

Incomplete Intertemporal Consumption

Smoothing and Incomplete Risksharing*

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Abstract

This paper develops a method to estimate jointly the degree of intertemporal consumption smoothing and the degree of "interregional" risksharing. The empirical results for the US states and OECD and EU countries suggest that: 1) regardless of the assumption on the degree of intertemporal consumption smoothing, the degree of risksharing within a country is larger than across countries; 2) the degree of intertemporal consumption smoothing within a country is also larger than across countries; 3) The difference between the degree of intertemporal consumption smoothing within US states and across OECD and EU countries is as large as the difference between the degree of risksharing, contrary to the findings of some past studies.

<http://econ.korea.ac.kr/new/prof/prof.php?profid=sykim>.

1. Introduction

Empirical studies on risksharing — i.e., consumption smoothing across states of nature — have grown rapidly in recent years. The formal literature started by testing the null hypothesis of full risksharing at various aggregation levels, such as among individuals in a village (Townsend 1994), among households (Mace 1991, Cochrane 1991, Altug and Miller 1990, Hayashi, Altonji and Kotlikoff 1996), and among countries (Canova and Ravn 1996, Lewis 1996). These seminal papers, which were essentially based on regressions of consumption on income (and possibly on other idiosyncratic variables), often controlling for aggregate consumption, originated two strands of macroeconomic literature. One line of research — firmly based on theoretical foundations — has allowed for the possibility of incomplete risksharing and has focused on its precise measurement (e.g. Obstfeld 1994, Crucini 1999, Athanasoulis and van Wincoop 2001, Crucini and Hess 2000). These studies usually focus on the degree of risksharing across regions (mutual insurance across states of nature against idiosyncratic regional risks, *ex ante*), but typically pay less attention to the degree of intertemporal consumption smoothing of the region (diversification of idiosyncratic consumption across time, *ex post*). For example, Athanasoulis and van Wincoop (2001) have performed estimations of

the degree of risksharing, assuming away intertemporal consumption smoothing. Other risksharing studies have assumed an extreme degree of intertemporal consumption smoothing, either by taking the permanent income hypothesis to hold fully (Crucini 1999, Crucini and Hess 2000), or by postulating no intertemporal consumption smoothing altogether (Obstfeld 1994, 1995).

On the other side of the consumption literature, there is a well-known body of empirical work that focuses on intertemporal consumption smoothing (Hall 1978, Campbell and Deaton 1989, Campbell and Mankiw 1990, Deaton 1992, and Østergaard, Sørensen, and Yosha 2002). Among them, only a few studies (Sørensen and Yosha 2000 or Bayoumi and Klein 1997) have investigated the degree of intertemporal consumption smoothing within a country vs. across countries. Typically, this literature focuses on disposable income aggregates, thereby abstracting from the risksharing issue.

This paper links together these two major strands of the empirical consumption literature, by developing a method that jointly estimates the degree of risksharing and the degree of intertemporal consumption smoothing. The empirical framework is consistent with both risksharing and intertemporal consumption smoothing theory.¹ Our methodology contributes to each of these previous lines of re-

¹A third line of work has concentrated on measuring the contribution to overall smooth-

search. Existing methods of estimating risksharing fail to allow for heterogeneity in the extent of intertemporal consumption smoothing. Conversely, investigations of intertemporal consumption choice typically ignore the risksharing dimension. By combining both dimensions in our empirical methodology we provide a concrete assessment of the possible biases in each component of consumption choice arising from interactions between the two. This is particularly relevant in comparing countries, members of monetary unions and regions within countries. For example, much is made of the cost of monetary unification in terms of the loss of policy flexibility in responding to inflationary pressure of business cycles. Yet a monetary union may enhance risksharing among member countries by deepening financial linkages and by facilitating the development of federal fiscal institutions. Similarly a monetary union also produces high correlation of inflation and nominal interest rates across time which is central to the intertemporal channel.

ing — possibly incomplete — of various smoothing channels (Asdrubali, Sørensen and Yosha 1996, Del Negro 1998, Sørensen and Yosha 1998, Mélitz and Zumer 1999, Dedola, Usai and Vannini 1999, Asdrubali and Kim 2004). An important contribution of these papers has been the distinction between risksharing and intertemporal smoothing channels. Compared to this "channels" literature, our methodology is more theory-based, and does not necessarily require data on national or disposable income (that is, income after risksharing), which is useful if such data is not available or is of a poor quality.

