

[6] *Galí uses Bartlett estimator in (1991) and (1993), but as he points out any consistent estimator will do the trick.*

Table 2. Variability ratios.

| | M | | | | |
|---|---|---|---|---|---|
| | **5** | **10** | **15** | **20** | **25** |
| **Durables (δ=0.125)** | 0.077749<br>(<0.01) | 0.061122<br>(<0.01) | 0.057099<br>(<0.01) | 0.056771<br>(<0.01) | 0.057909<br>(<0.01) |
| **Durables (δ=0.05)** | 0.02996<br>(<0.01) | 0.023553<br>(<0.01) | 0.022003<br>(<0.01) | 0.021876<br>(<0.01) | 0.022315<br>(<0.01) |
| **Durables (δ=0.025)** | 0.014794<br>(<0.01) | 0.01163<br>(<0.01) | 0.010865<br>(<0.01) | 0.010802<br>(<0.01) | 0.011019<br>(<0.01) |
| **Nondurables** | 0.78239<br>(<0.01) | 0.64974<br>(<0.01) | 0.617052<br>(<0.01) | 0.633961<br>(<0.01) | 0.675601<br>(<0.01) |

differences. The ADF test results show that no robust conclusions conserning the cointegration between the two consumption components can be made. While ADF1 just rejects the unit root null on 5% level thus indicating the existence of cointegration, ADF2 fails to reject the unit root hypothesis implying nonstationarity of the residuals and further that there is no cointegration relation between c and d.

The variability ratios for c and d with different size lag windows in the spectral density estimator are reported in table two. Though as noted earlier, the estimation bias decreases as M increases, the results seem quite similar with M ranging from 5 to 25. Since the variability ratio for durables is conditional to the depreciation rate δ, we calculated the statistic using three different values of δ. With a relatively high depreciation rate 0.125, which amounts to 50% annual depreciation the values for $\varphi_d$ were all under 0.078, implying strong excess smoothness. With a more realistic depreciation rate $\delta = 0.05$ (20% annual depreciation) all values are under 0.03, and with $\delta = 0.025$ (10% annually) under 0.015 with all window sizes. The results point strongly towards rejection of the PIH null $\varphi_d = 1$. The higher we set the depreciation rate the greater the variability ratios become, but remain significantly lower than one even with as unreasonably high as 50% annual depreciation.

Although spectral density estimators are asymptotically normally distributed, they tend to be somewhat biased with small sample sizes and thus any tests based on asymptotic distributions of these variability ratios would not give robust results. For this reason we are forced to focus our attention only to the estimated values and »artificial» p- values obtained by Monte Carlo[7] analysis under PIH null. The p- values are reported in brackets under the variability ratios.

For nondurables the estimated variability ratios are notably higher with all window sizes than for durables, but still they all reject PIH at 1% level. With M = 5 we get the highest value of over 0.78, while the lowest 0.61 with M = 15, so there appears to be clear excess smoothness in nondurables consumption. However, as expected nondurables consumption appears to be much more in line with PIH than durables expenditures. Our variability estimates seem to be quite similar to those of Galí's (1993). The main difference is that nondurables consumption seems to be slightly smoother in Finland than in the countries included in Galí's estimations. This result along with the history of financial regulation in Finland discussed above appears to indicate towards liquidity constraints as being amongst the main features causing excess smoothness as suggested in Campbell and Mankiw (1991). To what extent liquidity con-

[7] *The Monte Carlo p- values were obtained by 300 different simulated consumption change series each consisting of 150 observations. Critical values can be attained from the author on request.*

straints actually can be held responsible, and what is the role of the other possible explanations offered, requires further investigation.

Considering the extremely low variability ratios of the durables it seems quite obvious that there are some very important, previously disgarded factors that affect the behavior of durables time series. Such features like irreversibility and uncertainty are very likely to play an important role in the purchasing decisions of durables, more spesifically causing consumers to refrain from altering their durables stock whenever any small income changes occur thus causing durables expenditures to be notably smoother than implied by the traditional PIH models.

