Can limited stock market participation solve the equity premium puzzle? – An analysis using U.S. national account data

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1 Introduction

For more than a century, the returns on equity have been considerably higher than the returns on a relatively riskless security. Over the period 1900 to 2008 the U.S. real stock return has averaged 5.9%, compared to a 1.6% average real risk-free rate, implying thus an average equity premium of 4.3%.[1] Standard theory explains the higher stock returns as resulting from a premium for bearing non-diversifiable aggregate risk. However, as Mehra and Prescott (1985) noted, the observed historical equity premium is too large to be rationalized in the context of the standard neoclassical paradigm of financial economics. Building upon the consumption based asset pricing model of Lucas (1978), they find, that – given reasonable values for the parameter of relative risk aversion (RRA) – the risk inherent to stocks can explain an equity premium of at most 0.35%. This inconsistency between the theoretical model and financial data, named equity premium puzzle by Mehra and Prescott, cannot be dismissed lightly, since much of our economic intuition is based on the very same model. Quantitative predictions of such a model remain thus questionable, as long as the puzzle persists.

Since Mehra and Prescott came up with this puzzle, a great many economists have looked for solutions. The original exchange economy setup with a representative agent and power utility has been extended along several lines. Most notable among the adaptations are alternative assumptions on preferences (Abel (1990), Campbell and Cochrane (1999), Constantinides (1990), Epstein and Zin (1991)), incomplete markets (Constantinides and Duffie (1996), Heaton and Lucas (1996)), market imperfections (Basak and Cuoco (1998), Constantinides et al. (2002)), and the limited participation in the stock market by some agents of the economy.[2] However, in spite of 25 years of research efforts, the ultimate solution to the puzzle has not been found yet.

Mankiw and Zeldes (1991) were the first to note that accounting for the limited participation in stock markets of some agents of the economy, i.e. differentiating between stockholders and nonstockholders, can help to solve the equity premium puzzle. In the framework of the consumption based capital asset pricing model, the Euler equations resulting from the maximization problem of the representative agent can be solved for the equity premium. This premium is dependent upon the RRA-coefficient and the correlation between consumption growth and excess asset returns. Mankiw and Zeldes observed in U.S. household data, that the correlation between consumption growth and stock returns is higher for stockholders

[1]These figures are based on a dataset compiled by Robert J. Shiller available on `http://www.econ.yale.edu/~shiller/data.htm`.

[2]Comprehensive literature reviews about the equity premium puzzle can be found in Kocherlakota (1996), Mehra (2006), and De Long and Magin (2009) among others.

than for nonstockholders, implying thus a lower relative risk aversion for the former group. Their publication, as well as the subsequent literature on limited stock market participation, relies on microeconomic data. Some of the flaws connected to the use of this survey based data are measurement errors in the consumption measure as well as possible misclassifications of the observed households into the groups of stockholders and nonstockholders. To overcome these flaws and to complement the existing literature on limited participation, we employ macroeconomic data to determine the consumption of stockholders and nonstockholders. Macroeconomic data has moreover the advantage of being available for a high number of countries and makes, therefore, the implementation of cross-country comparisons straightforward. We follow the approach taken by De Vries and Zenhorst (2010) (VZ) and use income data from national accounts to construct the comsumption series. Specifically, we concentrate on U.S. data, which is available for a longer time span and at a higher frequency than the data used by VZ. Moreover, the U.S. data is more detailed than the OECD data in VZ and therefore allows for a better separation of income into the consumption of stockholders and nonstockholders. Taken together, these advantages allow us to see how far group-specific consumption series based on macroeconomic data can go in solving the equity premium puzzle.

The remainder of the paper is organized as follows. Section 2 reviews the literature that tries to solve the equity premium puzzle by accounting for limited participation in asset markets. In section 3 we present the model and the related identification strategy of the parameter of relative risk aversion. The methodology used to construct the consumption series from national account data is treated in the fourth section. Section 5 contains a description of the dataset. The empirical results will be discussed in section 6, and section 7 concludes.

2 Literature review

Following the lines of Mankiw and Zeldes (1991), we first lay out why the limited stock market participation of some agents of the economy can help to explain the size of the equity premium. We then review the subsequent literature which, in a similar fashion as Mankiw and Zeldes' publication, takes the equity premium as given, and estimates the coefficient of relative risk aversion on the basis of Euler equations. A discussion of simulation studies which assess the effect of limited participation on the ability of general equilibrium models to generate a high equity premium follows. Finally, the article by De Vries and Zenhorst (2010), which we closely follow in terms of methodology, is discussed.

