Quantitative Economics 11 (2020), 1109–1142 1759-7331/20201109

# Household risk-sharing channels

PIERFEDERICO ASDRUBALI
Department of Economics and Social Sciences, John Cabot University

SIMONE TEDESCHI
Department of Economics, Roma Tre University

LUIGI VENTURA
Department of Economics and Law, Sapienza University of Rome

This paper aims to fill the gaps in the analysis of risk-sharing channels at the microlevel, 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 risk-sharing mechanisms that so far have been documented separately. We find that Italian households were able to smooth on average about 85% of shocks to household head's earnings in both 2008–2010 and 2010–2012 spells. The most important smoothing mechanisms turn out to be self-insurance through savings/dissavings (40% and 47% in 2008–2010 and 2010–2012, respectively), and within-household risk-sharing (16% and 14%). Interestingly, risk-sharing through portfolio diversification and private transfers is rather limited, but the overall percentage of shock absorption occurring through private risk-sharing channels hovers around four-fifths, as opposed to around one-fifth of a shock cushioned by taxes and public transfers, excluding pensions. In addition, by exploiting subjective expectations on the following year's household income, we find significant evidence of a lower degree of smoothing of persistent shocks.

KEYWORDS. Household risk-sharing, precautionary savings, consumption smoothing, income smoothing.

JEL CLASSIFICATION. C31, D12, E21.

> ...[T]he only way to obtain such measures [of income and consumption] is by imposing an accounting framework on the data, and painstakingly constructing estimates from myriad responses to questions about the specific components that contribute to the total.
>
> ANGUS DEATON (1997)

Pierfederico Asdrubali: pasdrubali@johncabot.edu
Simone Tedeschi: simone.tedeschi@uniroma3.it
Luigi Ventura: luigi.ventura@uniroma1.it

We thank two anonymous referees and Stefano Fachin for very helpful comments and suggestion, which have greatly improved a first version of the paper. We also thank Marina Di Giacomo and the participants in the Workshop on "Household Finance and Retirement Savings", held in Torino in October 2017, for discussions and suggestions. The research of the third author was supported by Sapienza Research Grant RP116154D0309987. A replication file is posted (Asdrubali, Tedeschi, and Ventura (2020)).

## 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 nonmarket 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 (Becker (1973, 1974)), household economics has often stressed the idea that marriage (formal and informal) fosters risk-sharing, as transfers between spouses do achieve some smoothing of individual income streams' variability. Some authors (for example, Chami and Hess (2005)) have gone as far as to suggest that one of the motivations for marriage is to secure some hedging against income risk. Several applied studies (which most frequently employ microdata) provide some support for the idea that marriage achieves a certain amount of risk-sharing (as, for example, in the contributions by Rosenzweig and Wolpin (1985, 1994), Rosenzweig (1988), Rosenzweig and Stark (1989), 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 savings, as long as people feel more secure in their spousal agreement (as suggested, for example, by Devereux and Smith (1994)). This might decrease the buffer stock from which consumption shocks get smoothed, by the savings/dissavings channel.

As for risk-sharing across households, suffice it to note that the modern theory of risk-sharing has been developed centered on the household (or the individual) as its basic decision unit, entering transactions in the market (Arrow (1964), Townsend (1994); see Huang and Litzenberger (1988) or Deaton (1992) for a systematization).

Yet despite the pivotal role that household risk-sharing 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 risk-sharing were carried out at the microlevel (Cochrane (1991), Mace (1991), Nelson (1994), Hayashi, Altonji, and Kotlikoff (1996), Attanasio and Davis (1996), Declich and Ventura (2000), Grande and Ventura (2001), Krueger and Perri (2005, 2011b), Gervais and Klein (2010)); however, these studies could only test whether the null hypothesis of full risk-sharing 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 risk-sharing have been put forward.[1] On the other hand, the macroliterature on interregional/international risk-sharing, whose theoretical underpinning is typically a representative–agent extension of the basic microframework, has proceeded much further in the empirical analysis of risk-sharing channels.

[1]Incomplete risk-sharing 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); further developed by Kocherlakota (1996), Alvarez and Jermann (2000), Krueger and Uhlig (2006), Krueger and Perri (2011a)) and moral hazard.

After the first regression tests of full risk-sharing (Canova and Ravn (1996)), a vast body of literature has developed, starting with Asdrubali, Sørensen, and Yosha (1996) (henceforth ASY (1996)) with the aim of measuring the extent of risk-sharing channels across countries (or regions) within a unified framework.[2]

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.[3] In sum, as Blundell, Pistaferri, and Preston (2008) point out, beside household savings 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 risk-sharing channels at the microlevel, 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 nonfinancial 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 risk-sharing 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) and Townsend (1994), among others.[4] Another classical risk-sharing channel consists of fiscal transfer/tax mechanisms. This has been introduced by Sala-i-Martin and Sachs (1992) and Von Hagen (1992). Dynarski and Gruber (1997) study the smoothing effect on U.S. household consumption of government transfers (including retirement income) and taxes separately. For Italy, Dedola, Usai, and Vannini (1999), Mélitz and Zumer (1999), and Decressin (2002) carry out analyses of public risk-sharing, but at a macrolevel. An important, albeit less studied, channel of consumption smoothing is intrahousehold risk-sharing, that is, the smoothing of the household head's income shocks through other members' income changes. Hayashi, Altonji, and Kotlikoff (1996) and Dynarski and Gruber (1997) quantify the role of "wife's earnings," finding little effects. On the contrary, García-Escribano (2004) models risk-sharing within families explicitly, obtaining the opposite result. Informal risk-sharing between households—through private gifts, transfers, aid, and services—has been posited by Cox (1987) 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

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

[3]See the surveys by Deaton (1992) and Jappelli and Pistaferri (2017).

[4]As mentioned above, many seminal studies on risk-sharing, which explicitly or implicitly only took into account portfolio diversification, aimed at testing full risk-sharing without embarking on its quantification.

the (timing of) durable expenditures (see Attanasio (1999) 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 carryover of the ASY (1996) seemingly unrelated regression (SUR) estimation to a microsetting would be problematic. Indeed, differences exist between macrodata on countries and microdata 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) macrodata 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 sociodemographic 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.[5] 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 on risk-sharing channels at the microlevel in the last 20 years.[6]

This paper takes on the task of identifying and measuring household risk-sharing 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., risk-sharing) aspects. Third, we address the issue of measurement errors, which is particularly serious in survey microdata,[7] and other sources of endogeneity in

[5]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 microdata.

[6]To the best of our knowledge, only a few papers attempted to measure household risk-sharing channels. Three of them use a mere transposition of ASY (1996), without an explicit derivation from a theoretical model and without controlling for demographic and economic characteristics of the household (Park and Shin (2010), García-Escribano (2004)) or tackling the issue of the endogeneity of the main regressor in the risk-sharing equations (Balli, Pericoli, and Pierucci (2016)). Two others do not adopt an ASY-like methodology: Hayashi, Altonji, and Kotlikoff (1996) only deal with two broad channels (risk-sharing between and within families, not households), do not quantify them (as it only tests for full risk-sharing), and estimate them separately, with a risk of overlaps. Dynarski and Gruber (1997) measures the extent of risk-sharing mechanisms in the United States, 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 seven risk-sharing channels analyzed in this paper.

[7]See Nelson (1994).

the main predictor by using an alternative predictor, obtained by instrumental variables (IV) estimation. Fourth, by adopting a specification based on household's (household head's) earnings as a regressor (instead of aggregate income), we can more easily address the influence of taste shocks on the risk-sharing metric.[8]

Our reliance on SHIW data presents advantages which have been rarely exploited by the risk-sharing literature. Indeed, unlike the Panel Study of Income Dynamics (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 balanced panels of households over pairs of consecutive waves and using first differences, we avoid the inefficiencies of unbalanced data plaguing most previous analyses. Furthermore, unlike the Consumer Espenditure Survey (CEX) data, observations on consumption and incomes in SHIW are collected for coincident periods. As Dynarski and Gruber (1997) point out, the availability of U.S. representative consumption data only in the PSID and CEX surveys has forced researchers to merge them with income data at a higher level of aggregation,[9] but the resulting averaging out of individual earnings variation has been detrimental for risk-sharing estimates, which are based precisely on those variations.[10]

In terms of strategy, our goal is descriptive, in the sense that we aim to establish stylized facts on the degree of household risk-sharing, but we accomplish that by means of a causal identification, in the sense that we estimate cross-sectional effects of head's 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 risk-sharing behavior under several dimensions. First, we find that Italian households were able to smooth about 85% of shocks to household head's earnings in both 2008–2010 and 2010–2012 spells. Second, perhaps surprisingly, the most important smoothing mechanisms turn out to be self-insurance (i.e., (dis-)savings) and within-household risk-sharing (i.e., income pooling) which, in 2010–2012, were able to absorb as much as 47% and 14% of a shock, respectively. Informal risk-sharing and the capital income channel play a remarkably negligible role, as their small point estimate is accompanied by statistical nonsignificance; 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 underreporting of financial assets in the surveys, with the SHIW not being an exception (D'Aurizio, Faiella, Iezzi and Neri (2006)).[11]

[8]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's (household head's) income. See Sørensen and Yosha (1998).