### *Cross spectral evidence*

When considering the issue of excess smoothness and the different responses to income change of durables and nondurables it would be quite reasonable to think that the analysis would gain depth if we could somehow investigate this response at different time spans. A useful and illustrative tool for achieving this information is the cross spectral method. Cross spectral analysis is based on the consept of coherence, which is a measure of the strength of correlation between two time series at different frequencies, i.e. at different time spans. Coherence is defined as follows:

$$(13)\quad coh_{ij}(\lambda) = \left|corr(dw_i(\lambda), dw_j(\lambda))\right| = \frac{|f_{ij}(\lambda)|}{\sqrt{f_i(\lambda) f_i(\lambda)}}, \qquad i,j = c,d,$$

where $dw(\lambda)$ is the amplitude of a series at frequency $\lambda$ and $f_{ij}(\lambda)$ the cross-spectral density of the two series under analysis. Since permanent income is unmeasurable due to reasons discussed earlier, we have to be content with working with disposable income, which consists of labor income and income from assets. Using this, we get the saving identity:

$$(14)\quad S_t \equiv y_t^d - C_t,$$

where $y_t^d$ is the disposable income at period t. Permanent income hypothesis implies saving to be stationary, from which it can directly be interpreted that disposable income and consumption are cointegrated. Cointegration tests are shown in table 3. ADF test was performed using three different consumption variables: nondurables consumption, durables expenditures and total consumption (sum of the two). Analogously to the cointegration tests performed before, disposable income was regressed on all three consumption variables in turn with an intercept added to each of the regressions. The ADF(1) tests were then applied on the residuals[8]. Again, the critical values are based on MacKinnon's response surfaces. All tests fail to reject the unit root null, suggesting towards no cointegration. Results are clearest when using durables expenditures, while the test statistic for total consumption is just under the five percent critical value. Although these results prevent us from making any robust conclusions about cointegration, it would seem that this cointegration assumption implied by PIH would not be valid, or at least it has to be strongly suspected.

When we turn to coherence diagrams, it is important to note that when analysing the coherence between two variables, one should always simultaneously very closely inspect the corresponding phase diagram, which shows the lag length for each pair of frequency components, i.e. as in our case, what is the lag between income fluctuations of different duration and corresponding changes in consumption.

The coherence at zero frequency seems to be quite large for both consumption components. However, when looking at the univariate spectral densities it can be seen that in both cases

Table 3. Cointegration between consumption and disposable income.

| **Cointegration of disposable income and consumption** | |
|---|---|
| **Consumption variable** | **ADF** |
| nondurables | -1.265 |
| durables | -0.8956 |
| total consumption | -1.702 |
| Critical values: 1% -2.608, 5% -1.947 | |

[8] *The residuals were regressed on their own lags and lagged first differences, as before.*

