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Dipartimento di Economia
Università degli Studi Roma Tre
Via Silvio D'Amico, 77 - 00145 Roma
Tel. 0039-06-57335655 fax 0039-06-57335771
E-mail: dip_eco@uniroma3.it
http://dipeco.uniroma3.it

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Consumption Smoothing Channels within and between Households

Pierfederico Asdrubali[a], Simone Tedeschi[b], Luigi Ventura[c]

[a] *Department of Economics and Social Sciences, John Cabot University*
[b] *Department of Economics, Roma Tre University*
[c] *Department of Economics and Law, Sapienza University of Rome*

Abstract

This paper aims to fill the gap on the analysis of consumption smoothing/risksharing channels at the micro level, both within and across households. Using data from the Bank of Italy's Survey on Household Income and Wealth covering the financial crisis, we are able to quantify in a unified and consistent framework several risksharing mechanisms that so far have been documented separately. We find that Italian households were able to smooth about 83% of shocks household head's earnings in 2008-2010, a fraction rising to almost 87% in 2010-2012. The most important smoothing mechanisms turns out to be self-insurance through saving/dissaving and within-household risksharing Interestingly, risksharing through portfolio diversification and private transfers are rather limited, but the overall degree of shock absorption occurring through private risksharing channels hovers around two thirds, as opposed to around one fifth of a shock cushioned by public transfers and taxes.

JEL classification: C31, D12, E21.

Keywords: Household Risksharing; Precautionary Saving; Consumption Smoothing; Income Smoothing.

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1. Introduction

Households lie at the center of economic analysis, as they are the core unit of several decision-making processes and perform many economically relevant roles. In fact, there is a large literature focusing on the many roles that households play, both through market transactions (purchases of goods and services, supply of labor and capital services, management of home productions) and via non-market interactions (mutual assistance). Many of these activities are aimed at sharing risk both among household members and across households.

In fact, since Becker's contributions (1973, 1974)[11, 12], household economics has often stressed the idea that marriage (formal and informal) fosters risk sharing, as transfers between spouses do achieve some smoothing in individual income streams' variability. Some authors (for example, Chami and Hess, 2005[18]) have gone as far as to suggest that one of the motivations for marriage is to secure some hedging against income risk. A bunch of applied studies (which most frequently employ micro data) provide some support to the idea that marriage achieves a certain amount of risk sharing (as, for example, in the contributions by Rosenzweig and Wolpin, 1985[63], 1994[62]; Rosenzweig, 1988[60]; Rosenzweig and Stark, 1989[61], and others).

There is, however, another subtle way that marriage may influence risk sharing, as it may be the case that more risk sharing comes at the expense of saving, as long as people feel more secure in their spousal agreement (as suggested, for example, by Devereux and Smith 1994[26]). This might decrease the buffer stock from which consumption shocks get smoothed, by the saving/dissaving channel.

As for risksharing across households, suffice it to note that the modern theory of risksharing has been developed centering on the household (or the individual) as its basic decision unit, entering transactions in the market (Arrow 1964[2], Townsend 1994[70]; see Huang and Litzenberger 1988[39] or Deaton 1992[22] for a systematization).

Yet despite the pivotal role that household risksharing plays in basic economic agents' decisions, very little empirical research has been devoted to the identification and measurement of the mechanisms through which households cope with the risk of income shocks, both between and within them. To be sure, initial empirical tests of risksharing were carried out at the micro level (Cochrane, 1991[19]; Mace, 1991[50]; Nelson 1994[55]; Hayashi, Altonji and Kotlikoff 1996[37]; Attanasio and Davis 1996[5], Declich and Ventura 2000[23]; Grande and Ventura 2002[34]; Krueger and Perri 2005[46], 2011[47]; Gervais and Klein 2010[33]); however these studies could only test whether the null hypothesis of full risksharing was rejected or not, without being able to identify or measure the economic mechanisms at work. This is all the more unsatisfactory when one considers that theoretical

models predicting partial risksharing have been put forward.[1] On the other hand, the macro literature on interregional/international risksharing - whose theoretical underpinning is typically a representative-agent extension of the basic micro framework - has proceeded much further in the empirical analysis of risksharing channels. After the first regression tests[2] of full risksharing (Canova and Ravn 1996)[14], a vast body of literature has developed, starting with Asdrubali, Sørensen and Yosha (1996)[3], henceforth ASY (1996), with the aim of measuring the extent of risksharing channels across countries (or regions) within a unified framework.

A much larger literature on consumption responses to income shocks has focused on the intertemporal (as opposed to cross-sectional) reallocation of resources, under the (often implicit) assumption that the only shock-absorbing mechanism available to households was lending and borrowing in a bonds-only financial market. In sum, as Blundell, Pistaferri, and Preston (2008)[13] point out, beside household saving and borrowing, there is scattered evidence on the role played by various partial insurance mechanisms on household consumption.

This paper aims to fill the gap on the analysis of risksharing channels at the micro level, both within and across households. Using data from the Bank of Italy's Survey on Household Income and Wealth (SHIW) in 2008-2012, we regress consecutive household income measures (from household non-financial income to household income, to household disposable income) on household head's earnings. By doing so, we are able to quantify in a unified and consistent framework risksharing mechanisms that so far have been documented separately. A well-known mechanism is portfolio diversification, which can be implemented through complete markets for contingent claims or appropriate more parsimonious (and realistic) financial structures. Its role has been studied and quantified by Arrow (1964)[2] and Townsend (1994)[70], among others.[3] Another classical risksharing channel consists of fiscal transfer/tax mechanisms. This has been introduced by Sala-i-Martin and Sachs (1992)[64] and von Hagen (1992)[71]. Dynarski and Gruber (1997)[28] study the smoothing effect on US household consumption of government transfers (including retirement income) and taxes separately. For Italy, Dedola, Usai and

[1] Incomplete risksharing may arise due to exogenous factors, such as market incompleteness and transaction costs, or endogenous factors, such as limited commitment or enforceability (see Kehoe and Levine 1993[44], further developed by Kocherlakota 1996, Alvarez and Jermann 2000[1], Krueger and Uhlig 2006[45], Krueger and Perri 2011a[48]) and moral hazard.

[2] Tests of risksharing have also used correlation analysis to identify cross-country or cross-regional risksharing. Examples of this strand of the literature include Backus, Kehoe, and Kydland (1992)[8]), Pakko (1997)[57], Hess and Shin (1998)[38] and many others.

[3] As mentioned above, many seminal studies on risksharing – which explicitly or implicitly only took into account portfolio diversification – aimed at testing full risksharing, without embarking in its quantification.

Vannini (1999)[25], Mélitz and Zumer (1999)[53] and Decressin (2002)[24] carry out analyses of public risksharing, but at a macro level. An important - albeit less studied - channel of consumption smoothing is intra-household risksharing, that is the smoothing of the household head's income shocks through other members' income changes. Hayashi, Altonji and Kotlikoff (1996)[37] and Dynarski and Gruber (1997) quantify the role of "wife's earnings", finding little effects. On the contrary, García-Escribano (2004)[30] models risksharing within families explicitly, obtaining the opposite result. Informal risksharing between households - through private gifts, transfers, aid and services - has been posited by Cox (1987)[20] and extensively studied in developing economies, but rarely quantified in Western countries, at least in the way we do in our empirical analysis. Finally, household self-insurance through asset accumulation and depletion (lending and borrowing in credit markets) has received the most attention, as it stems from the literature on permanent income/life cycle behavior. A related mechanism of self insurance takes place through the (timing of) durable expenditures (see Attanasio 1999[6] for a discussion), and will also be part of our investigation.

While the basic idea of our paper consists in applying the ASY (1996) methodology to households instead of countries, a mere carry-over of the ASY (1996) SUR estimation to a micro setting would be problematic. Indeed, differences exist between macro data on countries and micro data on households, as: i) the former typically include the entire population, while the latter constitute a sample to make inference on, with consequences in terms of selection bias and representativeness; ii) macro data are typically more reliable, both because they originate from official sources and because they benefit from a sort of "washing out" due to aggregation, whereas the latter may be marred by measurement errors, especially in income variation; iii) by definition, at lower levels of aggregation the socio-demographic and economic factors confounding the relation between consumption and income are more numerous than at higher aggregation levels. Specifically, certain individual characteristics – such as age and the presence of children at different stages of the life cycle, plus other possible predictor covariates affecting preference and smoothing capacity – do not even have an obvious homologue at the aggregate level. Moreover, aggregation may get rid of additional factors, such as temporary or sectorial shocks at the household level.[4] Therefore risk sharing mechanisms at lower aggregation levels can be identified only subject to more controls (demographic, geographic, economic, family-linked) than at higher aggregation levels.These difficulties may partly explain the relative scarcity of studies

[4]While the analysis of aggregate data may, under some hypotheses, also disclose relevant microeconomic dynamics, thus making the so called "ecological inference problem" less relevant, this turns out not to be the case in the study of risk-sharing with micro data.

on risksharing channels at the micro level in the last 20 years.[5]

This paper takes on the task of identifying and measuring household risksharing channels, and addresses the issues outlined above in several ways. First, by focusing on the household head's income, rather than on the household income, we mitigate endogeneity arising from the joint determination of consumption and hours of work (Dynarski and Gruber 1997) or other household-specific unobservable characteristics. Second, by testing regressions with prime-age household heads, we can avoid issues arising from life-cycle/permanent-income intertemporal choices, and focus on cross-sectional (i.e. risksharing) aspects. Third, we address the issue of measurement errors - which is particularly serious in survey microdata[6] - in the main predictor, by using IV estimation. Fourth, by adopting a specification based on household (head)'s earnings as a regressor (instead of aggregate income), we can more easily address the influence of taste shocks on the risksharing metric.[7]