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

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

[11]However, financial capital incomes in our data set exhibit a limited variability, as they are reconstructed as a linear projection of the different assets' risk classes held by the households.

While private risk-sharing buffers the bulk of a shock, public risk-sharing only cushions about 20% of a shock in both periods, 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)), 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 risk-sharing channels. Section 5 discusses the empirical results. Section 6 concludes.

## 2. Methodology

### 2.1 *Conceptual framework*

This section provides the theoretical foundations of the risk-sharing 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.[12] 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

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

where $\rho^j$ is household $j$'s factor of time preference, $\lambda^j$ is its Pareto weight, $\delta^j$ is its taste shifter, and $\mu_t$ 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 are homogeneous across the population. Dividing the expression (1) at two successive dates can get rid of the time-invariant Pareto weight, yielding

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

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

The discounted growth of marginal utility is the same across households. The consequences for household consumption growth can be illustrated specifying a constant relative risk aversion (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 $\gamma^j$ is household $j$'s risk aversion coefficient and $b^j_t$ is a multiplicative taste shock.[13] The planner's optimal risk-sharing solution thus prescribes that household consumption growth—net of preference shocks $[\log(b^j_{t+1}/b^j_t), \gamma^j, \rho^j]$—must only depend on aggregate consumption growth represented by $\log(\mu_{t+1}/\mu_t)$, and must be independent of idiosyncratic household variables, including household's (household head's) endowments.[14] 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, and so forth.

Equation (3) constitutes the theoretical ground for all the consumption insurance tests which, since the seminal papers 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 (1996), Dynarski and Gruber (1997), and many others, the magnitude of $\beta$ has been interpreted as the extent of departure from a situation of perfect insurance, with respect to the shock variable used in equation (4).

### 2.2 *Channels of risk-sharing*

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 in Arrow–Debreu contingent claims (Arrow (1964)) or a specific set of securities (Duffie and Huang (1985))

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

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

allows households to implement the full risk-sharing solution through asset diversification. Similarly, the existence of appropriate government tax/transfers mechanisms allows insuring, at least partially, households whose head's nonfinancial income has been hit by a negative shock, drawing from incomes hit by a positive shock. In addition, risk-sharing can be provided through self-insurance, that is, by asset accumulation (savings) and depletion (dissavings) through lending and borrowing.[15] 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), Levine and Zame (2002), Willen (1999)). A peculiar type of (dis-)savings is represented by the timely purchase of durables, which may constitute an additional channel of self-insurance (see Cerletti and Pijoan-Mas (2012)). Furthermore, informal risk-sharing can take place, especially in developing economies, through private gifts, transfers, aid, or services. Finally, risk-sharing 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 risk-sharing 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 examination.

### 2.3 *Empirical model of risk-sharing channels*

Equation (3) implies that if risk is fully shared through market or nonmarket 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,

$$\log\left(\frac{C_{t+1}^j}{C_t^j}\right) = \alpha + \beta^1 \log\left(\frac{W_{t+1}^j}{W_t^j}\right) + u_{t+1}^j, \tag{5}$$

where the disturbance may include a measurement error. Here the intercept captures the effect on consumption variation of aggregate variables, notably aggregate consump-

[15] Self-insurance through (dis-)savings aimed at buffering idiosyncratic risk—that is, precautionary (dis-)savings—should be distinguished from intertemporal trade during the life cycle.

tion or aggregate income.[16] It is useful to keep in mind that no risk-sharing implies that the $\beta^1$ coefficient be equal to 1 (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 0.[17] Intermediate values can then be interpreted as measuring the degree of risk-sharing. As pointed out by Dynarski and Gruber (1997) and Fafchamps (2011), the $\beta^1$ 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,

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

is an appropriate measure of the extent of household consumption smoothing via risk-sharing. 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 regressor and control covariates, reduces endogeneity issues, and allows treating other household members' earnings as risk-sharing channels.

The main contribution of the risk-sharing channels methodology consists in a decomposition of the overall risk-sharing measure $1 - \beta^1$ into the smoothing contributions of the different risk-sharing 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[18]): $G$.
- Household disposable income (household gross income − taxes paid[19]): $T$.
- Household total disposable income (household disposable income + inter- and intragenerational (private) transfers[20]): $I$.

[16] In some specifications of the risk-sharing 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 (e.g., Obstfeld (1994)). However, in a cross section the aggregate term is replaced by the constant term.

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

[18] 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 (Assegno al Nucleo Familiaire (ANF)) that are simulated (see Appendix A).

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

[20] 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.

- Household total consumption (household total disposable income – household savings): $E$.
- Household nondurable 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 $j$:

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

After taking logs and first differences,

$$\Delta w^j = \left(\Delta w^j - \Delta h^j\right) + \left(\Delta h^j - \Delta k^j\right) + \cdots + \left(\Delta i^j - \Delta e^j\right) + \left(\Delta e^j - \Delta c^j\right) + \Delta c^j, \tag{8}$$

where lowercase letters indicate logs.

Multiplying both sides by $\Delta w^j$ and taking expectations, and then dividing through by $\mathrm{Var}(\Delta w^j)$, we obtain a constrained sum of simple regression coefficients:

$$1 = \frac{\mathrm{Cov}\left(\Delta w^j, \Delta w^j - \Delta h^j\right)}{\mathrm{Var}\left(\Delta w^j\right)} + \cdots + \frac{\mathrm{Cov}\left(\Delta w^j, \Delta e^j - \Delta c^j\right)}{\mathrm{Var}\left(\Delta w^j\right)} + \frac{\mathrm{Cov}\left(\Delta w^j, \Delta c^j\right)}{\mathrm{Var}\left(\Delta w^j\right)} \tag{9}$$

or

$$1 - \beta^1 = \beta^1_H + \beta^1_K + \beta^1_G + \beta^1_T + \beta^1_I + \beta^1_S + \beta^1_D. \tag{10}$$

The overall risk-sharing measure $1 - \beta^1$ is decomposed into seven coefficients. The first coefficient on the right-hand side (RHS), $\beta^1_H$, represents the slope in a regression of $\Delta w^j - \Delta h^j$ on $\Delta w^j$. If a unit positive shock hits the head's earnings, $\Delta w^j$ will increase by 1 unit; if household earnings $\Delta h^j$ also increase by 1 unit, that is, if the shock has passed through to household earnings, then $\beta^1_H = 0$, indicating that no intrahousehold risk-sharing has taken place, whereas if household earnings $\Delta h^j$ stay put, that is, if the shock has not passed through to household earnings, then $\beta^1_H = 1$, indicating that full intrahousehold risk-sharing has taken place. In general, $\beta^1_H$ measures the percentage of head earnings changes that is smoothed within the household. By the same token, the second coefficient, $\beta^1_K$, measures the percentage of earnings changes that is further smoothed by capital incomes; the third and the fourth, $\beta^1_G$ and $\beta^1_T$, measure the further smoothing provided by transfers and taxes, respectively; the fifth, $\beta^1_I$, represents the share that is further smoothed by informal transfers between households; then $\beta^1_S$ is the amount of smoothing provided by savings and dissavings. Finally, $\beta^1_D$ represents possible smoothing to nondurable 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 households, defined as groups of individuals related by blood, marriage, or adoption who share the same dwelling. The sample comprises about 8,000 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 1. The longitudinal component allows us to potentially follow over 50% of the households in two spells of twice-repeated observations.[21] 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, and income from financial assets and real estate).
- Consumption and savings (food consumption, other nondurables, expenses for housing, health, insurance, spending on durable goods, and household savings).
- Wealth in terms of real estate, financial assets, and liabilities.
- Special modules such as capital gains, inheritance, risk aversion, unpaid work, economic mobility, social capital, tax evasion, and 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).

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 the *EGaLiTe* tax-benefit microsimulation model—to recover gross figures for basic income and disentangle household allowances from disposable income.[22]

[21] 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).