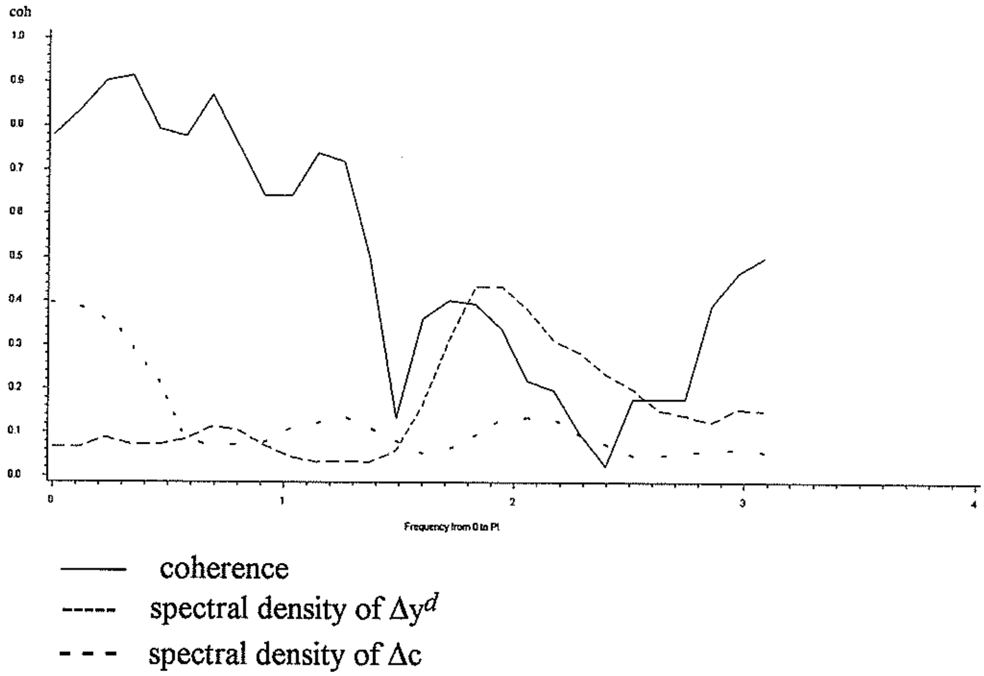


Figure 1. Coherence between $\Delta y^d$ and $\Delta c$.

high coherence cannot be interpreted as evidence of high correlation, since it appears to be caused by low value of the spectral density of disposable income at all lower frequencies. As shown in equation (13) the formula for coherence includes both univariate spectral densities in the denominator, and if one or both of them have low values at a given frequency it immediatelly affects coherence to get an artificially high value.

In both cases the low spectral density of income seems to be the cause of high coherence for all lower frequencies all the way up to frequency $\pi/2$ corresponding to wave legnth of one year[9]. When looking at higher frequencies, coherence between income and nondurables remains quite low all the way up to the highest frequencies, when it increases up to about 0.5. But again this somewhat high coherence seems to be caused by the low spectral density of nondurables. In fact the only case where both univariate densities seem to have simultaneously relatively high values is between durables and income at frequencies from $\pi/2$ to $5\pi/8$ , i. e. at wave lenghts from one year to approximatey ten months. Coherence at these frequencies declines from 0.5 to about 0.2 for ten month waves. As the corresponding phase diagram has a positive slope at these frequencies indicating income series to lead durables expenditures, this result can be interpreted as evidence of lagged income changes having predictive power on the changes in durables expenditures.

All in all, it seems that with the exception mentioned above the correlation between the changes in disposable income and the two consumption components, nondurables consumption and durables expenditures, seems to be quite low despite of the seemignly high coherence value. In fact this result appears to support the orthogonality between disposable income and consumption implied by the PIH.

Although the coherence results appear to provide support to permanent income hypothesis, especially in the case of nondurables consumption, in which no genuinely high coherence could be detected, closer analysis of figure 1.

[9] *Frequencies are converted into waves as follows: wave length in time units of the data = $2\pi$/frequency.*