Using a dataset updated up to 2004, we apply our method to three regions — the US states, the OECD countries, and the EU members — in order to provide a possible rationalization for the failure of the full risksharing hypothesis by comparing intra vs. inter-regional risksharing and intertemporal consumption smoothing, and to shed a light on the cost of the European monetary unification process.

The rest of the paper is organized as follows. Section 2 develops a method to estimate the degree of risksharing and the degree of intertemporal consumption smoothing. Section 3 reports the estimation results. Finally, Section 4 concludes with a summary of findings.

2. Analytical Framework

2.1. The risksharing arrangement

Since risksharing is arranged ex-ante while consumption is intertemporally smoothed ex-post, we first model risksharing arrangements, and then model intertemporal consumption smoothing on top of the risksharing arrangements. Consider possibly incomplete risksharing among J countries in an international organization, which we will call EU (or among J regions in a country, which we will call the

US).² As in Crucini (1999), we posit that each country j sells a fraction λ of its income stream Y_j in exchange for a claim to the pooled income streams of all J countries, so that λ can be naturally interpreted as the degree of risksharing achieved by the country.

The average date t amount in the pool of the EU is $Y_t \equiv \sum_{j=1}^J Y_{jt}/J$. The flow of domestic income after risk pooling is

$$\bar{Y}_{jt} \equiv \lambda Y_t + (1 - \lambda) Y_{jt}. \quad (2.1)$$

Domestic income after risksharing (or "disposable income") is equal to its own income stream when λ is 0 (no risksharing), and to the income stream of the pool when λ is 1 (full risksharing).³ When λ is between 0 and 1 (partial risksharing), a country's disposable income is a weighted average of its own income stream and of the income stream of the pool.⁴

²For simplicity, we follow the standard practice of assuming that all countries in the EU (or all regions in the US) are identical ex ante.

³Our definition includes risksharing achieved by both private and public sectors.

⁴Risksharing may be incomplete if markets are incomplete, if transaction costs in the goods markets are non-negligible, if contracts are costly to enforce or informational asymmetries exist that induce moral hazard.

2.2. Intertemporal smoothing

While complete risksharing implies full intertemporal consumption smoothing — in the sense that an Euler equation for intertemporal consumption allocation is satisfied — partial risksharing does not necessarily imply full intertemporal consumption smoothing. Therefore, we will consider possibly incomplete intertemporal consumption smoothing of each country j . When consumption is perfectly smoothed intertemporally, the country consumes its permanent (disposable) income.⁵ When consumption is not smoothed intertemporally at all, the country consumes its current (disposable) income. We define γ , the degree of intertemporal consumption smoothing achieved by the country, as the fraction of its permanent disposable income used to smooth its consumption. When a fraction, γ , of its permanent disposable income is used to smooth its consumption (and hence the remaining fraction $1 - \gamma$ is consumed out of its current disposable income), the change in consumption of country j is

$$\Delta C_{jt} = \mu_j + (1 - \gamma) \Delta \bar{Y}_{jt} + \gamma \bar{\varepsilon}_{jt} \quad (2.2)$$

where $\bar{\varepsilon}_{jt} \equiv (1 - \beta) \sum_{k=0}^{\infty} \beta^k [E_t \bar{Y}_{jt+k} - E_{t-1} \bar{Y}_{jt+k}]$ is the change in consumers' estimate of their permanent (disposable) income from $t - 1$ to t , which we will

⁵We assume that each country smooths consumption by borrowing or lending at a possibly different but constant exogenous real interest rate.

call the innovation in permanent (disposable) income. The consumption change is equal to the current disposable income change when γ is 0 (no intertemporal consumption smoothing), and to the innovation in permanent disposable income when γ is 1 (full intertemporal consumption smoothing). When γ is between 0 and 1 (partial intertemporal consumption smoothing), a country's consumption change is a weighted average of its current disposable income change and the innovation in permanent disposable income.⁶ Observe that, in characterizing incomplete intertemporal consumption smoothing, equation (2.2) allows for both excess sensitivity of consumption (Flavin 1981) and excess smoothness (Campbell and Deaton 1989), as well as "rule of thumb" behavior (Campbell and Mankiw 1989, 1990). The change in the consumption average of all countries leads to the expression for the change in the corresponding aggregate consumption of the EU:

⁶Intertemporal consumption smoothing can be incomplete, and the permanent income hypothesis may not hold, due to market imperfections, such as liquidity constraints. Other reasons why the permanent income hypothesis may not hold include a rate of impatience different from the gross real interest rate, the existence of precautionary savings, changing real interest rates (Michener 1984), home production (Baxter and Jermann 1999), non-additive utility and consumption-leisure non-separabilities (Mankiw, Rotemberg and Summers 1985).

$$\Delta C_t \equiv \frac{1}{J} \sum_{j=1}^J \Delta C_{jt} = \mu + (1 - \gamma) \Delta Y_t + \gamma \varepsilon_t \quad (2.3)$$

where $\mu \equiv \sum_{j=1}^J \mu_j / J$ and $\varepsilon_t \equiv \sum_{j=1}^J \varepsilon_{jt} / J$.

Using equations (2.1), (2.2), and (2.3), the change in country consumption becomes

$$\Delta C_{jt} = \tilde{\mu}_j + \lambda \Delta C_t + (1 - \gamma)(1 - \lambda) \Delta Y_{jt} + \eta_{jt} \quad (2.4)$$

where the intercept $\tilde{\mu}_j \equiv \mu_j - \lambda \mu$, the error $\eta_{jt} \equiv \gamma(\bar{\varepsilon}_{jt} - \lambda \varepsilon_t) = \gamma(1 - \lambda) \varepsilon_{jt}$ and the innovation $\varepsilon_{jt} \equiv (1 - \beta) \sum_{k=0}^{\infty} \beta^k [E_t Y_{jt+k} - E_{t-1} Y_{jt+k}]$. The change in country consumption is a weighted average of the changes in aggregate consumption, the changes in domestic income, and the innovation in permanent income. The coefficient λ reflects the degree of international risksharing while γ indicates the degree of intertemporal consumption smoothing of the country.

2.3. Comparison with special cases

In order to show how the model can comprise various special cases, including those discussed in past studies, Table 1 shows how the change in individual consumption

(ΔC_{jt}) is determined in nine cases that allow different values of γ and λ , based on equation (2.4).

[Table 1 around here]

When λ and γ both go to 0, both risksharing and consumption smoothing are null and the consumption change is closer to the change in current domestic income. As λ increases, risksharing is larger and the change in country consumption is closer to the change in aggregate consumption. As γ increases, intertemporal consumption smoothing is larger and the change in country consumption depends more on the innovations in its permanent income. However, there is an asymmetry between full risksharing ($\lambda = 1$) and complete intertemporal consumption smoothing ($\gamma = 1$). When $\lambda = 1$, the change in country consumption is equal to the change in aggregate consumption (and a constant) regardless of the value of γ . On the other hand, when $\gamma = 1$, the change in country consumption is equal to the innovations in its permanent income only if $\lambda = 0$. This often overlooked asymmetry reflects a clear implication of risksharing theory: while full risksharing ($\lambda = 1$) implies intertemporal consumption smoothing — in the sense that the Euler condition is satisfied regardless of the value of γ — full intertemporal con-

sumption smoothing ($\gamma = 1$) does not imply risksharing.⁷ Taking account of this asymmetry between risksharing and intertemporal smoothing is a value added of our formulation.

Table 1 also shows that there are four possible cases for the estimation of λ , γ , or both. While the most general case, which allows both λ and γ to range between 0 and 1, is used in this paper, the other three special cases are similar to the methods used in some past studies. For example, Obstfeld (1994, 1995) examined a variant of the $\gamma = 0$ case (no intertemporal consumption smoothing).⁸ On the other hand, Crucini (1999) and Crucini and Hess (2000) examined the case of $\gamma = 1$ (perfect intertemporal consumption smoothing).⁹ If Y_{jt} follows a random walk, then $\Delta C_{jt} = \tilde{\mu}_j + \lambda \Delta C_t + (1 - \lambda) \Delta Y_{jt}$ regardless of the restrictions on γ since the innovations in permanent income and current income changes are equal. However, realistically, Y_{jt} may follow a more general process, and this is

⁷See, for example, Sørensen and Yosha (1998) for a formal proof.