[22] See Appendix A

TABLE 1. Descriptive statistics of the main variables involved in the models estimation.

| | Years | Mean | Std. Dev. |
|---|---|---|---|
| Earnings plus pension growth (head) ($\Delta w^j$) | 2008–2010 | 2.0% | 32% |
| | 2010–2012 | −2.9% | 38% |
| Earnings plus pension growth (household) ($\Delta h^j$) | 2008–2010 | 3.6% | 36% |
| | 2010–2012 | −2.3% | 38% |
| Income growth (household (hh), incl. capital) ($\Delta k^j$) | 2008–2010 | 4.6% | 39% |
| | 2010–2012 | −1.7% | 40% |
| Gross income growth (hh, incl. public transfers) ($\Delta g^j$) | 2008–2010 | 4.8% | 37% |
| | 2010–2012 | −0.2% | 36% |
| Disposable income growth (hh, after tax) ($\Delta t^j$) | 2008–2010 | 4.1% | 34% |
| | 2010–2012 | −0.5% | 33% |
| Total disp. income growth (hh, incl. priv. transfers) ($\Delta i^j$) | 2008–2010 | 3.8% | 34% |
| | 2010–2012 | −0.2% | 34% |
| Total consumption growth (hh, excl. savings) ($\Delta e^j$) | 2008–2010 | 5.4% | 44% |
| | 2010–2012 | 7.7% | 42% |
| Nondurable consumption growth (hh, excl. durables) ($\Delta c^j$) | 2008–2010 | 8.4% | 29% |
| | 2010–2012 | 7.9% | 30% |

*Note*: Current prices. $N_{2008–2010} = 1{,}163$; $N_{2010–2012} = 1{,}138$. *Source*: Bank of Italy SHIW 2008–2010–2012. Panel components for consecutive waves. Selection of prime-age households.

Our variables are measured as reported in Section 2.3 and are all in nominal 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 ($\Delta w^j$), with mean equal to 2% and −2.9% in the first and the second periods, respectively. However, in the same spells the growth of nominal nondurable consumption ($\Delta c^j$) 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 regression results.[23]

## 4. Estimation

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

$$\Delta w^j - \Delta h^j = \nu_H + \beta_H^1 \Delta w^j + \varepsilon_H^j,$$

$$\Delta h^j - \Delta k^j = \nu_K + \beta_K^1 \Delta w^j + \varepsilon_K^j,$$

$$\Delta k^j - \Delta g^j = \nu_G + \beta_G^1 \Delta w^j + \varepsilon_G^j,$$

[23] For earlier years, Padula (2004) and Jappelli and Pistaferri (2006, 2010b, 2011) also employed the SHIW data to study the joint dynamics of household income and consumption.

$$\begin{aligned} \Delta g^j - \Delta t^j &= \nu_T + \beta_T^1 \Delta w^j + \varepsilon_T^j, \\ \Delta t^j - \Delta i^j &= \nu_I + \beta_I^1 \Delta w^j + \varepsilon_I^j, \\ \Delta i^j - \Delta e^j &= \nu_S + \beta_S^1 \Delta w^j + \varepsilon_S^j, \\ \Delta e^j - \Delta c^j &= \nu_D + \beta_D^1 \Delta w^j + \varepsilon_D^j, \end{aligned} \tag{11}$$

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. The ordering of the channels in the variance decomposition, and, hence, of the equations in (11), stems from the application to the household's' "income statement" of the ordering used in the Organization for Economic Cooperation and Development's (OECD's) National Accounts and adopted in the literature on risk-sharing channels, both macro (e.g., Sørensen and Yosha (1998)) and micro (e.g., Park and Shin (2010)). This ordering is "natural" in the sense that certain variables presuppose others. For example, for an economy, the construction of gross national income (GNI) implies the existence of gross domestic product (GDP), which generates, say, cross-border wage flows; in turn, GDI must build on a measure of gross income like GNI, on which, say, income taxes are derived. Similarly, household financial income builds on wage earnings, disposable income presupposes total income, and so on. Note that we do not posit any causality ordering (as in a recursive vector autoregression (VAR), for example), just a logical one.[24] 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:

$$\Delta c^j = \nu + \beta^1 \Delta w^j + \varepsilon^j. \tag{12}$$

Note that the sum of the $\beta_.^1$ coefficients from equations (11) equals $1 - \beta^1$, that is, the coefficient of equation (12). Hence, to estimate the overall degree of risk-sharing, 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 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 a bias

[24]By this standard, certain channels in our setup could indeed be switched. For example, there is no stringent reason why public transfers should precede taxes or why private transfers should follow public transfers. Hence, we carried out a robustness test (see discussion in Section 5.2 below) whereby we altered the ordering of those channels. As expected, results are essentially unaffected.

stemming from the earnings variable. Addressing this bias also corrects the inefficiency associated with the coefficient's standard error.[25]

A second source of bias is the potential correlation between the 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 nonseparability of the utility function (see Cochrane (1991)). The former is partially addressed by adding demographic and household characteristics; the latter 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, possibly more important, source of bias is the potential endogeneity of hours worked, as they might be driven by the same underlying factors driving growth in consumption.

We do not provide a formal solution for this problem, but rather propose and fit an alternative regression model for which such a problem may well be less severe. It consists of filtering out the average effect of endogenously changing labor supply, $\Delta$hrs, from the change in income, $\Delta w$, and then use the residual as a pure wage shock as the main regressor in the risk-sharing equation. Although this procedure is not equivalent to running an IV estimation for equation (12), it allows us both to address the issue of potential endogeneity in hours worked as a key component in overall head's earnings, as their effect is removed, and to get an insight as to whether shocks to different components of earnings are associated with different extents of smoothing, which is an interesting research question in and by itself.

To run this additional empirical analysis, we use information on the variation of head's hours worked, $\Delta$hrs, as well as other predictors of the head's labor income rate of variation, such as the experience and dummies indicating public sector and gender.

Since $\Delta$hrs is recovered from self-reported average weekly worked hours and months spent in employment, it may well suffer from rounding and misreporting. This makes a direct use of $\Delta$hrs less attractive in the ratio $\Delta w/\Delta\mathrm{hrs}$ to calculate the wage variation component of earnings. In fact, since with survey data both $\Delta w$ and $\Delta$hrs may suffer from nonsampling errors, the ratio is likely to suffer from so-called division bias. A viable alternative is a regression of $\Delta w$ on $\Delta$hrs which, however, must take into account the possible residual endogeneity of $\Delta$hrs itself due to the (correlated) measurement errors between $\Delta w$ and $\Delta$hrs.[26]

In practice, we proceed as follows. As a first step of our identification strategy, we estimate the following model through a two-stage least squares (2SLS) regression,

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

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

[26] 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 earnings, the effect will wash out when taking first differences (see Dynarski and Gruber (1997)).

where we model together the household head's earnings change and his/her change in hours worked. We are thus purging the change in earnings from the change in hours worked, possibly accounting for endogeneity in the latter by using suitable instruments (the vector $z^j$): an important worsening in health conditions and first-year child rearing (for females) in the first spell, and the occurrence of unemployment and first-year child rearing (for females) for the second spell.

For the common instrument (first-year child rearing), the identifying restriction rests on the following argument: during the period of compulsory absence, which in Italy is equal to 3 months after delivery, the worker is entitled to maternity allowances and/or indemnities which compensate the wage loss. The idea is therefore that in the first year of a child's life, workers (especially women) certainly experience a reduction in hours worked, with a fall in earnings that is less than proportional to the reduction in hours worked. Importantly, this event should have no direct effect on the wage rate, at least in the short run. A similar line of reasoning applies to the case of sickness leave and thus for the specific instrument of the second spell (marked worsening in health conditions). As for the occurrence of unemployment for prime-age males with children, we argue—supported by much of the empirical literature—that this type of worker is characterized by a fairly rigid (full-time) labor supply (Aaberge, Colombino, and Strøm (1999)) and therefore that his unemployment status is unlikely to be an endogenous decision.

Finally, we are using the residual of the income change equation, that is, $\widehat{u}_1^j$ (the estimates of $u_1^j$) as a valid measure for the pure wage shock to the head's earnings. This variable, more credibly exogenous with respect to $\Delta c$, is then used as the main regressor in place of $\Delta w$ in the risk-sharing regression

$$\Delta c^j = \nu + \beta^2 \widehat{u}_1^j + \epsilon^j \tag{14}$$

and in the related equation system

$$\begin{aligned} \widehat{u}_1^j - \Delta h^j &= \nu_H + \beta_H^2 \widehat{u}_1^j + \epsilon_H^j, \\ \Delta h^j - \Delta k^j &= \nu_K + \beta_K^2 \widehat{u}_1^j + \epsilon_K^j, \\ &\cdots \\ \Delta e^j - \Delta c^j &= \nu_D + \beta_D^2 \widehat{u}_1^j + \epsilon_D^j. \end{aligned} \tag{15}$$

As a last remark, it should be noticed that in order to meaningfully estimate the risk channels equations in (15), we had to generate successive measures of income, as in (7), consistent with rates of change in the head's earnings implicit in $\widehat{u}_1^j$. Therefore $\beta^2$ ($\beta^1$) will represent overall risk-sharing when we are using $\widehat{u}_1^j$ ($\Delta w$) as the shock variable, and $\beta_H^2, \ldots, \beta_D^2$ will represent the smoothing obtained by the various channels in this case.