Our reliance on SHIW data presents advantages which have been rarely exploited by the risksharing literature. Indeed, unlike the PSID - which until recently only collected consumption data on food and housing, and not every year - SHIW surveys collect data on all consumption items at a biannual frequency, providing us with a more complete view of total consumption expenditure. In addition, by using true panels of households over couples of consecutive waves and using first differences, we avoid the inefficiencies of unbalanced data plaguing most previous analyses. Furthermore, unlike CEX data, observations on consumption and incomes in SHIW are collected for coincident periods. As Dynarski and Gruber (1997) point out, the availability of US representative consumption data only in the PSID and CEX surveys has forced researchers to merge them with income

[5]To the best of our knowledge, only a few papers attempted to measure household risksharing channels. Three of them use a mere transposition of ASY, without an explicit derivation from a theoretical model and without controlling for demographic and economic characteristics of the household (Park and Shin (2010)[58], García-Escribano (2004)[30]) or tackling the issue of the endogeneity of the main regressor in the risksharing equations (Balli et al. (2016)[9]). Two others do not adopt an ASY-like methodology: Hayashi, Altonji and Kotlikoff (1996) only deals with two broad channels (risksharing between and within families – not households), does not quantify them (as it only tests for full risksharing) and estimates them separately, with a risk of overlaps. Dynarski and Gruber (1997) measures the extent of risksharing mechanisms in the US, but without embedding them in a unified, internally consistent and theoretically based framework; as a consequence it is not clear that the various mechanisms identified in the analysis are complementary and their measures do not overlap. None of these studies considers all 7 risk sharing channels analyzed in this paper.

[6]See Nelson (1994).

[7]Indeed, as shown by equation (3), household consumption (growth) depends on aggregate income (growth) and taste shock (growth), but not on idiosyncratic variables, such as household (head)'s income. See Sørensen and Yosha (1998).

data at a higher level of aggregation;[8] but the resulting averaging out of individual earnings variation has been detrimental for risksharing estimates, which are based precisely on those variations.[9]

In terms of strategy, our goal is descriptive, in the sense that we aim to establish stylized facts on the degree of household risksharing; but we accomplish that by means of a causal identification, in the sense that we estimate cross-sectional effects of heads earnings growth on consumption growth, controlling for the other intertemporal/life cycle effects, and strive to purge the earnings variation from endogenous components such as the change in labor supply. Using our framework, we obtain results that can shed light on household risksharing behavior under several dimensions. First, we find that Italian households were able to smooth at least 83% of shocks to household head's non-financial income in 2008-2010, a fraction rising to 87% in 2010-2012. Second, perhaps surprisingly, the most important smoothing mechanisms turns out to be self-insurance and within-household risksharing, which in 2010-2012 were able to absorb as much as 43% of the shock and 22% of the shock, respectively. Informal risk sharing and capital income risksharing play a remarkably negligible role, as their small economic significance is accompanied by statistical non-significance; this result is not totally surprising, given the often limited degree of financial depth uncovered in studies on Italian household portfolios as well as the well-known problem of under-reporting of financial assets in the surveys, with the SHIW not being an exception (D'Aurizio et al. 2006)[21]. While private risksharing buffers the big bulk of a shock, public risksharing only cushions about 17% of a shock in 2008-2010 and around 20% in 2010-2012, with taxes smoothing more than transfers. Interestingly, our study uncovers a smoothing role for substitution of goods with different durability, at least in the period 2008-2010. This is consistent with other findings in the literature (see, for example, Cerletti and Pijoan-Mas (2012)[17]), highlighting the role that this substitution plays in the transmission of income shocks to nondurable consumption.

The paper proceeds as follows. Section 2 develops the methodology to estimate channels of risk sharing within and between households. Section 3 presents the data. Section 4 illustrates the empirical implementation to quantify risksharing channels. Section 5 discusses the empirical results. Section 6 concludes.

[8] See for example Attanasio and Davis (1996).

[9] See Gervais and Klein (2010)[33], who show how Dynarski and Gruber's estimations of household risksharing are downward biased due to the CEX structure.

2. Methodology

2.1. Conceptual framework

This section provides the theoretical foundations of the risksharing mechanisms that help smooth household consumption by absorbing shocks to the household heads' earnings.

Consider a stochastic endowment economy, populated by J infinitely-lived households exhibiting time-separable Von Neumann-Morgenstern (VNM) expected utility functions over a single nondurable consumption good.[10] Uncertainty is represented by a state variable s_t which summarizes the history up to time t and the trajectory to infinity and can take on countably many values at any date t. The Pareto-optimal consumption allocations can be derived by solving the planning problem of maximizing the weighted sum of individual household utilities subject to the feasibility constraint that in each state of nature the sum of household consumptions cannot exceed the sum of all household endowments. Following standard treatments, such as Cochrane (1991), the first order conditions for all s_t look like:

$$(\rho^j)^t \lambda^j U_c(C_t^j, \delta_t^j) = \mu_t, j = 1, ..., J \tag{1}$$

where ρ^j is household $j's$ factor of time preference, λ^j its Pareto weight, δ^j its taste shifter and μ_t is the Lagrange multiplier associated with the feasibility constraint, divided by the probability of s_t. The importance of this condition is that it already shows how at the optimum, households' marginal utility is independent of individual household endowments, given aggregate consumption and the Pareto weights. This is true under the assumption, which is standard in the literature, that time and risk preferences[11] are homogeneous across the population. Dividing the expression (1) at two successive dates can get rid of the time-invariant Pareto weight, yielding:

$$\rho^j \frac{U_c(C_{t+1}^j, \delta_{t+1}^j)}{U_c(C_t^j, \delta_t^j)} = \frac{\mu_{t+1}}{\mu_t}, j = 1, ..., J. \tag{2}$$

The discounted growth of marginal utility is the same across households. The

[10] Generalization to a production economy (Cochrane 1991) and to a multicommodity environment (Hayashi, Altonji and Kotlikoff 1996) is immediate.

[11] A few recent papers (among others, Schulhofer-Wohl (2011)[68] and Asdrubali, Tedeschi and Ventura (2019)[4]) have argued that heterogeneity in risk aversion may affect risk sharing estimations at the household level

consequences for household consumption growth can be illustrated specifying a CRRA utility function. In this case,

$$\log\left(\frac{C^j_{t+1}}{C^j_t}\right) = \frac{1}{\gamma^j}\left[\log\left(\frac{\mu_{t+1}}{\mu_t}\right) - \log\left(\frac{b^j_{t+1}}{b^j_t}\right) - \log\left(\rho^j\right)\right] \tag{3}$$

where γ^j is household $j's$ risk aversion coefficient and b^j_t is a multiplicative taste shock.[12] The planner's optimal risksharing solution thus prescribes that household consumption growth - net of preference shocks $[\log\left(b^j_{t+1}/b^j_t\right), \gamma^j, \rho^j]$ - must only depend on aggregate consumption growth represented by $\log\left(\mu_{t+1}/\mu_t\right)$, and must be independent of idiosyncratic household variables, including household (head)'s endowments.[13] Therefore, optimal risk-sharing implies that idiosyncratic shocks are all smoothed out and pooled in the aggregate, regardless of their stochastic process – that is, whether they are transitory or permanent, anticipated or unanticipated, etc.

Equation 3 constitutes the theoretical ground for all the consumption insurance tests which, since the seminal paper by Cochrane (1991), Mace (1991) and Townsend (1994), have been proposed in the literature, and which in a cross sectional setup consist in estimating a simple equation of the form:

$$\log\left(\frac{C^j_{t+1}}{C^j_t}\right) = \alpha + \beta x^j_{t+1} + u^j_{t+1} \tag{4}$$

where x^j_{t+1} is any individual specific variable which, since the contribution by Mace (1991), has normally been represented by an income related variable. As mentioned above, perfect insurance implies $\beta = 0$ in equation (4).

Moreover, since the contributions by ASY, Dynarski and Gruber (1997), and many others, the magnitude of β has been interpreted as the extent of departure from a situation of perfect insurance, with respect to the shock variable used in equation (4).

[12] To relate to the previous notation, observe that $\delta^j_t = [b^j_t \ \gamma^j]$.

[13] As shown by Cochrane (1991) this result can be generalized to other utility functions, even non-separable in leisure. More precisely, the utility function may assume any form (provided it is concave and monotonic), may not be time-separable, may not be a VNM function; in addition, arbitrary shocks may be included.

2.2. Channels of risksharing

The optimal planner solution can be decentralized and implemented through several smoothing mechanisms, depending on the financial and institutional structure of the economy. All these mechanisms provide, in full or in part, a buffer to idiosyncratic shocks, so as to induce a cross-sectional pattern of consumption which is smoother than income. For example, the existence of complete markets of Arrow-Debreu contingent claims (Arrow, 1964), or a specific set of securities (Duffie and Huang, 1985[27]), allows households to implement the full risksharing solution through asset diversification. Similarly, the existence of appropriate government tax/transfers mechanisms allows insuring, at least partially, households whose head's non-financial income has been hit by a negative shock, drawing from incomes hit by a positive shock. In addition, risksharing can be provided through self insurance, that is by asset accumulation (saving) and depletion (dissaving) through lending and borrowing.[14] To be sure, in this case risk sharing (in the sense of cross-sectional smoothing) is a by-product of intertemporal consumption optimization. In fact, in a bonds-only economy, where this intertemporal reallocation is the only feasible risk sharing mechanism, the optimal risk sharing allocation could still be attained, provided all idiosyncratic shocks are temporary (Baxter and Crucini, 1995[10]; Levine and Zame, 2002[49]; Willen, 1999[72]). A peculiar type of (dis-)saving is represented by the timely purchase of durables, which may constitute an additional channel of self insurance (see Cerletti and Pijoan-Mas (2012)[17]). Furthermore, informal risksharing can take place, especially in developing economies, through private gifts, transfers, aid or services. Finally, risksharing can be attained if the household head's income can be pooled with the income of other household members, so as to attain a smoother consumption at the household level.