⁸Obstfeld (1994) further allowed the sum of the coefficient on aggregate consumption and the coefficient on country income not to be equal to 1, and the error term to be included as a country-specific preference shock.

⁹By assuming and estimating various stochastic processes for y_{jt} (log of Y_{jt}), Crucini (1999) constructs innovations in permanent income, and then estimates equation (3.1) by OLS.

the approach we take.¹⁰ Therefore, our method can be viewed as an advanced form of general risksharing test that allows partial intertemporal consumption smoothing.

Finally, it is easy to show that our model also embeds the baseline specification of intertemporal consumption smoothing (as in Campbell and Mankiw 1990) as a special case with no risksharing ($\lambda = 0$).¹¹

3. Estimation

Since income and consumption series do not follow exactly linear homoskedastic processes, an empirical test of an equation like (2.4) — which is cast in level-differences — is not entirely appropriate. Thus we follow the literature in taking

¹⁰First, changes in domestic income may depend on its own past changes. In fact, several studies (Campbell and Mankiw 1990, Campbell and Deaton 1989, Deaton 1992), suggested that income changes do depend on past income changes. In this regard, we estimate the auto-correlation of y_{jt} (log of Y_{jt}) for each state in the US and for each country in the OECD and EU. The average of the estimated auto-correlation of income is 0.31 for the US states, 0.29 for OECD countries, and 0.30 for EU members; the dependence is not trivial. Second, changes in domestic income may be affected by other variables, like changes in aggregate income.

¹¹More precisely, they correctly use disposable income as a regressor; this corresponds to our specification (2.2).

the log approximation of the equation (Campbell and Mankiw 1989, 1990, Obstfeld 1994 and Crucini 1999), so that our results will be comparable. Hence our estimating relation will be

$$\Delta c_{jt} = \tilde{\mu}_j + \lambda \Delta c_t + (1 - \gamma)(1 - \lambda) \Delta y_{jt} + u_{jt} \quad (3.1)$$

where lowercase letters indicate logs. The above formulation represents not only a parsimonious way of jointly characterizing partial risksharing and partial intertemporal smoothing. It is also quite general, in the sense that it can be derived in a full-fledged model as an approximation either from a standard quadratic utility function, or from an isoelastic utility function with log-normally distributed consumption.¹²

Equation (3.1) can be estimated by an instrumental variables (IV) approach. The error term u_{jt} , a function of the innovations in (the log of) permanent income, is orthogonal to lagged variables but not necessarily to current independent variables such as Δy_{jt} and Δc_t . The growth in domestic income, Δy_{jt} , is likely to be correlated to u_{jt} when the growth in domestic income is persistent. The growth in aggregate consumption, Δc_t may be correlated with u_{jt} ; both aggregate consumption growth and domestic permanent income growth are likely to be

¹²See Kimball (2003) for a defense of the certainty equivalence approximation to uncertainty.

correlated with aggregate permanent income growth.

We use lagged values of Δy_{jt} , Δy_t , Δc_{jt} , Δc_t , as well as of measures of country savings s_{jt} and aggregate savings s_t , as instruments. Own lagged variables are good predictors. In addition, the history of consumption growth may be a good predictor of income growth, and the two processes might be cointegrated. Therefore, we use lagged values of Δc_{jt} and s_{jt} . On the other hand, since lagged saving and income growth may be good predictors for consumption growth, lagged values of Δy_t and s_t are also employed. We include at least the second and the third lags of the instruments, but avoid using the first lags to guard against time aggregation bias. Following Crucini (1999), the model is estimated for each region, and the averages of the point estimates and their standard errors are reported; a pooled regression would give a near zero estimate of the coefficient on the aggregate consumption growth since the aggregate consumption growth (or the average consumption growth) is regressed on individual consumption growth. In each estimation, the values of λ and γ are restricted to be no larger than 1 and no smaller than 0.¹³ We estimate our model by using annual data for 50 US

¹³In very few cases, we found implausibly large and small values that change the average dramatically, so we restrict the values of λ and γ . We also experimented by restricting the values between -1 and 2, but the results are not much different.