*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

$$\Delta c^j = \nu + \beta^2 \widehat{u}_1^j + \boldsymbol{\gamma}' \boldsymbol{y}^j + \epsilon^j, \tag{16}$$

where $\boldsymbol{y}^j$ is a vector including standard controls, as suggested in most research on the topic.[27]

Consequently, the equation system in (15) is also estimated using additional covariates in each equation:

$$\begin{aligned}
\widehat{u}_1^j - \Delta h^j &= \nu_H + \beta_H^2 \widehat{u}_1^j + \boldsymbol{\gamma}_H' \boldsymbol{y}^j + \epsilon_H^j, \\
\Delta h^j - \Delta k^j &= \nu_K + \beta_K^2 \widehat{u}_1^j + \boldsymbol{\gamma}_K' \boldsymbol{y}^j + \epsilon_K^j, \\
&\cdots \\
\Delta e^j - \Delta c^j &= \nu_D + \beta_D^2 \widehat{u}_1^j + \boldsymbol{\gamma}_D' \boldsymbol{y}^j + \epsilon_D^j.
\end{aligned} \tag{17}$$

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.[28] 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 in regressions (16) and (17) 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 $\boldsymbol{y}^j$. 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 2 year spell. Although this choice might introduce some selection in the sample, it also circumscribes the household heads to inelastic labor suppliers, who are less likely to change their working hours in response to consumption changes, and above all mitigates concerns related to life-cycle choices such as moving from student to worker status or deciding to retire.[29]

*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

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

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

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

system (11) and in equation (12). To improve inference, we estimate the system by a maximum-likelihood conditional mixed-process estimator (CMP), 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 earnings in the start year.

*Attrition* We implicitly address issues of attrition that arise from the unavoidable changes of the sample over time (due to births, deaths, marriages, divorces, new sample units arriving, old sample units dropping) as we have to limit our sample to a balanced panel of households. In fact, we need to observe all households for two periods to be able to compute rates of change in the relevant variables. 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 ($\Delta w^j$), we trim observations from the tails for which the generic value $x$ is such that $x < Q(25) - 3\text{IQR}$ or $x > Q(75) + 3\text{IQR}$, where IQR (interquartile range) is equal to the difference between the 75th and the 25th 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, 1,163 and 1,136 observations in the first and in the second spell.

## 5. Results

This section illustrates the results of the implementation of our econometric model as laid out in Section 4. Table 2 shows, for both the 2008–2010 and the 2010–2012 spell, the ordinary least squares (OLS) and IV estimations of (13), with the change in head's hours worked ($\Delta$hrs) as the potentially endogenous regressor.

As exclusion restrictions ($z^j$), we use a dummy for the presence of children younger than 1 year for female heads (in both spells), a dummy indicating "marked worsening"[30] in health status compared to 2 years earlier (first spell only), and a dummy for the occurrence of unemployment for male heads with children (second spell only). The difference between the three instruments is that while the first, common one, identifies a shock that is likely temporary (mean reverting), the case of a severe deterioration of health is

[30] 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 1 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.

TABLE 2. IV versus OLS estimation of head's earnings variation and prediction of the wage shock.

| Dep. Variable: $\Delta w$ | (2008–2010) | | (2010–2012) | |
|---|---|---|---|---|
| | OLS | 2SLS – IV[i] | OLS | 2SLS – IV[i] |
| $\Delta$hrs | 0.081 | 0.082 | 0.091 | 0.160 |
| | (0.0096) | (0.0211) | (0.0105) | (0.030) |
| Experience | −0.013 | −0.013 | 0.003 | 0.002 |
| | (0.0051) | (0.0051) | (0.0014) | (0.0014) |
| Experience$^2$ | 0.000 | 0.000 | – | – |
| | (0.0001) | (0.0001) | – | – |
| Female | 0.036 | −0.036 | −0.042 | −0.051 |
| | (0.0196) | (0.0197) | (0.0229) | (0.0237) |
| Public sector | 0.058 | 0.058 | 0.04 | 0.05 |
| | (0.0217) | (0.0217) | (0.0279) | (0.0283) |
| Education | – | – | 0.021 | 0.016 |
| | – | – | (0.010) | (0.010) |
| Constant | 0.154 | 0.154 | −0.172 | −0.131 |
| | (0.0572) | (0.057) | (0.061) | (0.065) |
| $R^2$ | 0.07 | 0.07 | 0.08 | 0.04 |
| No. of cases | 1,163 | 1,163 | 1,136 | 1,136 |
| $F$-test of excl. instr. | – | 148.03 | – | 61.99 |
| Hansen's $J$ $p$-value | – | 0.32 | – | 0.28 |
| Endogeneity test $p$-value | – | 0.99 | – | 0.03 |

*Note*: OLS and IV estimation of model (13) and prediction of $\widehat{u}_1^j$ with estimator suggested by the endogeneity test.

[i]Instrumented: $\Delta$hrs. Excluded instruments: 1. Health conditions marked worsening (dummy) and 2. first-year child rearing for females (dummy) (2008–2010). 2. Occurrence of unemployment for males with children (dummy) and 2. first-year child rearing for females (dummy) (2010–2012). *Source*: Bank of Italy SHIW 2008–2010–2012. Panel components for consecutive waves. Selection of prime-age households.

generally associated with permanent innovations (see, for example, Jappelli and Pistaferri (2010a)). Regarding unemployment, although the related wage shock may persist in the medium run, it should not be permanent. Hence, it seems likely that in the first spell, we are identifying a rather temporary earnings shock and identifying a more persistent one in the second.

As expected, these indicators show a negative and significant explanatory power on the variation of head's hours worked, with the $F$-test statistic on excluded instruments that is well above the conventional threshold of 10 in both first stage equations in both periods, thus ruling out problems of weakness. Since we have two exclusion restrictions for one potential endogenous regressor in each spell, the structural parameters are, technically, overidentified[31] and we can test the instruments' orthogonality. In the first period, the endogeneity tests do not allow us to reject the null hypothesis of regressor exogeneity, while they do reject in the second. Finally, the Hansen $J$ test does not allow rejecting the null of instruments' orthogonality.

[31] For a discussion of identification issues, see Section 4.

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

| (2008–2010) | | | | (2010–2012) | | | |
|---|---|---|---|---|---|---|---|
| Percentiles | | | | Percentiles | | | |
| | Smallest | | | | Smallest | | |
| 1% | −0.845 | −1.072 | | 1% | −1.150 | −1.435 | |
| 5% | −0.561 | −1.063 | | 5% | −0.609 | −1.372 | |
| 10% | −0.383 | −1.039 | (Obs. 1,163) | 10% | −0.414 | −1.280 | (Obs. 1,136) |
| 25% | −0.134 | −1.039 | | 25% | −0.159 | −1.229 | |
| **50%** | **0.014** | **Mean** | **−0.001** | **50%** | **0.002** | **Mean** | **0.001** |
| | Largest | **(Std. Dev.** | **0.308)** | | Largest | **(Std. Dev.** | **0.369)** |
| 75% | 0.155 | 1.071 | | 75% | 0.177 | 1.248 | |
| 90% | 0.342 | 1.080 | Var. 0.095 | 90% | 0.392 | 1.280 | Var. 0.136 |
| 95% | 0.504 | 1.081 | Skew. −0.161 | 95% | 0.606 | 1.301 | Skew. 0.035 |
| 99% | 0.897 | 1.220 | Kurt. 4.78 | 99% | 1.181 | 1.343 | Kurt. 5.30 |

*Note*: Note: Prediction of $\widehat{u}_1^j$ from equation (13). *Source*: Bank of Italy SHIW 2008–2010–2012. Panel components for consecutive waves. Selection of prime-age households.

Table 2 shows both OLS and IV estimates for comparison, but since in the first spell the two estimates are practically identical, we use the IV estimator for both period to make correct inferences on the residuals $u_1^j$ (proxy of a 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 risk-sharing*

Table 4 illustrates the results for 2008–2010 and 2010–2012 of our baseline specification (12) as in the ASY (1996) original setup (columns 1 and 2), the specification based on wage shocks ($u_1^j$) without additional controls (14) (columns 3 and 4), and the full specification (16) (columns 5 and 6) based on wage shocks ($u_1^j$) with additional 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 and 6) shows that Italian households were able to smooth around 85% of a wage shock to the household head in both 2008–2010 and 2010–2012, while the above-mentioned interaction is not statistically significant at standard significance levels.[32]

That the $\beta^{\cdot}$ estimated coefficients are not very different across the three specifications is noteworthy, as it suggests that, overall, shocks to basic income are smoothed very much like pure wage shocks and that our basic econometric model is quite robust.