The starting point of both Mehra and Prescott's (1985) and Mankiw and Zeldes' (1991) analysis is a representative agent maximizing his lifetime utility by choosing optimal consumption levels. The agent can shift consumption between periods by trading riskless securities and a market portfolio of stocks. The choice of the optimal portfolio thus maximizes[3]

$$E_t \int_0^\infty e^{-\delta s} U(C_{t+s}) ds \tag{1}$$

where E_t denotes the expectation operator conditional on information available at time t, δ is the subjective time discount factor, $U(C)$ is the instantaneous utility function and C denotes consumption. Maximization of the above lifetime utility leads to the Euler equation

$$E_t \left[\frac{U'(C_{t+s}) e^{-\delta s}}{U'(C_t)} R^i_{t,t+s} \right] = 1 \tag{2}$$

where $R^i_{t,t+s}$ denotes the gross rate of return on asset i between time t and $t+s$. With the assumption of power utility

$$U(C) = \frac{C^{1-\gamma}}{1-\gamma} \tag{3}$$

where γ is the coefficient of relative risk aversion, the Euler equations for stock returns R^s and the risk-free rate R^f can be used to express the expected equity premium as

$$E(R^s_t - R^f_t) = \gamma * corr(R^s_t - R^f_t, GC_t) * \sigma(GC_t) * \sigma(R^s_t - R^f_t) \tag{4}$$

where E is the unconditional expectation operator and GC_t is the instantaneous rate of consumption growth. At this point, the coefficient of relative risk aversion can be computed by solving for γ and estimating the sample counterparts of the remaining terms.

The critical question at this point concerns the choice of data to estimate the moments incorporating consumption growth in equation (4). Traditionally, aggregate per capita consumption has been used. As Mankiw and Zeldes note, this may be inappropriate, since only some agents of the economy participate in stock markets. While for nonstockholders equation (4) is not valid, they still contribute to aggregate consumption. The use of aggregate consumption to estimate the moments in equation (4) can thus only be justified, if the consumption growth rates of stockholders and nonstockholders are identical. Guo (2001) argues that the problem is even aggravated by the concentration of stockholdings in the hands of few rich people whose share of aggregate consumption is quite low. These two features lead aggregate consumption to be a poor proxy for stockholders' consumption.

[3]Mankiw and Zeldes (1991) follow a continuous time approach. Mehra and Prescott (1985) as well as VZ use a discrete time model. As argued by Cochrane (2001), the choice between the two modeling approaches is merely a matter of modeling convenience.

Using data from the Panel Study of Income Dynamics, containing information on both consumption and financial wealth of households, Mankiw and Zeldes find that the consumption of stockholders exhibits a higher variance and is more strongly correlated with the excess returns of stocks than the consumption of nonstockholders. As a consequence, the implied coefficient of relative risk aversion is lower when the consumption of stockholders is used in the place of aggregate consumption. Mankiw and Zeldes, restating the equity premium puzzle, report estimates of the coefficient of relative risk aversion based on the consumption aggregated over both stockholding and nonstockholding households of 100. When using the consumption of only stockholding households, the estimate is lowered to a value of 35. While this is still far from reasonable figures below ten[4], it shows that the distinction between stockholders and nonstockholders brings us closer to solving the equity premium puzzle.

Jacobs' (2001) results, based on almost the same data as Mankiw and Zeldes' study, underline the importance of accounting for limited asset market participation. Jacobs uses the generalized method of moments (GMM) to estimate the preference parameters of a Cobb-Douglas per period utility function which is nonseparable in consumption and leisure. Only when considering the sample of stockholders, he obtains reasonable estimates of the parameter of relative risk aversion between two and five, compared to negative estimates when considering the full sample of households.

The somehow positive results of Mankiw and Zeldes (1991) and Jacobs (2001) have to be seen in the light of several limitations related to the poor quality of the dataset they use. First, food consumption is used as a proxy for the consumption of nondurables. Attanasio and Weber (1995) argue however, that due to the nonseparability of preferences in food and other nondurables, food consumption is a poor proxy for total nondurable consumption. Second, Mankiw and Zeldes base their estimations on merely thirteen yearly observations ranging from 1970 to 1984. Finally, the separation of households into the group of stockholders and nonstockholders is far from being perfect. In both studies households are classified conditional on information available for the year 1984 only. It cannot be excluded thus, that households owning stock prior to 1984, but not in 1984 and households owning stocks in 1984, but not before, are misclassified.