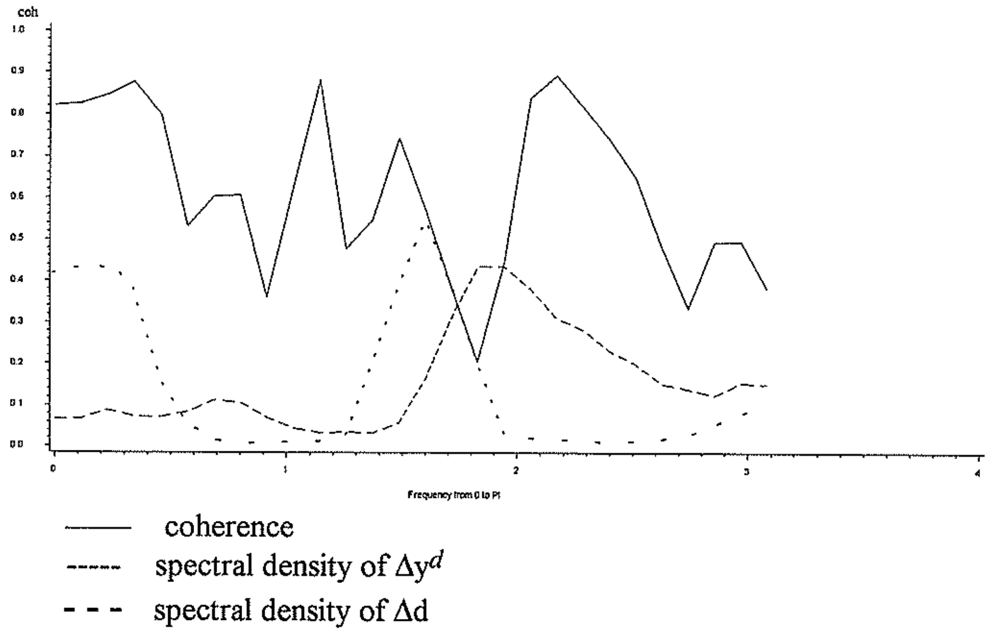


Figure 2. Coherence between $\Delta y^d$ and $\Delta d$.

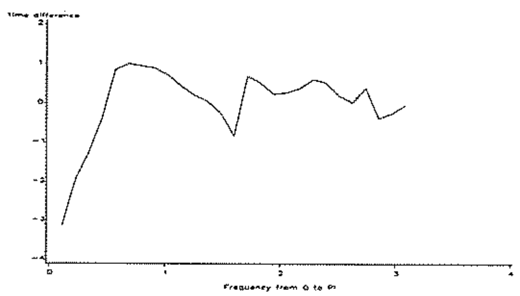

Figure 3. Phase diagram of $\Delta y^d$ and $\Delta c$.

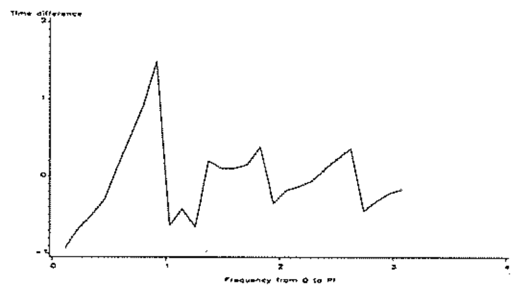

Figure 4. Phase diagram of $\Delta y^d$ and $\Delta d$.

provides stong evidence against PIH. As known, the main implication of PIH is that nondurables consumption should follow a random walk process. If this was the case, then the change in consumption should naturally equal white noise. The spectral density figure of white noise series is a straight horizontal line from zero to pi, i.e. the density is the same for all frequencies. As seen from figure 1. the spectral density of $\Delta c$ is highest at the lowest frequencies and declines notably as frequency increases towards pi. This clearly does not correspond to a spectral density of consumption change series as implied by PIH. Furthermore, since the density mass is quite low at high frequencies it seems reasonable to assume that the PIH consumption change spectrum would lie above the estimated spectral density at these frequencies thus confirming the excess smoothness result obtained with the variability ratios[10].

The phase function for disposable income and nondurables appears to be nearly horizontal at high and medium frequencies suggesting that the corresponding fluctuations of $\Delta y$ and

[10] *This finding is similar to that of Galí's (1991).*

Δc are approximately simultaneous. For lowest frequencies phase function has a positive slope of about 4, so the changes in income are leading the consumption series with one year at the longest waves. For durables and income changes the phase function looks on the whole very much alike. At lowest frequencies the slope of the function is approximately 2, i.e. income series appear to be leading with two quarters. The main difference with the two phase function is that at the middle frequencies (from $3\pi/5$ to $5\pi/6$) the slope in the latter is clearly positive with a value of about one suggesting income changes to lead $\Delta d$ with one quarter.