[32]In passing, it is worth noticing that partial lack of insurance is only imputable to negative shocks, as the overall insurance coefficient corresponding to positive shocks is always nonstatistically significant, and ranges from −0.018 to 0.08. Self-insurance is always viable with positive shocks.

Table 4. Overall risk-sharing.

| Dep. Variable: $\Delta c^j$ | (1) Benchmark OLS | | (2) Adjusted OLS | | (3) Full Model OLS | |
|---|---|---|---|---|---|---|
| | 2008–2010 | 2010–2012 | 2008–2010 | 2010–2012 | 2008–2010 | 2010–2012 |
| *Unsmoothed consumption* | | | | | | |
| $[\beta^{1\|2}]$: $(\Delta w^j \| \widehat{u}_1)$ | 0.170 | 0.151 | 0.143 | 0.133 | 0.146 | 0.149 |
| | (0.0452) | (0.0306) | (0.0446) | (0.0322) | (0.0430) | (0.0323) |
| $[\Delta\beta^2]$: $(\widehat{u}_1 * \text{reprate})$ | | | | | −0.065 | 0.157 |
| | | | | | (0.2055) | (0.1343) |
| Constant | 0.081 | 0.084 | 0.084 | 0.080 | 0.606 | −0.228 |
| | (0.0128) | (0.0120) | (0.0127) | (0.0121) | (0.4921) | (0.5317) |
| Controls | No | No | No | No | **Yes** | **Yes** |
| $R^2$ | 0.036 | 0.037 | 0.024 | 0.028 | 0.120 | 0.089 |
| No. of cases | 1,163 | 1,138 | 1,163 | 1,129 | 1,163 | 1,129 |

*Note*: Estimation of equations (12) (columns 1 and 2), (14) (columns 3 and 4), and (16) (columns 5 and 6). $[\beta^{1|2}]$ is the wage shock (i.e., $\Delta w^j$ in column 1, $\widehat{u}_1$ in columns 2 and 3) estimated coefficient; $[\Delta\beta^2] = \widehat{u}_1 * \text{reprate}$ is the variation of $[\beta^2]$ related to heterogeneity in pension expectations. *Source*: Bank of Italy SHIW 2008–2010–2012. Panel components for consecutive waves. Selection of prime-age households.

Nevertheless, we advocate the use of our augmented model in terms of $u_1^j$, 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 risk-sharing in Italy can smooth more than 80% of a primitive source of shocks such as those to the head's earnings. This result is consistent with most studies on risk-sharing in Italy, both at the micro- and macrolevel: for example, at the macrolevel, Scorcu (1997) and Cellini and Scorcu (2002) for 1971–1993 and Dedola, Usai, and Vannini (1999) for 1983–1992, Mélitz and Zumer (1999) for 1984–1992, Gardini, Cavaliere, and Fanelli (2005) for 1960–1995, and Cavaliere, Fanelli, and Gardini (2006) for 1960–2001 all find a notable and significant degrees of smoothing among Italian regions; at the microlevel Krueger and Perri (2011b) for 1987–2008 reach results on the overall degree of risk-sharing which are quite close to ours.

### 5.2 *Risk-sharing channels*

How the overall smoothing breaks down across the seven channels of risk-sharing 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 and 2), the specification based on wage shocks without additional controls (15) (columns 3 and 4), and the full specification (17) (columns 5 and 6) with controls. The table reveals that self-insurance ($\beta_S^2$) is the most important smoothing mechanism, which is able to absorb 40% of wage shocks in 2008–2010, and around 47% in 2010–2012. Here, the interaction ($\widehat{u}_1 * \text{reprate}$) should disentangle the role of life-cycle/pension motives from precautionary savings. Interestingly enough, the elasticity for the interaction is negative and sig-

TABLE 5. Risk-sharing channels.

| | (1) Benchmark System | | (2) Adjusted System | | (3) Full Model System | |
|---|---|---|---|---|---|---|
| | 2008–2010 | 2010–2012 | 2008–2010 | 2010–2012 | 2008–2010 | 2010–2012 |
| *Channels* | | | | | | |
| 1. Basic income from other members | | | | | | |
| [$\beta_H^{1\|2}$] | 0.159 | 0.285 | 0.158 | 0.173 | 0.162 | 0.137 |
| | (0.0406) | (0.0450) | (0.0447) | (0.0515) | (0.0434) | (0.0467) |
| [$\Delta\beta_H^2$]: ($\widehat{u}_1 *$ reprate) | | | | | −0.117 | −0.137 |
| | | | | | (0.2573) | (0.2129) |
| 2. Capital incomes (financial and real) | | | | | | |
| [$\beta_K^{1\|2}$] | 0.003 | −0.023 | 0.003 | 0.000 | −0.003 | −0.003 |
| | (0.0196) | (0.0194) | (0.0198) | (0.0131) | (0.0165) | (0.0113) |
| [$\Delta\beta_K^2$]: ($\widehat{u}_1 *$ reprate) | | | | | −0.023 | 0.011 |
| | | | | | (0.0812) | (0.0525) |
| 3. Public transfers other than pensions | | | | | | |
| [$\beta_G^{1\|2}$] | 0.067 | 0.110 | 0.064 | 0.081 | 0.078 | 0.079 |
| | (0.0153) | (0.0268) | (0.0170) | (0.0212) | (0.0132) | (0.0197) |
| [$\Delta\beta_G^2$]: ($\widehat{u}_1 *$ reprate) | | | | | 0.224 | 0.120 |
| | | | | | (0.1040) | (0.0723) |
| 4. PIT & property tax on OODs | | | | | | |
| [$\beta_T^{1\|2}$] | 0.106 | 0.100 | 0.107 | 0.092 | 0.114 | 0.104 |
| | (0.0106) | (0.0066) | (0.0113) | (0.0107) | (0.0123) | (0.0098) |
| [$\Delta\beta_T^2$]: ($\widehat{u}_1 *$ reprate) | | | | | 0.146 | 0.152 |
| | | | | | (0.0505) | (0.0457) |
| 5. Informal transfers | | | | | | |
| [$\beta_I^{1\|2}$] | 0.024 | −0.001 | 0.010 | 0.006 | −0.004 | 0.007 |
| | (0.0173) | (0.0062) | (0.0079) | (0.0056) | (0.0061) | (0.0085) |
| [$\Delta\beta_I^2$]: ($\widehat{u}_1$ reprate) | | | | | −0.182 | −0.011 |
| | | | | | (0.0866) | (0.0203) |
| 6. Savings/dissavings | | | | | | |
| [$\beta_S^{1\|2}$] | 0.397 | 0.313 | 0.412 | 0.478 | 0.401 | 0.474 |
| | (0.0716) | (0.0562) | (0.0714) | (0.0661) | (0.0736) | (0.0594) |
| [$\Delta\beta_S^2$]: ($\widehat{u}_1$ reprate) | | | | | −0.117 | −0.717 |
| | | | | | (0.3810) | (0.2666) |
| 7. Durable expenditures | | | | | | |
| [$\beta_D^{1\|2}$] | 0.073 | 0.064 | 0.102 | 0.038 | 0.105 | 0.054 |
| | (0.0570) | (0.0348) | (0.0537) | (0.0375) | (0.0548) | (0.0343) |
| [$\Delta\beta_D^2$]: ($\widehat{u}_1$ reprate) | | | | | 0.134 | 0.424 |
| | | | | | (0.2095) | (0.1678) |
| Controls | No | No | No | No | **Yes** | **Yes** |
| No. of cases | 1,163 | 1,136 | 1,163 | 1,129 | 1,163 | 1,129 |

*Note*: Estimation of equation systems (11) (columns 1 and 2), (15) (columns 3 and 4), and (17) (columns 5 and 6): $\beta_H^{1|2}$ is the head wage shock's estimated coefficient on the dependent variable $(\Delta w^j|\widehat{u}_1) - \Delta h^j$, $\beta_K^{1|2}$ is the head wage shock's estimated coefficient on the dependent variable $\Delta h^j - \Delta k^j, \dots$, and $\beta_D^{1|2}$ is the head wage shock's estimated coefficient on the dependent variable $\Delta e^j - \Delta c^j$. *Source*: Bank of Italy SHIW 2008–2010–2012. Panel components for consecutive waves. Selection of prime-age households.

nificant (albeit only in the second spell), revealing a lower shock absorption from savings/dissavings 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 old age might lower precautionary savings and thus attenuate the relevance of this smoothing channel.