Unlike some previous work, we maintain a very general setup by not assuming any particular financial or institutional structure for our economy, and let the empirical analysis reveal whether the extent of risksharing in our sample is full, partial or nil, and through which channels it is attained. We also refrain from modelling endogenous frictions leading to market imperfections (such as limited commitment or enforceability). In fact, the stylized facts and statistical linkages that we uncover will help shed some light precisely on the most appropriate financial and institutional structure or endogenous market imperfections characterizing the Italian economy in the period under exam.

[14] Self insurance through (dis-)saving aimed at buffering idiosyncratic risk – i.e., precautionary (dis-)saving – should be distinguished from intertemporal trade during the life cycle.

2.3. Empirical Model of Risk Sharing Channels

Equation (3) implies that if risk is fully shared through market or non-market institutions, household consumption growth should not respond to idiosyncratic shocks to household head's earnings growth, irrespective of the data generating process governing the latter.

As in Attanasio and Davis (1996), Park and Shin (2010) and Dynarski and Gruber (1997), we operationalize this notion by analyzing the regression coefficient of household nondurable consumption growth on the growth in household head's earnings:

$$\log\left(\frac{C^j_{t+1}}{C^j_t}\right) = \alpha + \beta \log\left(\frac{W^j_{t+1}}{W^j_t}\right) + u^j_{t+1} \tag{5}$$

where the disturbance may include a measurement error. Here the intercept captures the effect on consumption variation of aggregate variables, notably aggregate consumption or aggregate income.[15] It is useful to keep in mind that no risksharing implies that the β coefficient be equal to one (i.e. that any idiosyncratic shock is fully transmitted to consumption). On the other hand, if insurance markets and institutions are perfect, then this coefficient should be zero.[16] Intermediate values can then be interpreted as measuring the degree of risksharing. As pointed out by Dynarski and Gruber (1997) and Fafchamps (2011), the β coefficient captures the extent to which the household manages to smooth consumption in the face of shocks to the head's earnings. In other words,

$$1 - \beta = 1 - \frac{\mathrm{Cov}(\Delta log C^j, \Delta log W^j)}{\mathrm{Var}(\Delta log W^j)} \tag{6}$$

is an appropriate measure of the extent of household consumption smoothing via risksharing. The choice of household head's earnings as the shock variable, instead of the more usual household earnings, presents several advantages: it allows more consistency between the regessor and control covariates, reduces endogeneity issues and allows treating other household members' earnings as risk sharing channels.

The main contribution of the risksharing channels methodology consists in a de-

[15] In some specifications of the risksharing model, the term $\log(\mu_{t+1}/\mu_t)$ is specified as aggregate consumption growth (e.g. Mace 1991), and at times it is added as a regressor to the income growth measure. However, in a cross-section the aggregate term is replaced by the constant term.

[16] See Blundell, Pistaferri, and Preston (2008).

composition of the overall risksharing measure $1-\beta$ into the smoothing contributions of the different risksharing mechanisms mentioned above. For every household, we reconstruct the following variables:

- Head's Earnings (household head's wage income + self employed income + pensions): W
- Household Earnings (household members' wage income + self employed income + pensions): H
- Household Income (i.e., Household Earnings + capital income from real estate and financial assets + end-of-service gratuities): K
- Household Gross Income (Household Income + Public transfers received[17]): G
- Household Disposable Income (Household Gross Income - taxes paid[18]): T
- Household Total Disposable Income (Household Disposable Income + inter-and-intra-generational (private) transfers[19]): I
- Household Total Consumption (Household Total Disposable Income - Household Savings): E
- Household Non-durable Consumption: (Household Total Consumption Expenditure - Household Durable Consumption Expenditure): C

The econometric model is based on the idea that, if two successive income measures do not co-move, the smoothing mechanism represented by their difference is at work. For instance, to the extent that H and K do not co-move, it means that financial income flows have provided a smoothing effect. By the same token, to the extent that G and T do not co-move, it means that taxes have provided further smoothing. Consider the following identity for every household j:

$$W^j = \frac{W^j}{H^j}\frac{H^j}{K^j}\frac{K^j}{G^j}\frac{G^j}{T^j}\frac{T^j}{I^j}\frac{I^j}{E^j}\frac{E^j}{C^j}C^j. \tag{7}$$

[17]They include unemployment benefits, mobility allowances and various forms of social assistance payments (such as attendance and disability living allowance) which are directly surveyed in the SHIW plus family allowances (ANF) that are simulated (see Appendix A).

[18]A description of the imputation process of gross incomes is given in Appendix A.

[19]These include gifts and transfers from (non-cohabitant) relatives and friends and maintenance payments. Apart from the latter item this variable is conceivable as adding to T informal transfers between households.

After taking logs and first differences,

$$\Delta w^j = (\Delta w^j - \Delta h^j) + (\Delta h^j - \Delta k^j) + ... + (\Delta i^j - \Delta e^j) + (\Delta e^j - \Delta c^j) + \Delta c^j \quad (8)$$

where lowercase letters indicate logs.
Multiplying both sides by Δw^j and taking expectations, and then dividing through by $\text{Var}(\Delta w^j)$, we obtain a constrained sum of simple regression coefficients:

$$1 = \frac{\text{Cov}(\Delta w^j, \Delta w^j - \Delta h^j)}{\text{Var}(\Delta w^j)} + ... + \frac{\text{Cov}(\Delta w^j, \Delta e^j - \Delta c^j)}{\text{Var}(\Delta w^j)} + \frac{\text{Cov}(\Delta w^j, \Delta c^j)}{\text{Var}(\Delta w^j)} \quad (9)$$

or

$$1 - \beta = \beta_H + \beta_K + \beta_G + \beta_T + \beta_I + \beta_S + \beta_D. \quad (10)$$

The overall risksharing measure $1 - \beta$ is decomposed into 7 coefficients. The first coefficient on the RHS - β_H - represents the slope in a regression of $\Delta w^j - \Delta h^j$ on Δw^j. If a unit positive shock hits the head's earnings, Δw^j will increase by 1 unit; if household earnings Δh^j also increase by 1 unit – that is, if the shock has passed through to household earnings – then $\beta_H = 0$, indicating that no intra-household risk sharing has taken place, whereas if household earnings Δh^j stay put – that is, if the shock has not passed through to household earnings – then $\beta_H = 1$, indicating that full intra-household risk sharing has taken place. In general, β_H measures the percentage of head earnings changes that is smoothed within the household. By the same token, the second coefficient - β_K - measures the percentage of earnings changes that is further smoothed by capital incomes; the third and the fourth - β_G - and - β_T - measure the further smoothing provided by transfers and taxes, respectively; the fifth - β_I - represents the share that is further smoothed by informal transfers between households; then β_S is the amount of smoothing provided by saving and dis-saving. Finally, β_D represents possible smoothing to non-durable consumption provided by a variation in the timing of durable expenditures.

The next sections will detail the econometric methodology we use to gauge these coefficients as correctly as possible, addressing the estimation issues arising from our setup.

3. Data

Our analysis of household risk sharing uses the panel component of biannual data from the Bank of Italy's SHIW, for the periods 2008-2010 and 2010-2012. The main objective of the survey is to study the economic behavior of Italian house-

holds, defined as groups of individuals related by blood, marriage or adoption and sharing the same dwelling. The sample size comprises about 8000 households per year selected from population registers and the survey contains a sizable panel component which allows econometricians to estimate target variables' processes and transitions. The head of the household is the person responsible for the household finance, he/she is the main earner in the family and is labelled with an order number equal to one (NORD=1). The longitudinal component allows us to potentially follow over 50% of the households in two spells of twice-repeated observations.[20] Data collection is entrusted to a specialized company using professional interviewers and CAPI methodology. The survey collects the following information:

- characteristics of the household and of its members (number of income earners, gender, age, education, job status, industry sector, and characteristics of the dwelling);
- income (wage and salaries, income from self-employment, pensions and other financial transfers, income from financial assets and real estate);
- consumption and saving (food consumption, other nondurables, expenses for housing, health, insurance, spending on durable goods, and household saving);
- wealth in terms of real estate, financial assets, liabilities;
- special modules such as capital gains, inheritance, risk aversion, unpaid work, economic mobility, social capital, tax evasion, financial literacy.

From these items, we reconstructed households' balance sheets, income statements, statements of cash flows and consolidated financial statements, along the lines suggested by Samphantharak and Townsend (2006)[65]. Furthermore, since our data do not allow constructing household members' pre-tax incomes, we proceeded to reconstruct pre-tax incomes using an imputation methodology - through *EGaLiTe* tax-benefit microsimulation model[21] - to recover gross figures for head's earnings and disentangle household allowances from disposable income.
Our variables are measured as reported in section 2.3, and are all in nominal

[20] In the panel component, the sampling procedure is determined in two stages: (i) selection of municipalities (among those sampled in the previous survey); (ii) selection of households to re-interview. This implies that there is a fixed component in the panel (for instance, households interviewed 10 times between 1994 and 2012, or 4 times from 2006 to 2012) and a new component every survey (for instance, households interviewed only in 2012).