All these flaws have been overcome to a good extent by the subsequent literature that takes the equity premium as given and then estimates the coefficient of relative risk aversion. These more recent publications make use of longer time series or panel data and the employed datasets contain better consumption measures. Most of the studies rely on the U.S.

[4]Mehra and Prescott (1985), citing numerous studies, argue that a reasonable upper bound for the coefficient of relative risk aversion is ten, and use this value accordingly as a maximum in the calibration of their model. Also Mankiw and Zeldes (1991) conclude on the basis of a thought experiment, that values as large as 20 are already too high.

Consumer Expenditure Survey (CEX)[5], which contains sufficient information on asset holder status to classify households into the group of stockholders and nonstockholders reasonably well.

The consensus emerging from these studies is that the limited participation in asset markets is important in explaining the equity premium puzzle, but cannot solve it completely. Brav et al. (2002), in a similar fashion as Mankiw and Zeldes, compute the correlation between excess returns and consumption growth for different groups of stockholders. They observe that the correlation increases, as the threshold of assets held necessary for being classified as an asset holder is increased. Moreover, they test whether RRA coefficients between zero and 20 can - together with a stochastic discount factor based on the consumption of asset holding households - generate the historical equity premium. Brav et al. find some evidence, that a coefficient of relative risk aversion between 15 and 20 might explain the premium. However this result is sensible to the empirical design.[6]

Attanasio et al. (2002) and Paiella (2004) – instead of taking the unconditional version of equation (2) – rely on the conditional version to construct multiple orthogonality restrictions. The additional information about predictable movements in expected consumption growth and asset prices may lead to a higher precision of the estimates compared to Mankiw and Zeldes' approach. Attanasio et al. obtain estimates for the RRA coefficient that lie between 0.6 and 1.4 for shareholders and between 2.1 and 8.6 for nonshareholders.[7] Paiella finds a somewhat higher estimate of 7.5 with the difference being probably due to the dataset used[8]. Attanasio and Paiella (2010) explicitly incorporate fixed costs of participating in the asset market in their model. Together with a lower bound of participation costs in terms of nondurable consumption, the RRA coefficient is estimated. The estimates are robust to changes in the empirical specification and lie between 1.2 and 2.0.

Vissing-Jørgensen (2002) estimates the elasticity of intertemporal substitution (EIS) for

[5]One exception is Attanasio et al. (2002). In this study the authors use the U.K. Family Expenditure Survey which consists in repeated cross sections. Since they cannot observe consumption and asset holding status in two adjacent periods, they construct groups of likely shareholders using a probit specification. The classification error which arises due to the use of this empirical strategy leads however to a bias towards the results which would be obtained using aggregate consumption instead of stockholders' consumption as shown by Paiella (2004).

[6]More specifically Brav et al. are not able to generate the observed equity premium with values of the RRA coefficient between zero and 20, when the holding period of an asset is only three months or when the start of the holding period is shifted by a quarter.

[7]Whereas the estimates for shareholders are based on two Euler equations involving both stock and treasury bill returns with the coefficient of relative risk aversion being restricted to be the same across equations, the estimates for nonshareholders rely only on the Euler equation for treasury bill returns.

[8]Paiella's analysis is based on the U.S. CEX, whereas Attanasio et al. analyze U.K. data. With respect to the methodology however, Paiella closely follows Attanasio et al., especially in terms of the construction of the group of likely stockholders and nonstockholders.

participants and nonparticipants in the asset market without imposing the restriction of power utility on consumer preferences. When estimating the EIS for stock and treasury returns jointly, the estimates for stockholders lie between 0.26 and 0.44, implying a coefficient of relative risk aversion under power utility between 2 and 4. However, the related tests of overidentifying restrictions are rejected.[9] In a subsequent publication Attanasio and Vissing-Jørgensen (2003) generalize their approach by assuming the preference structure developed by Epstein and Zin (1991). Under realistic assumptions they obtain values for the RRA coefficient that lie between 5 and 10.