## 4. Conclusions

A great deal of the recent work done in the field of consumer behavior has focused on the departures from traditional permanent income hypothesis model on the grounds of empirical findings. Two main features have arisen. Firstly consumption has been found to be excessively sensitive to lagged changes in current income (Flavin, 1981, Campbell and Mankiw, 1991). The fact that consumption seems to be predictable contradicts the random walk property of consumption implied by PIH. Secondly Galí (1991) and (1993) and Campbell and Deaton (1989) found consumption to be smoother than permanent income, i.e. that consumption doesn't respond fully to the innovations in permanent income. Features like liquidity constraints caused by undeveloped credit markets and consumers' superior information have been suggested to be main causes for this failure of permanent income hypothesis. Since credit market deregulation took place in Finland as late as during the late 1980's plus the fact that our economy has for past half a decade suffered from mass unemployment resulting to increase in general uncertainty about the future, it seemed more than possible that excess smoothness could also be detected from Finnish consumption data.

We applied Galí -type nonparametric variability measure on Finnish time series data from 1979(1) to 1992(3) to determine whether excess smoothness could be detected. Our results showed durables purhases to be extremely too smooth while nondurables consumption seemed to be more in line with PIH, although it also seemed to be clearly too smooth. The main difference between our results and Galí's (1993) is that nondurables consumption appears to be smoother in Finland than in the countries he used in his estimations, namely UK, US, Canada, Italy, France and Japan. Considering the economic conditions in Finland as discussed earlier during our sample period, this can be interpreted as evidence of liquidity constraints being one of the main causes of excess smoothness and thus excess sensitivity as suggested by Campbell and Mankiw (1991). Also the role of uncertainty needs to be noted and put under a closer inspection.

Because of the lack of distributional tests a Monte Carlo simulation was constructed to obtain p- values for the variability statistics. Although the values of the test statistics are relatively close to one for nondurables, their p- values were all less than 0.01, indicating towards rejection of standard PIH. To gain robustness for our variability results cross spectral method was used to determinate the coherence, i.e. correlation of the first difference of disposable income and corresponding transformations of the two consumption components studied.

Cross spectral analysis indicated a high coherence with both Δd and Δc for the lowest frequencies, which however was uninterpretable because of the low values of univariate spectral density of Δy. The only case where we could detect coherences not affected by low values of univariate spectral density was between disposable income and durables for the frequencies corresponding to the wave lengths from approximately one year to ten months. The value of the coherence was around 0.5, and the phase diagram indicated income series to be leading the durables, thus suggesting that disposable income could have predictive power on the changes in durables expenditures.

The interesting feature is that this coherence occured around the middle frequencies, thus pointing towards importance of features like uncertainty on the purchasing decisions of durables. As the changes in income process become more permanent, i.e. the uncertainty about future income level decreases, consumers appear to adjust their durables stock correspondingly. When looking this phenomena from different side, one can conclude that consumers are reluctant to adjust their durables stock on the basis of any short lasting income changes, and this in turn contributes to low values of estimated variability ratios, i.e. causing excess smoothness of durables expenditures.

When looking at the univariate spectral densities further evidence against traditional PIH appears: The spectral density function of the first difference of nondurables consumption is not a straight horizontal line as it should be if consumption was a random walk process as permanent income hypothesis suggests. Futhermore, the low values of the estimated spectral density at higher frequencies could be interpreted as supporting the excess smoothness result of the variability ratios.

Both the variability statistic and the coherence (and univariate spectral density) diagrams point towards excess smoothness in the durables expenditures and nondurables consumption series. For durables expenditures variability statistics show extremely strong excess smoothness. In the light of these results it seems that the traditional permanent income hypothesis is unable to explain how consumers adjust their durables stock when their permanent income changes. Possible reasons for this failure could be for example the irreversibility property of durable goods or the uncertainty regarding the future income level of the consumers.

The role of uncertainty and irreversibility in households' investment decisions has only recently received more attention. The results so far (eg. Lam 1989) show irreversibility to be a major factor in causing durables expenditures to be independent of any short lasting chances in disposable income, which appears as excess smoothness of durables expenditures time series. Much work in this field still remains to be done with main challenges being in modelling and estimation of these features.

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