[21] See Appendix A.

terms.
Table 1 shows some descriptive statistics summarizing the distribution of the key model variables for the two subperiods. In particular, the first biennium of the crisis (2008-2010) is characterized by a very wide distribution for (Δw^j), with mean equal to 2% and -2.9% in the first and in the second period, respectively. However, in the same spells the growth of nominal nondurable consumption (Δc^j) is higher for the average household (5.4% and 8.4%, respectively), while a contraction in durable consumption is also recorded, in the first of our two periods. This simple comparison of consumption and income growth is suggestive of a rather large decoupling of income and consumption dynamics, which we will indeed find in the regressions' results.[22]

Table 1: Descriptive statistics of the main variables involved in the models estimation

	Years	**Mean**	**Std. Dev.**
Earnings growth (head) (Δw^j)	2008-10	2.0%	32%
	2010-12	-2.9%	38%
Earnings plus pensions growth (household) (Δh^j)	2008-10	3.6%	36%
	2010-12	-2.3%	38%
Income growth (household, incl. capital) (Δk^j)	2008-10	4.6%	39%
	2010-12	-1.7%	40%
Gross income growth (hh, incl. public transfers) (Δg^j)	2008-10	4.8%	37%
	2010-12	-0.2%	36%
Disposable income growth (hh, after-tax) (Δt^j)	2008-10	4.1%	34%
	2010-12	-0.5%	33%
Total disp. income growth (hh, incl. priv. transfers) (Δi^j)	2008-10	3.8%	34%
	2010-12	-0.2%	34%
Total consumption growth (hh, excl. saving) (Δe^j)	2008-10	5.4%	44%
	2010-12	7.7%	42%
Non-durable consumption growth (hh, excl. durables) (Δc^j)	2008-10	8.4%	29%
	2010-12	7.9%	30%

Notes: Current prices. $N_{2008-10} = 1,163$; $N_{2010-12} = 1,138$ Source: Bank of Italy SHIW 2008-10-12. Panel components for consecutive waves. Selection of prime-age households.

[22]For earlier years, Padula (2004)[56] and Jappelli and Pistaferri (2006)[41], 2010[42],2011[43]) also employ the SHIW data to study the joint dynamics of household income and consumption.

4. Estimation

At the empirical level, our baseline estimation model implementing the identity (10) above is the following cross-sectional system of linear equations:

$$\begin{array}{ll}
\Delta w^j - \Delta h^j & = \nu_H + \beta_H \Delta w^j + \varepsilon_H^j \\
\Delta h^j - \Delta k^j & = \nu_K + \beta_K \Delta w^j + \varepsilon_K^j \\
\Delta k^j - \Delta g^j & = \nu_G + \beta_G \Delta w^j + \varepsilon_G^j \\
\Delta g^j - \Delta t^j & = \nu_T + \beta_T \Delta w^j + \varepsilon_T^j \\
\Delta t^j - \Delta i^j & = \nu_I + \beta_I \Delta w^j + \varepsilon_I^j \\
\Delta i^j - \Delta e^j & = \nu_S + \beta_S \Delta w^j + \varepsilon_S^j \\
\Delta e^j - \Delta c^j & = \nu_D + \beta_D \Delta w^j + \varepsilon_D^j
\end{array} \tag{11}$$

where the $\nu_.$ intercepts capture the effect on the dependent variables of aggregate changes. The equation system accounts for the likely cross-equation error correlations, in view of the symmetric structure of our problem. Before estimating the system in 11 we separately estimate the following single equation which, in view of equation (10), is linearly dependent on the others:

$$\Delta c^j = \nu + \beta \Delta w^j + \varepsilon^j. \tag{12}$$

Note that the sum of the $\beta_.$ coefficients from equations (11) equals $1 - \beta$, that is the coefficient of equation (12). Hence, to estimate the overall degree of risksharing we may as well estimate this coefficient.
Starting from this baseline estimation, we construct augmented estimations to better pinpoint the values of the coefficients in (10) by addressing potential econometric issues plaguing (11) and (12), as described below.

Measurement errors, preference shocks, omitted variables bias, and endogeneity. Because of the survey characteristics (e.g., response bias), and the imputation exercise we carried out to recover gross incomes, our data - and particularly head's earnings - may be subject to measurement errors. This problem is only partially mitigated by the accurate surveying methodology applied in sampling SHIW households and by our use of changes in variables. As is well known, such (classical) measurement error boils down to an endogeneity bias stemming from the head's earnings variable. Addressing this bias also corrects the inefficiency associated to the coefficient's standard error.[23]

[23] As the gross incomes are - almost entirely - deterministic functions of net incomes, we do not adjust the head's earnings standard errors for generated regressor bias.

A second source of endogeneity bias is the potential correlation between the head's earnings growth measure and the household preference variation (taste shifter, risk aversion coefficient and rate of time preference) as well as the leisure measure in case of non-separability of the utility function (see Cochrane 1991). The former problem is partially addressed by adding demographic and household characteristics; the latter problem is addressed in part by using household head's earnings as a regressor (as opposed to household income), in part by including a measure of aggregate leisure, which in our cross-sections amounts to adding an intercept in the regressions.
A third source of endogeneity bias is potential omitted variables bias, to the extent that the explanatory variables indicated by consumption theory and econometric practice (which we have included) capture some effect of other variables lumped in the error term.
In our final specification, we address all these endogeneity problems by adopting an indirect approach: rather than instrumenting Δw, we use information on the variation of head's hours worked (Δhrs) – and other predictors of the head's labor income rate of variation, such as the experience, the level of education and a dummy indicating public sector - to filter the variable from the average effect of changing labor supply. Since Δhrs are recovered by self-reported average weekly worked hours and months spent in employment, they may well suffer from rounding and mis-reporting. This makes a direct use of Δhrs less attractive in the ratio $\Delta w/\Delta hrs$ to calculate the wage variation component ($\Delta wage$) of head's earnings. In fact, since with survey data both Δw and Δhrs may suffer from non-sampling errors, the ratio is likely to suffer from the so-called "division bias." A viable alternative is a regression approach which, however, must take into account the likely residual endogeneity of Δhrs itself due to the (correlated) measurement errors between Δw and Δhrs.[24] Standard OLS-based inference will likely yield biased estimates of the average hours elasticity, but with the availability of valid instrument(s) for Δhrs we can test for its exogeneity and, in case of a rejection of the null, we can correct the bias through IV estimation.

Therefore, as a first step of our identification strategy, we estimate the follow-

[24]The bulk of the correlation between the measurement error in the original variable and the instrument will likely disappear with the time differencing we adopt. For example, if a household head systematically underreports her head's earnings, the effect will wash out when taking first differences (see Dynarski and Gruber 1997).

ing model through a two-stage least squares regression:

$$\begin{aligned} \Delta w^j &= \beta_{w,0} + \beta_{w,1}\Delta hrs^j + \boldsymbol{\beta'_{w,2}}\boldsymbol{x^j} + u_1^j \\ \Delta hrs^j &= \beta_{h,0} + \boldsymbol{\beta'_{h,1}}\boldsymbol{z^j} + \boldsymbol{\beta'_{h,2}}\boldsymbol{x^j} + u_2^j \end{aligned} \tag{13}$$

We use $\widehat{u}_1^j$ – the estimates of u_1^j – as a valid measure for the wage shock to the head's earnings change. This variable, more credibly exogenous with respect to Δc, is then used as the main regressor in place of Δw in the risk sharing regression:

$$\Delta c^j = \nu + \beta\widehat{u}_1^j + \varepsilon^j \tag{14}$$

and in the related equation system:

$$\begin{aligned} \widehat{u}_1^j - \Delta h^j &= \nu_H + \beta_H\widehat{u}_1^j + \varepsilon_H^j \\ \Delta h^j - \Delta k^j &= \nu_K + \beta_K\widehat{u}_1^j + \varepsilon_K^j \\ &..... \\ \Delta e^j - \Delta c^j &= \nu_D + \beta_D\widehat{u}_1^j + \varepsilon_D^j \end{aligned} \tag{15}$$

Note that the use of these instruments can address simultaneously all the sources of endogeneity mentioned above.

Household characteristics and life-cycle behavior. Household-level data are subject to numerous influences, which are typically controlled for by using an additional set of demographic and economic variables, so that equation (14) above becomes:

$$\Delta c^j = \nu + \beta\widehat{u}_1^j + \gamma'\mathbf{x}^j + \varepsilon^j \tag{16}$$

where $\mathbf{x}^j$ is a vector including standard controls, as suggested in most research on the topic.[25]
Consequently, the equation system in (15) is also estimated using additional co-

[25]See Mace (1991) or Dynarski and Gruber (1997).

variates in each equation:

$$\begin{array}{l} \widehat{u}_1^j - \Delta h^j \ = \nu_H + \beta_H \widehat{u}_1^j + \gamma_H' \mathbf{x}^j + \varepsilon_H^j \\ \Delta h^j - \Delta k^j \ = \nu_K + \beta_K \widehat{u}_1^j + \gamma_K' \mathbf{x}^j + \varepsilon_K^j \\ ..... \\ \Delta e^j - \Delta c^j \ = \nu_D + \beta_D \widehat{u}_1^j + \gamma_D' \mathbf{x}^j + \varepsilon_D^j \end{array} \tag{17}$$

Two of these controls are of particular interest: a measure of household's net wealth, and the head's expectation for his/her future replacement rate achievable with the public pension, both alone and interacted with the head's wage shock ($\widehat{u}_1^j$). Not only will these variables control for size effects in consumption but, more importantly, they will also ensure that influences on consumption stemming from life-cycle behavior are mitigated.[26] Additional covariates include changes in household components, possibly controlling for the dynamics in households' economies of scale and for taste shocks due to changes in the household structure, the initial level in the number of earners, head's (quadratic in) age, the presence of children at different stages of the life cycle, head's sector of employment, possible early retirement or unemployment in the arrival year, house ownership as opposed to tenancy, and geographical area.