At a macrolevel, Dedola, Usai, and Vannini (1999) 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, Krueger and Perri (2011b) 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)) are consistent with our results.

Within-household risk-sharing ($\beta_H^2$) is also quite large, as it cushions 16% of the shocks in 2008–2010 and about 14% in 2010–2012. This result is in contrast to the findings on the PSID in Hayashi, Altonji, and Kotlikoff (1996) and on both the PSID and the CEX in Dynarski and Gruber (1997), who find nonsignificant effects of nonhead income, but parallels the results on the PSID in García-Escribano (2004), who uses an ASY (1996)-style measure of smoothing. Our result reflects Mocetti, Olivieri, and Viviano's (2011) finding that the effects of the economic crisis on the Italian labor markets 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. It is also very interesting to compare the estimate in column 6 with that in column 2. As the coefficient's estimate in column 6 is about half of the coefficient's estimate in column 2, we conclude that (a) there might be an endogeneity bias affecting the choice of hours worked and that (b) the added worker effect is associated mainly to a change in head's hours worked. Capital income risk-sharing ($\beta_K^2$) does not seem to play any role, as it is neither clearly positive nor statistically significant. This result 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 underreporting of financial assets in household surveys, SHIW not being an exception (D'Aurizio, Faiella, Iezzi and Neri (2006)).[33] Moreover, our result is consistent with Massa and Simonov's (2006) 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.[34]

[33] See Guiso and Jappelli (2000).

[34] We must also report a limited variability of financial capital incomes in the survey that are reconstructed as a linear projection of the different risk classes of the assets held by the households.

To these formal channels we can add the informal one that consists of private transfers between households ($\beta_I^2$) that, however, is not particularly sizable in either spell and does not exhibit, on average, statistical significance.

While private risk-sharing channels buffer about four-fifths of a shock in both spells, public risk-sharing only cushions about 20% of a shock in both spells of time, with taxes smoothing more than transfers. However, it is worth noting that pensions are included in the head's base income and the tax channel excludes risk-sharing through tax evasion—a phenomenon which is particularly widespread in Italy and which we could not take into account in the reconstruction of basic incomes.[35]

At a macrolevel, in Italy, Decressin (2002) finds similar results and Dedola, Usai, and Vannini (1999) find even higher coefficients for 1983–1992, whereas Mélitz and Zumer (1999) find the public risk-sharing channel to be insignificant for 1984–1992.

Looking attentively at the systems of risk-sharing channels provides a deeper insight into the mechanisms underlying the increase in risk-sharing when hours worked are controlled for; not surprisingly, we find intrahousehold income, savings, and durables, that is, the channels which are most dependent on the number of hours worked by the household head.

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 $\beta_{\cdot}^2$ coefficients for intrahousehold risk-sharing in 2010–2012 for public taxes/transfers and for durables), again corroborating our modelling choice.[36]

### 5.3 *Overall risk-sharing and shock persistence*

As already mentioned, the theory only distinguishes between aggregate and idiosyncratic shocks, irrespective of whether they are permanent or transitory, anticipated or unanticipated. However, since we look at deviations from the risk-sharing allocation, measured consumption may well behave suboptimally, reacting differently to permanent versus temporary or anticipated versus unanticipated shocks, presumably depending on market incompleteness or frictions in the attainment of the optimal risk-sharing

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

[36]As anticipated in Section 4, we carried out a robustness test to check the ordering of the channels in the estimating equations. As there is no stringent reason why public transfers should precede taxes or private transfers should follow public transfers, we altered the ordering of those channels. As expected, results are essentially unaffected. As a further stress test, we randomly switched the ordering of several channels, irrespective of their logical placement. In this case, it is possible to show that if the changes in the incomes' definitions are small, compared to the total, the impact on coefficients will be very small. The largest difference with the standard ordering's coefficients only attains the second decimal digit when we move a very relevant channel, that is, intrahousehold smoothing, from the first to the last place in the decomposition, that is, just before savings. Even with such an extreme change in the ordering of channels, however, the overall degree of risk-sharing and the channels' relative importance are preserved.

allocation. From this viewpoint, a fuller characterization of the deviation from the optimal risk-sharing allocation would therefore also be interesting. Since we work essentially with a pair of "two-period" panels, we cannot separate the shocks using time-series techniques; instead, we use responses to survey questions conceived for that purpose. While we cannot use the observations on subjective expectations about permanent versus temporary shocks, as they contain too many missing data, we exploit information on subjective expectations about following year's household income variation surveyed in the 2012 wave of the SHIW[37] and combine them with realized household head's earnings changes.

More specifically, we split the sample into positive and negative earnings shock realizations. Then we use the interaction of a positive (negative) expectation for the following year's household income with a realized positive (negative) head's wage shock to identify the effect of a shock that is subjectively expected to be nontransitory. In other words, we interpret the coexistence of a negative (positive) shock to current head's earnings with a negative (positive) expectation for household income for the following year as an indication of "subjective" persistence of the earnings shock. Then we assess whether a head's earnings shock that is combined with an expectation of the same sign has a different impact on current household consumption than an average idiosyncratic shock to head's earnings. The estimation on the overall household sample (Table B.9) shows that while the positive interaction detects no difference in the earnings change slope, the negative interaction is positive (with a size of 0.29) and significant.

One might observe that there is a discrepancy between the expectation, which is related to household income, and the idiosyncratic shock, which is related to head's earnings. However, since the head is usually also the survey respondent and his/her labor income often represents the greatest share of household income (precisely, on average, it amounts to 78% in our estimation subsample), we are fairly confident that the assumption of a direct link between realized shock and expectation is reasonable. In any case, we also carry out a robustness check by restricting the sample to single earner households. Estimates are reported in the Appendix B, Table B.8. We believe findings confirm our conclusions. In the first estimation, which guarantees the tightest link between realization and expectation, while the dummies for positive (Posexp) and negative (Negexp) expectations are nonsignificant, their interactions with the head's wage shock are significant at the 10% level. In particular, the estimated coefficient of interaction is negative (−48) in the positive shock/positive expectation (i.e., positive persistence) subsample, while it is positive (+49%) in the negative shock/negative expectation (i.e., negative persistence) subsample. This is equivalent to saying that the excess sensitivity of household consumption to an (head's) earnings shock is, in fact, very low for positive shocks perceived as nontransitory and significantly amplified in the case of negative nontransitory shocks. Our interpretation is that households experiencing a persistent positive shock to

[37]The question is, "In 12 months, your family's income will be (distribute 100 points) (i) much higher than today (at least 10% higher), (ii) slightly higher than today (between 2 and 10% higher), (iii) substantially unchanged (no more than 2% higher or lower), (iv) slightly lower than today (between 2 and 10% lower), or (v) much lower than today (at least 10% lower)."

the head's earnings can afford a fuller smoothing of their consumption, whereas households experiencing a persistent negative shock to the head's earnings will just reduce their consumption, in line with intertemporal consumption optimization.

It should be noted that the identification in the single-earner subsample may be affected by the small sample size; therefore, the findings should be read with caution and the signs rather than the exact measures of our point estimates should be emphasized.

## 6. Conclusions

The literature has long raised the question of the economic mechanisms underlying the high degree of risk-sharing often found in microdata. Indeed, while a stream of the literature has always implicitly assumed that risk-sharing is carried out solely through portfolio diversification, the emergence of the channels literature has shifted the focus toward the diversity of mechanisms implementing (or preventing) the planner allocation. This paper sheds a light on such risk-sharing mechanisms operating across households. Hence, for example, our results provide a set of possible mechanisms underlying Krueger and Perri's (2011b) findings in SHIW data of a low correlation between labor income and consumption; even more importantly, our methodology can be carried over to other settings to investigate household risk-sharing in countries where adequate income and consumption data on households are available.

Our finding of a very large role played by intrahousehold risk-sharing bears important consequences also for microeconomic modelling. Indeed, as pointed out by Attanasio and Lechene (2002), the pooling of monetary resources is a necessary condition of the unitary model of household behavior. A high degree of intrahousehold risk-sharing also brings about macroeconomic consequences: findings for the United States by Halla and Scharler (2012) 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 macromodelling, our results show that the bulk of risk-sharing takes place either through self-insurance or within the household, that is, by using the simplest financial tools available to borrow or lend. This suggests that in modelling 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 risk-sharing capacity along a number of dimensions such as the position of households in the wealth distribution, access to credit, preferences heterogeneity, and more.