The above discussed literature which estimates the coefficient of relative risk aversion based on Euler equations points towards the importance of limited participation for the solution of the equity premium puzzle. The evidence arising from simulation studies is less clear. In these studies, given relative risk aversion coefficients below ten, a model is checked with respect to its ability of generating a high equity premium as well as other time series characteristics of asset market and consumption data. A direct comparison between the simulation studies remains questionable, since they differ considerably in terms of methodology.

Constantinides et al. (2002, 2007) and Gomes and Michaelides (2005, 2008), for instance, employ overlapping generations (OLG) models. Constantinides et al. assume that there are three agents: a young agent receiving only labour income and restricted from the stock market through borrowing constraints, a middle-aged agent receiving labour income and participating in asset markets, and an old agent consuming the wealth accumulated in the second life stage. This heterogeneity in asset market participation between generations is successful in generating a reasonable equity premium. However, as Constantinides et al. test in their 2002 paper, the introduction of additional exogenous non-participation within the older two generations does not lead to substantial changes in the observed statistics. Gomes and Michaelides (2005, 2008) calibrate a model where the participation in the asset market is determined endogenously. The assumption of Epstein-Zin preferences, fixed asset market entry cost and heterogeneity between agents in relative risk aversion made in their 2005 publication lead the less risk averse agents to hardly ever invest in stocks. The simulations show, that under this setting a reasonable equity premium can be generated. Nevertheless the fact that stockholders are endogenously more risk averse is not supported by other empirical work. The model studied in their 2008 paper includes the extension of household specific uninsurable labour income shocks. As Gomes and Michaelides argue in this publication,

[9] The tests of overidentifying restrictions are not rejected, when the Euler equations for stock and treasury bill returns are estimated separately. Yet, these results are of less interest, since the coefficient of relative risk aversion within the equity premium puzzle framework should be related to the excess return of stocks, and not the simple stock return.

the limited participation is not crucial in generating reasonable values for the statistics of interest, since the nonparticipants in the stock market are significantly less wealthy and therefore their exclusion from the asset markets has negligible effects. Nevertheless the higher correlation between stockholders' consumption growth and excess stock returns facilitates the calibration of the model economy, strengthening the importance of accounting for limited participation.

Other papers (Guo (2004), Polkovchinenko (2004), Guvenen and Kuruscu (2006), Guvenen (2009) and De Graeve et al. (2010)) study infinite horizon models where the nonparticipation in asset markets of some agents is exogenously assumed. Guo (2004) relies on borrowing constraints and limited participation to generate a high equity premium. While the borrowing constraints of stockholders lead to a high premium on stocks, the precautionary saving demand lowers the risk-free rate. Polkovchinenko (2004) does not find evidence for the limited participation hypothesis instead. He argues, that the fraction of labour income received by stockholders plays a crucial role. If 75% of stockholders' endowments are derived from labour, the implied equity premium amounts to merely 0.2%. Only under the restrictive assumptions of stockholders' endowments being merely derived from capital income and a higher relative risk aversion for stockholders than for nonstockholders an equity premium of 4.3% can be obtained. Guvenen and Kuruscu (2006) are able to generate an equity premium of 6.1% when agents have an inelastic labour supply and the stockholding agents have a RRA coefficient of 4 compared to the value of 10 for nonstockholders. Also Guvenen (2009), following the path taken by Guvenen and Kuruscu, assumes limited stock market participation and heterogeneity in the relative risk aversion between market participants and nonparticipants. His model is able to match the historical equity premium, however it relies on the restrictive assumption of no long run growth. De Graeve et al. (2010) differentiate between workers, bondholders and stockholders. Whereas workers and bondholders have a RRA coefficient of 10, stockholders are less risk averse (relative risk aversion coefficient of 4). The concentration of consumption risk in the group of stockholders leads to a high equity premium in this model.

A conclusion with respect to the importance of limited participation cannot be easily drawn from the above discussed simulation studies. Almost always the models contain additional features as for instance market imperfections, which make it difficult to isolate the effect of limited stock market participation. Moreover, sometimes restrictive assumptions are made or the first and second moments of financial and macroeconomic data are not well matched by the model. However, as pointed out by Gomes and Michaelides (2008), limited participation can be important for the calibration of the models. In fact, even if the role in explaining the equity premium is not fully determined, limited participation should be part of the models, as it is a well documented empirical fact.