Note that the $\beta_{\cdot}$ coefficients in regressions (16) and (17) maintain the property of summing up to unity, as in equations (12) and (11). In fact, it is straightforward to show that – since the set of controls is homogeneous across equations – the $\beta_{\cdot}$'s sum corresponds to the sum of the $\beta_{\cdot}$'s in simple regressions where each variable is replaced by the residual of its projection onto the control vector $\mathbf{x}$. In other words, we are recasting the variance decomposition in (9) in terms of the "purged" variables.

The models we present are estimated on a restricted sample of households with prime-age household heads (aged 30-55); moreover, we drop households whose head changes in the two year spell; this also mitigates concerns related to life-cycle choices, such as moving from student to worker status, or deciding to retire.[27]

Heteroskedasticity. Though heteroskedasticity problems that are common in cross-sectional data are slightly mitigated by our formulation in terms of percentage variations, standard tests still reveal the presence of this problem both in the equation system 11 and in equation 12. To improve inference we estimate the system by a maximum-likelihood conditional mixed-process estimator (CMP),

[26] Controls for demographic and household characteristics also contribute to minimize the effect of life-cycle behavior.

[27] Still there is the chance of early retirement and in few cases it is recorded in our estimation data.

which produces heteroscedasticity-consistent standard errors.

Nonlinearities. An important source of potential bias might be nonlinearities in the determination of consumption, such as the existence of liquidity constraints. As Dynarski and Gruber (1997) point out, consumption changes may not respond to small and frequent variations in the head's earnings, but they may well suffer from large, low-frequency changes (such as an unemployment spell). Hence, our use of variation in hours worked to purge head's labor income may reveal the existence of such liquidity constrained (or simply rule-of-thumb, myopic) behavior. We also try to mitigate issues related to liquidity constraints by focusing on household heads with positive income in the start year.

Sample selection bias. We need to ensure that the probability of a household-year being included in the sample only depends on the exogenous variables and the permanent component of the error term.[28] The response bias and sample selection bias stemming from the administration of the survey have been thoroughly addressed in several papers by the Bank of Italy, which provide the weights necessary to recalibrate the sample variables to make them representative of population variables.

Attrition. We address issues of attrition - arising from the unavoidable changes of the sample over time (due to births, deaths, marriages, divorces, new sample units arriving, old sample units dropping) - by limiting our scope to a true panel of households; thus, our cross-sections contain the same households followed across the entire sample period. As for changes within the same household, we control for the initial number and variation of components. Furthermore, we exclude households whose head changed over time.

Outliers. To deal with influential outliers and high leverage data points, particularly relevant in the case of the head's income variation (Δw^j), we trim observations from the tails for which the generic value x is such that $x < Q(25) - 3IQR$ *or* $x > Q(75) + 3IQR$, where IQR (Interquartile Range) is equal to the difference between the 75^{th} and the 25^{th} percentiles. More precisely, we remove 147 and 188 observations in the first and in the second spell, respectively. This leaves us with an estimation sample of, respectively, 1137 and 1101 observations in the first and in the second spell.

[28] As pointed out by Hayashi, Altonji and Kotlikoff (1996), this assumption is made, often implicitly, in virtually all panel data studies on consumption.

5. Results

This section illustrates the results of the implementation of our econometric model, as laid out in section 4. Table 2 shows the IV estimation results of (13) for both the 2008-2010 and the 2010-2012 spells, under the assumption of endogeneity of both Δhrs and – as standard in the labor economics literature – individual's education (Educ).

As exclusion restrictions (z^j) we use a dummy indicating "marked worsening" in health status compared to two years earlier,[29] the head's father education, the head's mother education. Since we have three exclusion restrictions for two potentially endogenous regressors, the structural parameters are - technically - over-identified and we can test the instruments' orthogonality. In both periods the endogeneity tests clearly reject the null hypothesis of regressor exogeneity. The F-test statistic on excluded instruments is well above the conventional threshold of 10 in both first stage equations in both periods, thus ruling out problems of weakness; finally, the Hansen J test does not allow rejecting the null of instruments' orthogonality.[30]

We are thus able to make correct inferences on the residual u_1^j (wage shock) – whose distributions are reported in Table 3 – and we can estimate equations (14) and (16) with robust OLS and the systems (15) and (17) with CMP-SUR, by using head's wage shock as the main predictor in all equations.

5.1. Overall risksharing

Table 4 illustrates the results for 2008-2010 and 2010-2012 of our baseline specification (12) as in the ASY (1996) original set up (columns 1-2), the specification based on wage shocks without additional controls (14) (columns 3-4), and the full specification (16)(columns 5-6) where, to improve on our estimates of β along the lines illustrated in section 4, we augment the risksharing regression with statistical controls, whose estimated coefficients are not reported for the sake of space, with the exception of the interaction between the expectation for the future replacement rate achievable with the public pension (*reprate*) and household head's wage shocks (i.e. $\widehat{u}_1 * reprate$). Our preferred estimation (Full model OLS in columns 5-6) shows that Italian households were able to smooth at least 83% of a shock to

[29] We build this indicator by comparing contemporaneous and lagged scores for self-reported health status (ranging from 1 = very good to 5 = very bad). This dummy is set equal to one if the head reports a score greater than or equal to 4 while reported a score less than or equal to 2 in the previous survey wave. As expected this indicator shows a negative and significant explanatory power - in the IV first stage - on the variation of head's hours worked.

[30] The first spell equation is overidentified, while for the second spell, due to lack of instruments in excess, the equation is exactly identified and the Hansen test can not be performed.

the household head's earnings changes in 2008-2010, a fraction rising to 87% in 2010-2012. While the above mentioned interaction is not statistically significant at standard levels. The evidence that the β estimated coefficients are not very different across the three specifications suggests that our basic econometric model is quite robust. However, we advocate the use of our augmented model as we believe it yields more reliable results, under general conditions.
Despite slight differences between the various specifications, the qualitative conclusions carry over across all estimations: household risksharing in Italy can smooth at least three quarters of a shock to the head's earnings. This result is consistent with most studies on risksharing in Italy, both at the micro and macro level: for example, at the macro level, Scorcu (1997)[66] and Cellini and Scorcu (2002)[16] for 1971-1993, Pellegrini (1997)[59] and Dedola, Usai and Vannini (1999)[25] for 1983-1992, Mélitz and Zumer (1999)[53] for 1984-1992, Gardini, Cavaliere and Fanelli (2005)[31] for 1960-1995, and Cavaliere, Fanelli and Gardini (2006)[15] for 1960-2001 all find a notable and significant degree of smoothing among Italian regions; at the micro level Krueger and Perri (2011)[47] for 1987-2008 reach results on the overall degree of risksharing which are quite close to ours.

5.2. Risksharing channels

How this overall smoothing breaks down across the seven channels of risksharing we have identified is shown in Table 5, which compares the results for 2008-2010 and 2010-2012 of our baseline system equation specification (11) (columns 1-2), the specification based on wage shocks without additional controls (15) (columns 3-4), and the full specification (17) (columns 5-6) where, as mentioned above, we improve on our estimates of the β_s by augmenting the risksharing regression with statistical controls. The table reveals that self-insurance (β_S) is the most important smoothing mechanism, which is able to absorb 35% of wage shocks in 2008-2010, and 43% in 2010-2012. Here, the interaction ($\widehat{u}_1 * reprate$) should disentangle the role of life-cycle/pension motives from precautionary savings. Interestingly enough, the elasticity for the interaction is negative and significant (albeit only in the second spell), revealing a lower shock absorption from savings/dis-savings for those households whose head has a higher-than-average expectation for her replacement rate. This is likely evidence that a higher expected (permanent) income in the old age might lower precautionary savings, and thus attenuate the relevance of this smoothing channel.
At a macro level Dedola, Usai and Vannini (1999)[25] find somewhat lower but still notable results for credit market insurance in Italy in 1983-1992.
A form of self insurance through the timing of consumption, the adjustment of durable expenditure, seems to achieve a sizable (about 11%) smoothing effect in

the first time spell, while it is not statistically significant in the second. A similar effect has been found by Gervais and Klein (2010) in their OLS estimation of CEX data over the 1980-2002 period. Even more to the point, Kruger and Perri (2011) find that in SHIW data from 1987 to 2008 changes in durables are significantly associated with changes in income but are much smaller than the income changes. Also previous findings showing a substitution between durable and nondurable expenditures in periods of crisis (see, among others, McKenzie 2006[52]) are consistent with our results.