## 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 microdata 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, Pistaferri, and Saporta-Eksten (2016), for instance, use the functional form suggested by Heathcote, Storesletten, and Violante (2014)), we replicate faithfully the Italian taxation system in force at the time using microsimulation.

*EGaLiTe* (Gastaldi, Liberati, Pisano, and Tedeschi (2017)) is a static tax and 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 microanalysis 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), Immervoll and O'Donoghue (2001)). 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 they 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

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

| Bracket (Euros × 1,000) | Tax Rate (%) |
|---|---|
| Up to 15 | 23 |
| From 15 to 28 | 27 |
| From 28 to 55 | 38 |
| From 55 to 75 | 41 |
| Over 75 | 43 |

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:

Step 1. Identify total income, that is, the sum of the different sources of income subject to the IRPEF.

Step 2. Simulate and subtract the standard deductions (e.g., deduction for owner-occupied housing) from Step 1 to find the taxable income.

Step 3. Apply the tax scale (Table A.6) to Step 2 to find the gross tax.

Step 4. Subtract income tax credits, relief, and tax expenditures from Step 3 (see Table A.7 for the employee tax relief pattern) to get the net tax.

Table A.7. Employee tax relief (2008–2012).

| Total Annual Income ($Y$) (Euros × 1,000) | Annual Deduction (Euros × 1,000) |
|---|---|
| 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 |

## Appendix B: Expectations and persistent income shocks

Table B.8. Overall risk-sharing: single-earner households.

| Dep. Variable: $\Delta c^j$ | (1) (Positive Persistent) | (2) (Negative Persistent) |
|---|---|---|
| $[\beta^2]$: $\widehat{u}_1$ | 0.198 | 0.137 |
| | (0.1105) | (0.1167) |
| Posexp | −0.128 | – |
| | (0.0929) | – |
| Negexp | – | −0.065 |
| | – | (0.0583) |
| $[\Delta\beta^2]$: $\widehat{u}_1 * \text{Posexp}$ | −0.477 | – |
| | (0.2626) | – |
| $[\Delta\beta^2]$: $\widehat{u}_1 * \text{Negexp}$ | – | 0.492 |
| | – | (0.2510) |
| Constant | −0.483 | 0.153 |
| | (1.0760) | (1.0817) |
| Controls | Yes | Yes |
| $R^2$ | 0.275 | 0.188 |
| No. of cases | 171 | 202 |

*Note*: Estimation of equations (16) breaking down the sample by the sign of the shock. The interaction of a positive (negative) expectation for the following year's household income with an experienced positive (negative) wage shock is used to identify the differential effect of a "persistent" shock. *Notation*: $[\beta^2]$ is the wage shock ($\widehat{u}_1$) estimated coefficient; Posexp is the positive subjective expectation for next year's household income; Negexp is the negative subjective expectation for next year's household income; $\widehat{u}_1 * \text{Posexp}$ and $\widehat{u}_1 * \text{Negexp}$ are shock persistency interactions. *Source*: Bank of Italy SHIW 2010–2012 panel components. Selection of prime-age, single-earner households.

Table B.9. Overall risk-sharing: all households.

| Dep. Variable: $\Delta c^j$ | (1) (Positive Persistent) | (2) (Negative Persistent) |
|---|---|---|
| $[\beta^2]$: $\widehat{u}_1$ | 0.045 | 0.094 |
| | (0.0613) | (0.0638) |
| Posexp | −0.113 | – |
| | (0.0535) | – |
| Negexp | – | −0.008 |
| | – | (0.0460) |
| $[\Delta\beta^2]$: $\widehat{u}_1 * \text{Posexp}$ | 0.115 | – |
| | (0.1687) | – |
| $[\Delta\beta^2]$: $\widehat{u}_1 * \text{Negexp}$ | – | 0.287 |
| | – | (0.1412) |
| Constant | −0.216 | −0.568 |
| | (0.6758) | (0.7815) |
| Controls | Yes | Yes |
| $R^2$ | 0.132 | 0.148 |
| No. of cases | 578 | 558 |

*Note*: Estimation of equations (16) breaking down the sample by the sign of the shock. The interaction of a positive (negative) expectation for the following year's household income with an experienced positive (negative) wage shock is used to identify the differential effect of a "persistent" shock. *Notation*: $[\beta^2]$ is the wage shock ($\widehat{u}_1$) estimated coeffcient; Posexp is the positive subjective expectation for next year's household income; Negexp is the negative subjective expectation for next year's household income; $\widehat{u}_1 * \text{Posexp}$ and $\widehat{u}_1 * \text{Negexp}$ are shock persistency interactions. *Source*: Bank of Italy SHIW 2010–2012 panel components. Prime-age households.

## References

Aaberge, R., U. Colombino, and S. Strøm (1999), "Labour supply in Italy: An empirical analysis of joint household decisions, with taxes and quantity constraints." *Journal of Applied Econometrics*, 14 (4), 403–422. [1123]

Alvarez, F. and U. Jermann (2000), "Efficiency, equilibrium, and asset pricing with risk of default." *Econometrica*, 68 (5), 775–797. [1110]

Arrow, K. J. (1964), "The role of the securities in the optimal allocation of risk-bearing." *Review of Economic Studies*, 31 (2), 91–96. [1110, 1111, 1115]

Asdrubali, P., B. E. Sørensen, and O. Yosha (1996), "Channels of interstate risk sharing: United States 1963–1990." *Quarterly Journal of Economics*, 111, 1081–1110. Reprinted in P. de Grauwe, ed., *The Political Economy of Monetary Unions*, Edward Elgar, Cheltenham (2001). [1111]

Asdrubali, P., S. Tedeschi, and L. Ventura (2020), "Supplement to 'Household risk-sharing channels'." *Quantitative Economics Supplemental Material*, 11, https://doi.org/10.3982/QE1000. [1109]

Attanasio, O. P. (1999), "Consumption." In *Handbook of Macroeconomics*, Vol. 1 (J. B. Taylor and M. Woodford, eds.), Elsevier, Amsterdam. [1112]

Attanasio, O. P. and S. J. Davis (1996), "Relative wage movements and the distribution of consumption." *Journal of Political Economy*, 104 (6), 1227–1262. [1110, 1113, 1116]

Attanasio, O. P. and V. Lechene (2002), "Tests of income pooling in household decisions." *Review of Economic Dynamics*, 5, 720–748. [1133]

Backus, D., P. Kehoe, and F. Kydland (1992), "International real business cycles." *Journal of Political Economy*, 100 (4), 745–775. [1111]

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. [1112]

Baxter, M. and M. J. Crucini (1995), "Business cycles and the asset structure of foreign trade." *International Economic Review*, 36, 821–854. [1116]

Becker, G. B. (1973), "A theory of marriage: Part I." *Journal of Political Economy*, 81, 813–846. [1110]

Becker, G. B. (1974), "A theory of marriage: Part II." *Journal of Political Economy*, 82, 11–26. [1110]

Blundell, R., L. Pistaferri, and I. Preston (2008), "Consumption inequality and partial insurance." *American Economic Review*, 98 (5), 1887–1921. [1111, 1117]

Blundell, R., L. Pistaferri, and I. Saporta-Eksten (2016), "Consumption inequality and family labor supply." *American Economic Review*, 106 (2), 387–435. [1134]

Canova, F. and M. O. Ravn (1996), "International consumption risksharing." *International Economic Review*, 37 (3), 573–601. [1111]

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. [1128]

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. [1128]

Cerletti, E. A. and J. Pijoan-Mas (2012), "Durable goods, borrowing constraints and consumption insurance." Working Paper 2012-1206, CEMFI. [1114, 1116]

Chami, R. and G. Hess (2005), "For better or for worse? State-level marital formation and risk sharing." *Review of Economics of the Household*, 3 (4), 367–385. [1110]

Cochrane, J. H. (1991), "A simple test of full consumption insurance." *Journal of Political Economy*, 99, 957–976. [1110, 1114, 1115, 1122]

Cox, D. (1987), "Motives for private income transfers." *Journal of Political Economy*, 95, 508–546. [1111]

D'Aurizio, L., I. Faiella, S. Iezzi, and A. Neri (2006), "The under-reporting of financial wealth in the Survey on Household income and Wealth." Temi di discussione (Economic Working Paper) 610, Bank of Italy, Economic Research and International Relations Area. [1113, 1130]

Deaton, A. (1992), *Understanding Consumption*. Clarendon Press, Oxford. [1110, 1111]

Deaton, A. (1997), *The Analysis of Household Surveys*. The Johns Hopkins University Press, Baltimore, MD. [1109]

Declich, C. and L. Ventura (2000), "Incompletezza dei mercati e assicurazione del consumo: un'analisi empirica per le regioni italiane." *Rivista di Politica Economica*, 9, 29–57. [1110]