Overall, taking the two discussed literature streams on limited participation together, accounting for limited participation contributes to a solution of the equity premium puzzle. The approach we follow in our paper is closely related to Mankiw and Zeldes' original work. Given consumption growth of stockholders and nonstockholders, we estimate the coefficient of relative risk aversion. Our paper differs with respect to the previous literature in that it does not rely on microeconomic data, but uses aggregate income data to construct consumption series of asset market participants and nonparticipants. This idea has been introduced by De Vries and Zenhorst (2010). They classify the different components of net national disposable income to be either capital or labour income. The capital income series then serves as a basis for the consumption of stockholders, whereas the labour income series is used to proxy for nonstockholders' consumption. As with microeconomic data, there are several potential drawbacks related to the use of macroeconomic data. First, for the selection of OECD countries studied by VZ, the net national disposable income series are available for households only at an annual frequency. Second, some of the components of net national disposable income are not attributed to either of the two income series. Finally the consumption growth rates based on the consumption streams of stockholders and nonstockholders are not adjusted for the number of (non)stockholders. Our attempt is to overcome the first two drawbacks by focusing merely on the U.S., since the income data available at the U.S. Bureau of Economic Affairs (BEA) is more detailed, has a higher frequency and covers a longer time span.

3 Model

In order to compare the results of our paper with those of VZ (2010), we adopt their model setup. They use a discrete time representation of the consumption based capital asset pricing model, which is originally due to Breeden (1979). The implications of this discrete time version have been explored by Grossman and Shiller (1981), Shiller (1982), Hansen and Jagannathan (1991) and Cochrane and Hansen (1992). Starting point of the model is a representative investor who chooses his portfolio to maximize his time-separable expected life time utility

$$E_0\left[\sum_{t=0}^{\infty}\delta^t U(C_t)\right] \tag{5}$$

where E_0 denotes the expectation operator conditional on information available at time $t = 0$, δ is the subjective time discount factor, $U(C)$ is the per period utility function and C_t is the consumption at time t. Assuming power utility, the Euler equation for asset i originating from the maximization problem reads

$$E_t\left[\delta\left(\frac{C_{t+s}}{C_t}\right)^{-\gamma} R^i_{t,t+s}\right] = 1 \tag{6}$$

with γ denoting the coefficient of relative risk aversion and $R^i_{t,t+s}$ denoting asset i's gross rate of return between time t and $t+s$. Making Hansen and Singleton's (1983) simplifying assumption of joint conditional lognormality and homoskedasticity of asset returns and consumption growth, and taking logs of both sides of equation (6) leads to

$$\ln\delta - \gamma E_t\left[\Delta_s c_{t+s}\right] + E_t\left[r^i_{t,t+s}\right] + \frac{1}{2}\left(\sigma_i^2 + \gamma^2\sigma_c^2 - 2\gamma\sigma_{ic}\right) = 0 \tag{7}$$

where small letters denote logarithms and Δ_s denotes the difference operator for time t and $t-s$. σ_i^2, σ_c^2 and σ_{ic} are the unconditional variance of asset i's log return innovations $Var[r^i_{t,t+s} - E_t(r^i_{t,t+s})]$, the unconditional variance of consumption growth[10] innovations $Var[\Delta_s c_{t+s} - E_t(\Delta_s c_{t+s})]$ and the unconditional covariance of innovations $Cov[r^i_{t,t+s} - E_t(r^i_{t,t+s}), \Delta_s c_{t+s} - E_t(\Delta_s c_{t+s})]$ respectively. For the log risk-free asset we have instead

$$\ln\delta - \gamma E_t[\Delta_s c_{t+s}] + E_t[r^f_{t,t+s}] + \frac{1}{2}\gamma^2\sigma_c^2 = 0 \tag{8}$$

since its innovations have variance zero and are uncorrelated with the consumption growth innovations. Solving for the expected premium $E_t[r^i_{t,t+s} - r^f_{t,t+s}]$ leads to

$$E_t[r^i_{t,t+s} - r^f_{t,t+s}] = -\frac{1}{2}\sigma_i^2 + \gamma\sigma_{ic}. \tag{9}$$

At this point the coefficient of relative risk aversion can be computed by estimating the moments contained in equation (9). To show how far the distinction between stockholders and nonstockholders can go in resolving the equity premium puzzle, we estimate the correlation between consumption growth and log asset returns with aggregate consumption, stockholders' consumption and the consumption of nonstockholders. Even if the implied estimates of the RRA coefficient are inconsistent for the latter two groups, these estimates are reported for benchmark purposes.