states (1963–2004) and 22 OECD (of which 15 are EU) countries (1960–2004).¹⁴

4. Empirical Results

Table 2 shows the empirical results of estimating equation (3.1) and various special cases.¹⁵ The first noteworthy result is that the degree of risksharing is higher among the US states than across the OECD countries; the estimated λ is 0.55 on average for US states but 0.45 for the OECD countries and 0.46 for the EU countries. Second, the degree of intertemporal consumption smoothing is also higher in the US states than in the OECD and EU countries; the estimated γ

¹⁴Our variables are all in real per capita terms. For US state-level data, we took Gross State Product, CPI and State Population from the BEA, and State Consumption from the Bureau of the Census; for OECD and EU data, we took Gross Domestic Product, Domestic Consumption, Country Population, and Country CPI from OECD’s National Accounts. For details on data sources and construction, refer to Asdrubali, Sørensen, and Yosha (1996) and Asdrubali and Kim (2004).

¹⁵We report the average for the results of the regression with 2-3 lags, 2-4 lags, and 2-5 lags of instruments (for saving, only the second lag is used in all cases), except for the no smoothing case. In that case, instruments are not necessary because innovations in permanent income disappear when $\gamma = 0$. At any rate, the results do not differ much even when instruments are used.

is 0.39 on average for the US¹⁶ but 0.21 for the OECD and 0.11 for the EU. In addition, the difference in the degree of intertemporal consumption smoothing across US states and that across OECD countries is as large as the difference in the degree of risksharing. This result is interesting since some past studies (Sørensen and Yosha 1998, Sørensen and Yosha 2000) reached opposite conclusions on this difference.

[Table 2 around here]

To put our results in perspective, we compare our method to various special cases. First, when the degree of intertemporal consumption smoothing is restricted to one ($\gamma = 1$), the estimate of the degree of risksharing (λ) is biased upward (compared to the unrestricted case). This result vindicates our multivariate approach, for it stems from the omission of the domestic income growth variable among the regressors, as confirmed by the positive covariance between aggregate consumption growth (the included variable) and domestic income growth.¹⁷ Sec-

¹⁶For individual US states regressions, the estimate of γ is significant at 5% level in more than 2/3 of cases; a few large standard errors make the average large.

¹⁷A regression of domestic income growth on aggregate consumption growth yields positive and significant regression coefficients for all our samples, regardless of the instrument specifications.

ond, when the degree of intertemporal consumption smoothing is restricted to zero ($\gamma = 0$), both aggregate consumption growth and domestic income growth appear in the regression, but the coefficient on ΔY_{jt} is restricted to $(1 - \lambda)$ (from $(1 - \gamma)(1 - \lambda)$ in the unrestricted one). The results for OECD and EU countries are not much different from the unrestricted case since the restriction is close to the true value. But the results for the US states are different since the restriction is more away from the true value. For the US states, the estimate of the degree of risksharing (λ) is biased upward probably because a higher value of λ is needed given the coefficient on domestic income growth when γ is restricted to zero. These combined results suggest an overestimation of the degree of risksharing in the literature. Finally, when the degree of risksharing is restricted to zero ($\lambda = 0$), the estimate of the degree of intertemporal consumption smoothing (γ) is biased upward. This result is related to both the omitted variable problem and an "omitted parameter" problem, that is the change in the coefficient on domestic income growth due to the restriction.¹⁸

¹⁸A regression of aggregate consumption growth on domestic income growth yields positive and significant regression coefficients for all our samples, regardless of the instrument specifications. Therefore, the coefficient on Δy_{jt} in the omitted regression should be biased upward. Note that the coefficient on Δy_{jt} is $(1 - \gamma)(1 - \lambda)$ in the unrestricted regression but $(1 - \gamma)$ in the omitted regression. Given the true value of λ in the unrestricted regression, this implies

5. Conclusion

Models of consumption smoothing in open economies have typically assumed two extreme international financial structures: the "bonds only" and the "complete markets" framework (Baxter and Crucini 1995 and Baxter 1995). In the former, only ex post international borrowing and lending is available to smooth consumption, whereas, in the latter, complete markets in contingent claims allow for consumption buffering through full risksharing of income shocks. Since the evidence seemed to point away from full risksharing or optimal intertemporal smoothing, recent work in empirical open economy macroeconomics has tried estimation either of possibly incomplete risksharing, or of possibly incomplete intertemporal smoothing.