Decressin, J. (2002), "Regional income redistribution and risk sharing: How does Italy compare in Europe?" *Journal of Public Economics*, 86, 287–306. [1111, 1131]

Dedola, L., S. Usai, and M. Vannini (1999), "An assessment on risk sharing in Italy and the United Kingdom." In *Economic Growth and Change. National and Regional Patterns of Convergence and Divergence* (J. Adams and F. Pigliaru, eds.), Edward Elgar, Cheltenham. [1111, 1128, 1130, 1131]

Devereux, M. B. and G. W. Smith (1994), "International risk sharing and economic growth." *International Economic Review*, 35 (3), 535–550. [1110]

Duffie, J. D. and C.-F. Huang (1985), "Implementing Arrow–Debreu equilibria by continuous trading of a few long-lived securities." *Econometrica*, 53, 1337–1356. [1115]

Dynarski, S. and J. Gruber (1997), "Can families smooth variable earnings?" *Brookings Papers on Economic Activity*, 28 (1), 229–303. [1111, 1112, 1113, 1115, 1116, 1117, 1122, 1124, 1125, 1130]

Fafchamps, M. (2011), "Risk sharing between households." In *Handbook of Social Economics*, Vol. 1A (J. Benhabib, A. Bisin, and M. O. Jackson, eds.), North-Holland, Amsterdam. [1117]

García-Escribano, M. (2004), "Does spousal labor smooth fluctuations in husbands' earnings? The role of liquidity constraints." IMF Working Paper WP/04/20. [1111, 1112, 1130]

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. [1128]

Gastaldi, F., P. Liberati, E. Pisano, and S. Tedeschi (2017), "Regressivity-reducing VAT reforms." *International Journal of Microsimulation*, 10 (1), 39–72. [1134]

Gervais, M. and P. Klein (2010), "Measuring consumption smoothing in CEX data." *Journal of Monetary Economics*, 57 (8), 988–999. [1110, 1113, 1130]

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. [1110]

Guiso, L. and T. Jappelli (2000), "Household portfolios in Italy." In *Household Portfolios* (L. Guiso, M. Haliassos, and T. Jappelli, eds.), 251–308, MIT Press. [1130]

Halla, M. and J. Scharler (2012), "Marriage, divorce, and interstate risk sharing." *Scandinavian Journal of Economics*, 114 (1), 55–78. [1133]

Hayashi, F., J. Altonji, and L. Kotlikoff (1996), "Risk-sharing between and within families." *Econometrica*, 64 (2), 261–294. [1110, 1111, 1112, 1114, 1130]

Heathcote, J., K. Storesletten, and G. L. Violante (2014), "Consumption and labor supply with partial insurance: An analytical framework." *American Economic Review*, 104 (7), 2075–2126. [1134]

Hess, G. D. and K. Shin (1998), "Intranational business cycles in the US." *Journal of International Economics*, 44 (2), 289–313. [1111]

Huang, C. and R. Litzenberger (1988), *Foundations for Financial Economics*. North-Holland, New York, NY. [1110]

Immervoll, H. and C. O'Donoghue (2001), "Imputation of gross amounts from net incomes in household surveys: An application using EUROMOD." EUROMOD working paper. [1134]

Jappelli, T. and L. Pistaferri (2006), "Intertemporal choice and consumption mobility." *Journal of the European Economic Association*, 4, 75–115. [1120]

Jappelli, T. and L. Pistaferri (2010a), "The consumption response to income changes." *Annual Review of Economics*, 2 (1), 479–506. [1126]

Jappelli, T. and L. Pistaferri (2010b), "Does consumption inequality track income inequality in Italy?" *Review of Economic Dynamics*, 13 (1), 133–153. [1120]

Jappelli, T. and L. Pistaferri (2011), "Financial integration and consumption smoothing." *The Economic Journal*, 121 (553), 678–706. [1120]

Jappelli, T. and L. Pistaferri (2017), *The Economics of Consumption: Theory and Evidence*. Oxford University Press, Oxford. [1111]

Kehoe, T. and D. Levine (1993), "Debt constrained asset markets." *Review of Economic Studies*, 60 (4), 865–888. [1110]

Kocherlakota, N. R. (1996), "Implications of efficient risk sharing without commitment." *Review of Economic Studies*, 63 (4), 595–609. [1110]

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. [1110]

Krueger, D. and F. Perri (2011a), "Public versus private risk sharing." *Journal of Economic Theory*, 146, 920–956. [1110]

Krueger, D. and F. Perri (2011b), "How does household consumption respond to income shocks?" Report. [1110, 1128, 1130, 1133]

Krueger, D. and H. Uhlig (2006), “Competitive risk sharing contracts with one-sided commitment.” *Journal of Monetary Economics*, 53, 1661–1691. [1110]

Levine, D. and W. Zame (2002), “Does market incompleteness matter?” *Econometrica*, 70 (5), 1805–1839. [1116]

Mace, B. J. (1991), “Full insurance in the presence of aggregate uncertainty.” *Journal of Political Economy*, 99 (5), 928–956. [1110, 1115, 1117, 1124]

Massa, M. and A. Simonov (2006), “Hedging, familiarity and portfolio choice.” *Review of Financial Studies*, 19 (2), 633–685. [1130]

McKenzie, D. J. (2006), “The consumer response to the Mexican peso crisis.” *Economic Development and Cultural Change*, 55, 139–172. [1130]

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. [1111, 1128, 1131]

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. [1130]

Nelson, J. A. (1994), “On testing for full insurance using Consumer Expenditure Survey data.” *Journal of Political Economy*, 102 (2), 384–394. [1110, 1112]

Obstfeld, M. (1994), “Evaluating risky consumption paths: The role of intertemporal substitutability.” *European Economic Review*, 38 (7), 1471–1486. [1117]

Padula, M. (2004), “Consumer durables and the marginal propensity to consume out of permanent income shocks.” *Research in Economics, Elsevier*, 58 (4), 319–341. [1120]

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. [1111]

Park, K. and D. Shin (2010), “How do families smooth household heads’ earnings volatility?” *Journal of Economic Research*, 15, 79–97. [1112, 1116, 1121]

Rosenzweig, M. R. (1988), “Risk, implicit contracts and the family in rural areas of low-income countries.” *The Economic Journal*, 98, 1148–1170. [1110]

Rosenzweig, M. R. and O. Stark (1989), “Consumption smoothing, migration, and marriage: Evidence from rural India.” *Journal of Political Economy*, 97, 905–926. [1110]

Rosenzweig, M. R. and K. I. Wolpin (1985), “Specific experience, household structure and intergenerational transfers: Farm family land and labor arrangements in developing countries.” *Quarterly Journal of Economics*, 100, 961–987. [1110]

Rosenzweig, M. R. and K. I. Wolpin (1994), “Parental and public transfers to young women and their children.” *American Economic Review*, 84, 1195–1212. [1110]

Sala-i-Martin, X. and J. Sachs (1992), “Fiscal federalism and optimum currency areas: Evidence for Europe from the United States.” In *Establishing a Central Bank: Issues in*

*Europe and Lessons From the U.S.* (M. Canzoneri, P. Masson, and V. Grilli, eds.), 195–219, Cambridge University Press, London. [1111]

Samphantharak, K. and R. M. Townsend (2006), "Households as corporate firms: Constructing financial statements from integrated household surveys." Available at SSRN 911964. [1119]

Scorcu, A. E. (1997), "Contiguitá territoriale e shock sul consumo nelle regioni italiane." *Rivista di Politica Economica*, 87 (11), 3–24. [1128]

Sørensen, B. E. and O. Yosha (1998), "International risk sharing and European monetary unification." *Journal of International Economics*, 45, 211–238. [1113, 1121]

Sutherland, H. (2001), "EUROMOD: An integrated European benefit-tax model: Final report." EUROMOD Working Paper, Department of Applied Economics, University of Cambridge. [1134]

Townsend, R. M. (1994), "Risk and insurance in village India." *Econometrica*, 62, 539–591. [1110, 1111, 1115]

Von Hagen, J. (1992), "Fiscal arrangements in a monetary union: Evidence from the US." In *Fiscal Policy, Taxation, and the Financial System in an Increasingly Integrated Europe* (D. E. Fair and C. de Boissieu, eds.), 337–359, Kluwer, Boston, MA. [1111]

Willen, P. (1999), "Welfare, financial innovation and self insurance in dynamic incomplete market models." Princeton University. [1116]

---

Co-editor Christopher Taber handled this manuscript.

Manuscript received 16 October, 2017; final version accepted 29 February, 2020; available online 23 March, 2020.