Within-household risksharing (β_H) is also quite large, as it cushions 19% of the shocks in 2008-2010, and over 22% in 2010-2012. This result is in contrast with the findings on the PSID in Hayashi, Altonji and Kotlikoff (1996)[37] and on both the PSID and the CEX in Dynarski and Gruber (1997)[28] - who find non-significant effects of non-head income - but parallels the results on the PSID in García-Escribano (2004)[30] - who uses an ASY (1996)-style measure of smoothing. Our result reflects Mocetti, Olivieri and Viviano (2011)'s[54] finding that the effects of the economic crisis on the Italian labour market have been partly absorbed within the households, thanks to i) the greater diffusion of plurinuclear households (the more adults present the lower the risk of joblessness) and ii) the greater propensity to link household formation to employment status. Capital income risksharing (β_K) plays an extremely limited role, as it is neither clearly positive, nor statistically significant. This result, while unknown to the previous literature, is not really surprising, given the often limited degree of financial depth uncovered in studies on Italian household portfolios as well as the well-known problem of under-reporting of financial assets in household surveys, SHIW not being an exception (D'Aurizio et al. 2006).[31] Moreover, our result is consistent with Massa and Simonov (2006)'s[51] finding that Swedish investors do not hedge but invest in stocks closely related to their nonfinancial income. Massa and Simonov document that this is directly related to "familiarity", that is, the tilt to invest in stocks that are geographically and professionally close to the investor or that have been held for a long period.

To these formal channels we can add the informal one - consisting in private transfers between households (β_I) - that, however, is not particularly sizeable in either spell of the recession and does not exhibit, on average, statistical significance. While these private risksharing channels buffer about two thirds of a shock in both spells, public risksharing only cushions about 17% of a shock in the first spell and around 20% in the second spell, with taxes smoothing more than transfers. However, it is worth noting that pensions are included in the head's earnings and the tax channel excludes risksharing through tax evasion -

[31] See Guiso and Jappelli (2000)[35].

a phenomenon which is particularly widespread in Italy and which we could not take into account in the reconstruction of income figures (see footnote 20).[32] At a macro level, in Italy Decressin (2002) finds similar results and Dedola, Usai and Vannini (1999) even higher coefficients for 1983-1992, whereas Mélitz and Zumer (1999) find the public risksharing channel to be insignificant for 1984-1992.

By comparing results in estimations with or without instruments (employed as described in section 4), we observe that in the equations on the overall degree of risksharing the β coefficient drops by about 20%; this is an indication that previous studies that did not strictly control for endogeneity or nonlinearities might have understated the total degree of risksharing. In particular, the increase in risksharing when head's earnings change is substituted with the prediction for head's wage shocks suggests that hours worked are likely a non-negligible source of departure from optimal consumption behavior. The comparison of the systems of risksharing channels provides a deeper insight on which mechanisms underlie the increase in risksharing when hours worked are controlled for; not surprisingly, we find intra-household income, savings and durables, that is the channels which are most dependent on the number of hours worked by the household head. These results appear to vindicate our choice of substituting head's earnings with wage shocks as the main predictor. Also the use of a set of controls does make a difference both in the channels' estimates and in their precision (see e.g. the β coefficients for intra-household risksharing in 2010-2012, for public taxes/transfers and for durables), again corroborating our modelling choice.

6. Conclusions

The literature has long raised the question of the economic mechanisms underlying the high degree of risksharing often found in micro data. Indeed, while a stream of the literature has always implicitly assumed that risksharing is carried out solely through portfolio diversification, the emergence of the channels literature has shifted the focus towards the diversity of mechanisms implementing (or preventing) the planner allocation. This paper sheds a light on such risksharing mechanisms operating across households. Hence, for example, our results provide a set of possible mechanisms underlying Krueger and Perri (2011)'s findings in SHIW data of a low correlation between labor income and consumption; even more

[32] The biggest discrepancy between our measure of tax risksharing and the actual tax risksharing including tax evasion risksharing arises in the case the interviewed household head lies on the growth of her gross income (to the tax authorities) but not on the growth of her net income (to SHIW interviewers). In this case the tax risksharing that we measure is presumably smaller than the tax risksharing illicitly attained by the household.

importantly, our methodology can be carried over to other settings to investigate household risksharing in countries where adequate income and consumption data on households are available.

Our finding of a preponderant role played by intra-household risksharing bears important consequences also for microeconomic modelling. Indeed, as pointed out by Attanasio and Lechene (2002)[7], the pooling of monetary resources is a necessary condition of the unitary model of household behavior. A high degree of intra-household risksharing also brings about macroeconomic consequences: findings for the US by Halla and Scharler (2012)[36] show that marriages do not just improve the allocation of risk at the individual level, but also have implications for the allocation of risk at the more aggregated state level. Finally, in terms of macro modelling, our results show that the bulk of risksharing takes place either within the household or through self-insurance, that is by using the simplest financial tools available to borrow or lend. This suggests that, in modeling consumption in economies like Italy, a bonds-only financial structure might be enough to support the basic patterns of consumption. Further research should be devoted to assess between-households heterogeneity in terms of risksharing capacity along a number of dimensions such as the position of households in the wealth distribution, access to credit, preferences heterogeneity, and more.

Table 2: IV estimation of head's earnings variation and prediction of the wage shock

Dep. variable: Δw	**(2008-10)**	**(2010-12)**
Δhrs	0.316***	0.249***
	(0.0615)	(0.0230)
Education	-0.027	0.061**
	(0.0222)	(0.0245)
Experience	-0.020***	0.010
	(0.0063)	(0.0069)
$Experience^2$	0.000***	-0.000
	(0.0001)	(0.0001)
Public sec.	0.060**	0.021
	(0.0271)	(0.0333)
constant	0.374***	-0.475***
	(0.1452)	(0.1736)
R-squared	0.062	0.122
N. of cases	1,012	996
F-test of excluded variables	47.83/42.45	120.27
Hansen's J p-value	0.271	$exact.\ identified$
Endogeneity test	0.073	0.025

Notes: IV estimation of model (13) and prediction of $\widehat{u}_1^j$.
Instrumented: Δhrs and *Education* (2008-10); *Education* (2010-12).
Included instruments: *Experience*, $Experience^2$, *Public sec.*.
Excluded instruments: Health conditions marked worsening (dummy), head's father education, head's mother education (2008-10); head's father education (2010-12).
Source: Bank of Italy SHIW 2008-10-12. Panel components for consecutive waves. Selection of prime-age households.

Table 3: Household head's wage shock ($\widehat{u}_1^j$) distributions

(2008-10)					(2010-12)				
Percentiles		Smallest			Percentiles		Smallest		
1%	-0.804	-1.079			1%	-0.897	-1.261		
5%	-0.577	-0.978			5%	-0.562	-3.181		
10%	-0.350	-0.966	(Obs	1,142)	10%	-0.415	-1.124	(Obs	1,107)
25%	-0.137	-0.933			25%	-0.149	-1.100		
50%	**0.018**	**Mean**	**-0.006**		**50%**	**0.0116**	**Mean**	**0.002**	
		Largest	**(Std.Dev.**	**0.291)**			Largest	**(Std.Dev.**	**0.326)**
75%	0.143	0.983			75%	0.184	1.154		
90%	0.336	1.074	Var.	0.084	90%	0.358	1.157	Var.	0.106
95%	0.478	1.080	Skewn.	-0.065	95%	0.489	1.167	Skewn.	-0.210
99%	0.754	1.202	Kurt.	4.411	99%	0.818	1.182	Kurt.	4.642

Note: prediction of $\widehat{u}_1^j$ from eqaution (13).
Source: Bank of Italy SHIW 2008-10-12. Panel components for consecutive waves. Selection of prime-age households.

Table 4: Overall risksharing

	(1) Benchmark OLS		(2) Adjusted OLS		(3) Full model OLS	
	2008-10	2010-12	2008-10	2010-12	2008-10	2010-12
Dep. var.: Δc^j						
Unsmoothed consumption						
$[\beta]$	0.218***	0.154***	0.164***	0.129***	0.166***	0.133***
	(0.0486)	(0.0347)	(0.0459)	(0.0378)	(0.0413)	(0.0377)
$[\Delta\beta]$=$\widehat{u}_1 * reprate$					-0.261	0.261
					(0.2191)	(0.2051)
Constant	0.078***	0.084***	0.083***	0.079***	0.591	-0.289
	(0.0128)	(0.0123)	(0.0128)	(0.0124)	(0.4934)	(0.5311)
Controls	No	No	No	No	**Yes**	**Yes**
R^2	0.051	0.032	0.027	0.020	0.134	0.075
N. of cases	1,137	1,101	1,137	1,101	1,137	1,101

Note: Estimation of equations (12) (column 1-2), (14) (column 3-4) and (16) (column 5-6).
Source: Bank of Italy SHIW 2008-10-12. Panel components for consecutive waves. Selection of prime-age households.