[10]Consumption growth rates are computed as $ln(C_{t+s}/C_t)$.

4 Methodology

In this section we lay out how the consumption streams for the groups of stockholders and nonstockholders are computed from national account data. We start by recapitulating the method used by VZ. We then describe how we replicate their methodology and describe the drawbacks of their approach. Two extensions of their methodology follow. Finally we describe the block jackknife procedure developed by Pozzi et al. (2010), which we make use of in our paper to gauge the uncertainty related to the estimation of the RRA coefficients.

4.1 Methodology used by De Vries and Zenhorst (2010)

Contrary to household survey data, national account data does not contain direct information that would allow to compute consumption streams separately for stockholders and nonstockholders, i.e. consumption expenditures are available only as an aggregate for all households. To circumvent this problem, VZ base their analysis not on consumption, but on the primary and secondary distribution of income accounts of households, arguing that income is intimately linked to consumption. Whereas these income accounts still do not contain a subdivision for stockholding and nonstockholding households, it is possible to assign the different components of net disposable income to the production factors by which they are earned. VZ differentiate between the two factors capital and labour and assign all the income accruing to the factor capital to stockholders, whereas the labour income is allocated to the nonstockholders. Out of the different components of household net disposable income (table 1) the compensation of employees, the gross operating surplus and mixed income, and the consumption of fixed capital are used to construct two income streams.[11] Since the gross mixed income of households, defined as surplus arising from the productive activities of a household unincorporated enterprise, usually consists of a mixture of capital and labour income, VZ divide this item into two parts, one accruing to stockholders and the other to nonstockholders. The part of mixed income assigned to nonstockholders, i.e. the part earned by the factor labour is estimated as follows. The yearly mean compensation per employee is computed using the corresponding item from the primary income distribution account and the number of employees. This figure is multiplied by the number of the self-employed to obtain the compensation of the self-employed. The compensation of the self-employed is then subtracted from gross mixed income and the remainder is assigned to the stockholding households. While the gross operating surplus is added to stockholder income and the consumption of fixed capital is subtracted from it, the compensation of employees is assigned to nonstockholder income (table 2).

[11] See appendix A, SNA93 definitions, for a detailed description of the components of table 1.

Table 1: **Derivation of household net disposable income**

	(1)	Compensation of employees
+	(2)	Gross operating surplus and mixed income
−	(3)	Consumption of fixed capital
+	(4)	Net property income
+	(5)	Net social contributions and benefits other than social transfers in kind
+	(6)	Net current transfers
−	(7)	Current taxes on income, wealth etc.
=		Household net disposable income

Notes: Table summarizes the SNA93 primary and secondary distribution of income accounts to show the derivation of household disposable income; Source: De Vries and Zenhorst (2010).

Table 2: **Derivation of stockholder and nonstockholder income**

	Compensation of employees
+	Estimated labour income of self-employed
=	nonstockholder income
	Gross operating surplus and mixed income
−	Consumption of fixed capital
−	Estimated labour income of self-employed
=	Stockholder income

Notes: Table shows how stockholder and nonstockholder income are derived in De Vries and Zenhorst (2010).

The resulting income streams are deflated with the CPI and real aggregate nondurables and services consumption is assigned to stockholders and nonstockholders in proportion to their income. Based on the resulting consumption streams, the consumption growth rates are computed.

One problem encountered by VZ is the low frequency of the data available in the OECD database. The items “compensation of employees”, “gross operating surplus”, “gross mixed income” and “consumption of fixed capital” are available for the household sector only at a yearly frequency, whereas they are reported quarterly for the whole economy. To obtain quarterly figures for households, VZ compute the yearly percentages of the items accruing to households and then multiply these percentages with the quarterly series for the whole economy.

4.2 Replication of De Vries and Zenhorst's (2010) methodology

The replication of VZ's methodology for the U.S. is possible only with slight modifications. The reason lies in the concepts and guidelines used to compile the national accounts. Whereas the data available in the OECD database follows the United Nations System of National Accounts 1993 (SNA93), the original format of the U.S. national accounts, as published by the U.S. BEA is inspired by the specific needs of U.S. institutions. National account data for the U.S. compatible with the SNA93 is specifically assembled for international organizations, but does not reach back in time as far as the original U.S. National Income and Product Accounts (NIPA). More specifically, quarterly integrated national account data complying with the SNA93 is available only from 1992 onwards, whereas quarterly U.S. NIPA tables are available from 1947 onwards.