By developing a theoretically grounded specification that allows for varying degrees of both risksharing and intertemporal smoothing, we are better able to estimate the role of each in the consumption process as well as their interaction. The main findings are as follows. First, even after allowing for the possibility of partial intertemporal consumption smoothing, the degree of risksharing within a country is larger than across countries, in line with the literature. Second, the degree of intertemporal consumption smoothing within a country is also larger

that γ should be biased upward.

than across countries. Third, the difference between the degree of intertemporal consumption smoothing within US states and across OECD and EU countries is as large as the difference between the degree of risksharing. From a policy point of view, this result suggests that there is ample scope in the EU for a further development of intertemporal smoothing mechanisms — in the form of a deepening of domestic and international financial markets, and possibly of a greater flexibility of national fiscal policies — in order to better absorb the shocks that economic and monetary integration entail. Further investigation in this line of research would be worthwhile to shed more light on the interplay between risksharing and intertemporal smoothing.¹⁹

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¹⁹As a recent attempt in this direction, see Asdrubali and Kim (2007).

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Table 1: Theoretical benchmarks for the determination of consumption change

	No smoothing ($\gamma = 0$)	$0 \leq \gamma \leq 1$	Perfect smoothing ($\gamma = 1$)
No risksharing ($\lambda = 0$)	$\mu_j + \Delta Y_{jt}$	$\mu_j + (1 - \gamma) \Delta Y_{jt} + \gamma \varepsilon_{jt}$	$\mu_j + \varepsilon_{jt}$
$0 \leq \lambda \leq 1$	$\tilde{\mu}_j + \lambda \Delta C_t + (1 - \lambda) \Delta Y_{jt}$	$\tilde{\mu}_j + \lambda \Delta C_t + (1 - \gamma) (1 - \lambda) \Delta Y_{jt} + \gamma (1 - \lambda) \varepsilon_{jt}$	$\tilde{\mu}_j + \lambda \Delta C_t + (1 - \lambda) \varepsilon_{jt}$
Perfect risksharing ($\lambda = 1$)	$\tilde{\mu}_j + \Delta C_t$	$\tilde{\mu}_j + \Delta C_t$	$\tilde{\mu}_j + \Delta C_t$

Notes: Special cases of equation $\Delta C_{jt} = \tilde{\mu}_j + \lambda \Delta C_t + (1 - \gamma) (1 - \lambda) \Delta Y_{jt} + \eta_{jt}$. The coefficient γ measures the extent of intertemporal consumption smoothing while the coefficient λ represents the extent of risksharing. The error η_{jt} equals $\gamma (1 - \lambda) \varepsilon_{jt}$ where the term $\varepsilon_{jt} \equiv (1 - \beta) \sum_{k=0}^{\infty} \beta^k [E_t Y_{jt+k} - E_{t-1} Y_{jt+k}]$ is the innovation in permanent income for country j in period t .

Table 2: Estimates of intertemporal consumption smoothing and risksharing under alternative assumptions

	Extent of Intertemporal Consumption Smoothing (γ)		Extent of Risksharing (λ)		
	Risksharing Unrestricted	No Risksharing ($\lambda = 0$)	Smoothing Unrestricted	Perfect Smoothing ($\gamma = 1$)	No Smoothing ($\gamma = 0$)
United States	0.39 (0.29)	0.74 (0.16)	0.55 (0.19)	0.74 (0.16)	0.70 (0.12)
European Union	0.21 (0.07)	0.34 (0.11)	0.45 (0.15)	0.77 (0.10)	0.43 (0.07)
OECD	0.11 (0.07)	0.28 (0.10)	0.46 (0.06)	0.82 (0.09)	0.40 (0.07)

Notes: Regression estimates of the equation $\Delta c_{jt} = \tilde{\mu}_j + \lambda \Delta c_t + (1 - \gamma)(1 - \lambda) \Delta y_{jt} + u_{jt}$. The coefficient γ measures the extent of intertemporal consumption smoothing while the coefficient λ represents the extent of risksharing.