Table 5: Risksharing channels

	(1) Benchmark system		(2) Adjusted system		(3) Full model system	
	2008-10	2010-12	2008-10	2010-12	2008-10	2010-12
Channels						
1. Basic income from other members $[\beta_H]$	0.141***	0.214***	0.187***	0.238***	0.187***	0.220***
	(0.0332)	(0.0348)	(0.0420)	(0.0359)	(0.0362)	(0.0336)
$[\Delta\beta_H]=\widehat{u}_1 * reprate$					-0.131	-0.120
					(0.1884)	(0.2327)
2. Capital incomes (financial and real) $[\beta_K]$	0.007	-0.025	0.006	-0.026	0.005	-0.030
	(0.0228)	(0.0236)	(0.0213)	(0.0309)	(0.0185)	(0.0314)
$[\Delta\beta_K]=\widehat{u}_1 * reprate$					-0.052	0.058
					(0.0693)	(0.0875)
3. Public transfers other than pensions $[\beta_G]$	0.066***	0.116***	0.053***	0.096**	0.063***	0.093**
	(0.0164)	(0.0317)	(0.0171)	(0.0385)	(0.0130)	(0.0384)
$[\Delta\beta_G]=\widehat{u}_1 * reprate$					0.278***	0.046
					(0.0925)	(0.0964)
4. PIT & Property tax on OODs $[\beta_T]$	0.116***	0.105***	0.108***	0.109***	0.111***	0.112***
	(0.0102)	(0.0077)	(0.0108)	(0.0079)	(0.0086)	(0.0084)
$[\Delta\beta_T]=\widehat{u}_1 * reprate$					0.191***	0.041
					(0.0319)	(0.0505)
5. Informal transfers $[\beta_I]$	0.024	-0.002	0.008	-0.002	0.002	-0.001
	(0.0192)	(0.0076)	(0.0090)	(0.0081)	(0.0059)	(0.0076)
$[\Delta\beta_I]=\widehat{u}_1 * reprate$					-0.047	-0.014
					(0.0312)	(0.0309)
6. Saving/dissaving $[\beta_S]$	0.355***	0.358***	0.348***	0.419***	0.353***	0.427***
	(0.0833)	(0.0496)	(0.0808)	(0.0544)	(0.0819)	(0.0520)
$[\Delta\beta_S]=\widehat{u}_1 * reprate$					-0.026	-0.607**
					(0.4456)	(0.2974)
7. Durable expenditures $[\beta_D]$	0.074	0.079*	0.126**	0.039	0.114*	0.047
	(0.0666)	(0.0413)	(0.0610)	(0.0451)	(0.0596)	(0.0427)
$[\Delta\beta_D]=\widehat{u}_1 * reprate$					0.047	0.336
					(0.2496)	(0.2379)
Controls	No	No	No	No	**Yes**	**Yes**
N. of cases	1,137	1,101	1,137	1,101	1,137	1,101

Note: Estimation of equation systems (11) (column 1-2), (15) (column 3-4) and (17) (column 5-6).
Source: Bank of Italy SHIW 2008-10-12. Panel components for consecutive waves. Selection of prime-age households.

[1] Alvarez, F. and U. Jermann (2000),"Efficiency, equilibrium, and asset pricing with risk of default", *Econometrica*, **68(5)**, 775-797.

[2] Arrow, K.J. (1964), "The Role of the Securities in the Optimal Allocation of Risk-bearing", *Review of Economic Studies* **31(2)**, 91-96.

[3] Asdrubali, P., B. E. Sørensen and O. Yosha (1996), "Channels of interstate risk sharing: United States 1963-1990, *Quarterly Journal of Economics*, **111(4)**, 1081-1110, reprinted in P. de Grauwe, ed., The political economy of monetary unions, 2001, (Edward Elgar, Cheltenham).

[4] Asdrubali, P., Tedeschi, S., and Ventura, L. (2019), "Heterogeneity in Risk Aversion and Risk Sharing Regressions", *Journal of Applied Econometrics*, forthcoming (https://doi.org/10.1002/jae.2686).

[5] Attanasio, O.P. and S.J. Davis (1996), "Relative Wage Movements and the Distribution of Consumption," *Journal of Political Economy* **104(6)**, 1227-1262.

[6] Attanasio, O.P. (1999), "Consumption" in J.B. Taylor and M. Woodford, eds., Handbook of Macroeconomics, Volume **1**,741-812. Elsevier Science B.V

[7] Attanasio, O.P. and V. Lechene (2002), "Tests of Income Pooling in Household Decisions", *Review of Economic Dynamics* **5(4)**, 720-748.

[8] Backus, D., P. Kehoe, and F. Kydland (1992), "International real business cycles", *Journal of Political Economy*, **100(4)**, 745-775.

[9] Balli, F., F.M. Pericoli, and E. Pierucci (2016), "Channels of risk sharing at micro level: Savings, investments and risk aversion heterogeneity." *International Journal of Finance & Economics*, **(21(1))**, 90-104.

[10] Baxter, M. and M. J. Crucini (1995), "Business cycles and the asset structure of foreign trade", *International Economic Review*, **36(4)**, 821-854.

[11] Becker, G.B. (1973),"A Theory of Marriage: Part I". *The Journal of Political Economy*, **81(4)**. 813-846.

[12] Becker, G.B. (1973), "A Theory of Marriage: Part II". *The Journal of Political Economy*, **82(2)**. 11-26.

[13] Blundell, R., L. Pistaferri, and I. Preston (2008), "Consumption Inequality and Partial Insurance" *American Economic Review*, **98(5)**, 1887-1921.

[14] Canova, F., Ravn, M.O. (1996), "International consumption risksharing", *International Economic Review*, **37(3)**, 573-601.

[15] Cavaliere, G., L. Fanelli, and A. Gardini (2006), "Regional consumption dynamics and risk sharing in Italy", *International Review of Economics and Finance*, **15(4)**, 525-542.

[16] Cellini, R., and A.E. Scorcu (2002), "Ripartizione del rischio nelle aree territoriali italiane nel lungo e nel breve periodo", *Rivista di Politica Economica*, **92(3)**, 171-199.

[17] Cerletti, E. A. and Pijoan-Mas, J. (2012), "Durable goods, borrowing constraints and consumption insurance", Working Papers No. 2012-1206, CEMFI.

[18] Chami, R., Hess, G. (2005), "For Better or For Worse? State-Level Marital Formation and Risk Sharing", *Review of Economics of the Household*, **3(4)**, 367-385.

[19] Cochrane, J.H. (1991), "A Simple Test of Full Consumption Insurance" *Journal of Political Economy*, **99(5)**, 957-976.

[20] Cox, D. (1987), "Motives for Private Income Transfers" *Journal of Political Economy*, **95(3)**, 508-546.

[21] D'Aurizio, L., Faiella, I., Iezzi, S.,Neri, A. (2006), "The under-reporting of financial wealth in the Survey on Household income and Wealth," Temi di discussione (Economic working papers) **610**, Bank of Italy, Economic Research and International Relations Area.

[22] Deaton, A. (1992), *Understanding Consumption*, Clarendon Press.

[23] Declich C. and L. Ventura (2000), "Incompletezza dei mercati e assicurazione del consumo: un'analisi empirica per le regioni italiane", *Rivista di Politica Economica*, **90(9)**, 29-57.

[24] Decressin, J. (2002), "Regional income redistribution and risk sharing: how does Italy compare in Europe?", *Journal of Public Economics*, **86**, 287-306.

[25] Dedola, L., Usai, S., and M. Vannini (1999), "An assessment on risk sharing in Italy and the United Kingdom", in J. Adams, and F. Pigliaru (Eds.), Economic growth and change. National and regional patterns of convergence and divergence. Cheltenham: Edward Elgar.

[26] Devereux, M.B. and Smith, G.W. (1994), "International Risk Sharing and Economic Growth", *International Economic Review*, **35**, 535-550.

[27] Duffie, J. D. and C.F. Huang (1985), "Implementing Arrow-Debreu equilibria by continuous trading of a few long-lived securities", *Econometrica*, **53(6)**, 1337-1356.

[28] Dynarski, S. and J. Gruber (1997), "Can Families Smooth Variable Earnings?", Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, **28(1)**, 229-303.

[29] Fafchamps, M. (2011), "Risk Sharing Between Households", in Handbook of Social Economics, Volume 1A, Jess Benhabib, Alberto Bisin, and Matthew O. Jackson (eds.), North-Holland, San Diego and Amsterdam.

[30] García-Escribano, M. (2004), "Does Spousal Labor Smooth Fluctuations in Husbands' Earnings? The Role of Liquidity Constraints", IMF Working Paper WP/04/20.

[31] Gardini, A., G. Cavaliere, and L. Fanelli (2005), "Risk sharing, avversione al rischio e stabilizzazione delle economie regionali in Italia", *Rivista di Politica Economica*, **95(3)**, 219-266.

[32] Gastaldi F., Liberati P., Pisano E., Tedeschi S. (2017), "Regressivity-Reducing VAT Reforms", *International Journal of Microsimulation*, **10(1)**, 39-72.

[33] Gervais, M., and P. Klein (2010), "Measuring consumption smoothing in CEX data", *Journal of Monetary Economics*, **57(8)**, 988-999.

[34] Grande, G., and L. Ventura (2001) "Labor income and risky assets under market incompleteness: Evidence from Italian data," *Journal of Banking & Finance*, **26(2-3)**, 597-620.

[35] Guiso, L. and T. Jappelli (2000), "Household Portfolios in Italy", in L. Guiso, M. Haliassos, T. Jappelli eds., *Household Portfolios*, MIT Press, p. 251-308.

[36] Halla, M. and J. Scharler (2012), "Marriage, Divorce, and Interstate Risk Sharing", *The Scandinavian Journal of Economics*, **114(1)**, 55-78.

[37] Hayashi, F., J. Altonji and L. Kotlikoff (1996), "Risk-sharing between and within families", *Econometrica*, **64(2**), 261-294.

[38] Hess, G.D., and K. Shin (1998), "Intranational business cycles in the US", *Journal of International Economics*, **44(2**), 289-313.

[39] Huang, C., and R. Litzenberger (1988), Foundations for Financial Economics, New York: North Holland.

[40] Immervoll, H., and C. O'donoghue (2001) "Imputation of gross amounts from net incomes in household surveys: an application using EUROMOD", No. EM1/01. EUROMOD Working Paper.

[41] Jappelli T. and L. Pistaferri (2006), "Intertemporal Choice and Consumption Mobility", *Journal of the European Economic Association*, **4(1)**, 75-115.

[42] Jappelli T. and L. Pistaferri (2010), "Does consumption inequality track income inequality in Italy?" *Review of Economic Dynamics*, **13(1**), 133-153.

[43] Jappelli, T. and L. Pistaferri (2011) "Financial Integration and Consumption Smoothing", *The Economic Journal*, **121**(553), 678-706.

[44] Kehoe, T. and D. Levine (1993), "Debt constrained asset markets", *Review of Economic Studies*, **60(4)**, 865-888.

[45] Krueger, D. and H. Uhlig (2006), "Competitive risk sharing contracts with one-sided commitment", *Journal of Monetary Economics*, **53(7)** 1661-1691.

[46] Krueger, D. and F. Perri (2005), "Understanding consumption smoothing: Evidence from US consumer expenditure data", *Journal of the European Economic Association*, **3 (2-3)**, 340-350.

[47] Krueger, D. and F. Perri (2011), "How does Household Consumption Respond to Income Shocks?", mimeo.

[48] Krueger, D. and F. Perri (2011a), "Public versus private risk sharing", *Journal of Economic Theory*, **146(3)**, 920-956.

[49] Levine, D. and W. Zame (2002), "Does market incompleteness matter?" *Econometrica*, **70(5)**, 1805-1839.

[50] Mace, B.J. (1991), "Full insurance in the presence of aggregate uncertainty", *Journal of Political Economy*, **99(5)**, 928-956.

[51] Massa, M. and A. Simonov (2006), "Hedging, familiarity and portfolio choice" *The Review of Financial Studies*, **19(2)**, 633-685.

[52] McKenzie, D. J. (2006), "The Consumer Response to the Mexican Peso Crisis" *Economic Development and Cultural Change*, University of Chicago Press, **55(1)**, 139-172.

[53] Mélitz, J., and F. Zumer (1999), "Interregional and international risk sharing and lessons for EMU", Carnegie-Rochester Conference Series on Public Policy, **51(1)**, 149-188.

[54] Mocetti, S., E. Olivieri and E. Viviano (2011), "Italian households and labour market: structural characteristics and effects of the crisis," *Stato e mercato*, **2**, 223-243.

[55] Nelson, J. A. (1994), "On testing for full insurance using Consumer Expenditure Survey data", *Journal of Political Economy*, **102** (2), 384-394.

[56] Padula, M. (2004), "Consumer durables and the marginal propensity to consume out of permanent income shocks," *Research in Economics*, Elsevier, **58(4)**, pages 319-341, December.

[57] Pakko, M.R., (1997), "International Risk Sharing and Low Cross-Country Consumption Correlations: Are They Really Inconsistent?", *Review of International Economics*, **5(3)**, 386-400.

[58] Park, K., and D. Shin (2010), "How Do Families Smooth Household Heads' Earnings Volatility?" *Journal of Economic Research*, **15(1)** , 79-97.

[59] Pellegrini, G. (1997) "Lo stato come assicurazione contro il rischio di fluttuazioni del reddito e del consumo regionale: l'esperienza italiana (1983-1992)", paper presented at the XVIII Italian Conference on Regional Science, 8-11 October 1997, Siracusa.

[60] Rosenzweig, M. R. (1988). "Risk, Implicit Contracts and the Family in Rural Areas of Low-Income Countries", *Economic Journal*, **98(393)**, 1148-1170.

[61] Rosenzweig, M. R., Stark, O. (1989). "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India", *Journal of Political Economy*, **97(4)**, 905-926.

[62] Rosenzweig, M. R., Wolpin, K. I. (1994). "Parental and public transfers to young women and their children", *American Economic Review*, **84(5)**, 1195-1212.

[63] Rosenzweig M. R., Wolpin, K. I. (1985). "Specific Experience, Household Structure and Intergenerational Transfers: Farm Family Land and Labor Arrangements in Developing Countries", *Quarterly Journal of Economics*, **100(Supplement)**, 961-987.

[64] Sala-i-Martin, X., Sachs, J. (1992), Fiscal federalism and optimum currency areas: evidence for Europe from the United States, in: Canzoneri, M., Masson, P., Grilli, V., eds., Establishing a Central Bank: Issues in Europe and Lessons from the U.S. (Cambridge University Press, London, UK) 195–219.

[65] Samphantharak, K., Townsend, R. M. (2006). Households as corporate firms: constructing financial statements from integrated household surveys. Available at SSRN 911964

[66] Scorcu, A. E. (1997), "Contiguitá territoriale e shock sul consumo nelle regioni italiane",*Rivista di Politica Economica,* **87(11)**, 3-24.

[67] Sørensen, B.E. and O. Yosha (1998), "International risk sharing and European monetary unification", *Journal of International Economics*, **45(2)**, 211-238.

[68] Schulhofer-Wohl, S. (2011), "Heterogeneity and tests of risk sharing", *Journal of Political Economy*, **119(5)**, 925-958.

[69] Sutherland, H. (2001), Final Report: EUROMOD: An Integrated European Benefit-Tax Model, Department of Applied Economics, University of Cambridge.

[70] Townsend, R.M. (1994), "Risk and insurance in village India", *Econometrica*, **62(4)**, 539-591.

[71] Von Hagen, J., (1992), Fiscal arrangements in a monetary union: evidence from the US, in: Fair, D.E., de Boissieu, C., eds., Fiscal Policy, Taxation, and the Financial System in an Increasingly Integrated Europe (Kluwer, Boston, MA) 337-359.

[72] Willen, P. (1999), "Welfare, financial innovation and self insurance in dynamic incomplete market models", Princeton University.

Appendix A. Simulation of gross incomes

Income variables in household survey data are often recorded net of income taxes and other levies on income, such as social contributions. However, for many research tasks gross income information is crucial. Examples are the calculation of tax wedges and effective tax rates or issues related to the distribution or determinants of market incomes. Another application of household micro-data where the lack of gross incomes can be a major problem is tax-benefit microsimulation. These models feature detailed social and fiscal policy rules as they apply to individuals and households and are largely used by governments as well as academic researchers. In addition to their main use as tools to analyze the effects of fiscal and social policy measures, these models are used to impute tax figures that are not gathered in the survey questionnaire.

In the case of our analysis, raw data from the survey must be appropriately treated in order to determine the net income for personal income tax (PIT) purposes, then the net-to-gross income procedure can be carried over. Rather than approximating the tax system using a functional form (Blundell *et al.* 2016[**?**], for instance, use the functional form suggested by Heathcote, Storesletten, and Violante (2014)), we decided to replicate faithfully the Italian taxation system in force at the time using microsimulation.

EGaLiTe ([32]) is a static tax&benefit microsimulation model. It uses a standard iterative method to simulate net-to-gross personal income trajectories. The codes are written in STATA. The fiscal module is based on microdata on Italian families provided by the Bank of Italy Survey of Households Income and Wealth (SHIW) that surveys after-tax income variables. The model aims to simulate personal income tax paid by Italian taxpayers (IRPEF) in order to determine the status quo distribution of the tax burden as well as the distributive effects of alternative reforms. In particular it simulates the IRPEF progressive structure, including its regional/local surtaxes and the main tax expenditures. Moreover, it approximates the distribution of family allowances (Assegno al Nucleo Familiare) which represent the main subsidy for households with dependent children in Italy but - unfortunately - cannot be directly disentangled from the labor income information reported in the survey. Finally, the fiscal module simulates the tax impact of owner-occupied dwellings (whose imputed rent is fully deductible from the PIT tax base in the period 2008-2010) which in the second spell is embodied in the new property tax "IMU". This latter tax-payment for 2012 is self-reported by respondents in the survey.

Since a micro analysis of tax evasion behavior is beyond the scope of this study, we adopt the simplifying assumption of no tax evasion in earnings. This can be easily accepted for employees while bringing lower accuracy in reconstructing gross figures for the self-employed. The loss of accuracy is however mitigated by

the fact that we work with changes in variables, and tax evasion in Italy does not tend to vary much over time.
Given the impossibility of analytically deriving an individual measure of gross income starting from net income, an iterative algorithm is adopted (see Sutherland, 2001[69]; Immervoll and O'Donoghue, 2001[40]). In practice it consists in estimating a plausible individual gross value starting from the self-reported disposable amount. Then, the tax rules for obtaining the net value are applied to this gross value. This value is compared with the sample original value and if these are equal - net of a margin of tolerance - the gross income estimate is considered a good approximation of the unknown value. Outside the tolerance margin, the algorithm predicts a new gross value (larger or smaller, depending on the sign of the error) and applies the tax rules again. This iteration continues until convergence is achieved for all tax payers in the sample. In fact, given the self-reported after-tax income, the characteristics of the tax payer (number of children, dependent spouse, presence of owned properties, mortgages) as well as the potential tax relief for income source plus other allowances and tax expenditures, there is only one taxable income such that, by applying the tax rules, one obtains the original after-tax income.
To determine the tax structure the following steps are followed:

1. identification of total income, i.e. the sum of the different sources of income subject to the IRPEF;

2. simulation and subtraction of the standard deductions (e.g. deduction for owner-occupied housing) from 1. = taxable income;

3. Application of the tax scale (A.6) to 2. = gross tax;

4. Subtraction of income tax credits, relief and tax expenditures from 3. (see A.7 for the employee tax relief pattern) = net tax.

Table A.6: Statutory tax rates and brackets (2008-2012)

Bracket (Euros x 1000)	**Tax rate** (%)
Up to 15	23
From 15 to 28	27
From 28 to 55	38
From 55 to 75	41
Over 75	43

Table A.7: Employee tax relief (2008-2012)

Total annual income (Y) (Euros x 1000)	**Annual deduction** (Euros x 1000)
Up to 8	1.840
From 8 to 15	1.338+[0.502*(15-Y)/7]
From 15 to 55	1.338*[(55- Y)/40]
Over 55	0