Since we would like to exploit the longer time span, we follow the U.S. NIPA concepts. The basis of our analysis is represented by the quarterly U.S. NIPA table "Personal Income and Outlays" for households (see table 3).[12] The items contained in this U.S. table closely

Table 3: **Personal income and outlays**

	(1)	Compensation of employees
+	(2)	Proprietors' income
+	(3)	Rental income
+	(4)	Net income receipts on assets
+	(5)	Net current transfer receipts
=	(6)	Personal income
−	(7)	Personal current taxes
−	(8)	Personal saving
=	(9)	Consumption expenditures

Notes: Synthetized version of the U.S. NIPA table "Personal Income and Outlays". Net income receipts on assets are income receipts on assets minus interest payments. Net current transfer receipts are received transfers minus paid transfers minus contributions for government social insurance.

follow the SNA93 simplified account for disposable income. However, contrary to the SNA93 primary and secondary distribution of income accounts, the U.S. account does not contain the item gross operating surplus. In the SNA93 accounts this item measures the production of own-account housing services. In the U.S. NIPAs these imputed rents are added instead to the item "rental income". Since this rental income also contains the rental income of real property and the royalties received by persons from patents, copyrights and rights to natural resources, we prefer not to include it in stockholders' income.

[12]See appendix A, NIPA definitions, for a description of the items displayed in table 3.

Another difference between the NIPA table and the SNA93 account is the fact, that the operating surplus of unincorporated enterprises owned by households (proprietors' income) is reported net of consumption of fixed capital. This difference does not represent an obstacle, since VZ subtract the consumption of fixed capital from the gross operating surplus and mixed income. As VZ, we tried to separate proprietors' income into a compensation for the factor capital and the factor labour. Subtracting the imputed labour income of the proprietors from their total income leads however to the stockholder income series containing negative values. Moreover for a prolonged time, the series shows values close to zero. We cannot think of a feasible way to compute reasonable growth rates from such a series. We therefore opt for treating all the proprietors' income as capital and, as a consequence, as stockholder income. Not dividing proprietors' income into a capital and labour compensation might seem unwarranted. Besides the method applied by VZ to make this separation, other methods exist. Gollin (2002) for example suggests to estimate capital and labour compensation shares for incorporated and government enterprises, and to apply these shares to proprietor's income. Lequiller and Blades (2006) propose to compute the return to capital in incorporated enterprises and apply it to the capital stock used by unincorporated businesses. However, a substantial part of high net worth households' income is represented by self-employment income.[13] Moreover these high net worth households hold most of the stocks in the economy. Assuming, as we do here and in the remainder of this paper, that high net worth households hold all the stocks makes the assignment of proprietors' income to stockholder income justifiable. In summary, we assign the compensation of employees to the nonstockholding households, whereas the proprietors' income forms the stockholders' income.

Another difference with respect to VZ's methodology lies in the computation of consumption growth rates. VZ constrain the sum of nonstockholder and stockholder consumption to be equal to aggregate nondurables and services consumption. This can be thought of as an advantage since realistically computed consumption streams should not differ systematically from actual consumption. Another reason to make this transition from income to consumption is the higher variability of income. As VZ argue, the higher standard deviation of income leads to a lower implied RRA estimate, and the comparison of results based on consumption growth rates computed directly from income with results obtained from aggregate nondurables and services consumption might thus be inappropriate. However, the consumption growth rates obtained in VZ's framework not only mirror changes in income, but also changes in savings and income components which are not taken into account by VZ. Since we extend (non)stockholder income as defined by VZ to arrive at a definition where the

[13]See Bucks, B. K., A. B. Kennickell, T. L. Mach, and K. B. Moore (2009).

sum of nonstockholder and stockholder income equals aggregate consumption, and later to a definition where capital gains are included, we prefer to compute the consumption growth rates directly from our income streams in order to isolate the effect of changing income definitions.[14] We show however in the robustness analyses of section 6, that the differences introduced by computing growth rates directly from the income streams are small when the income definitions of VZ are used.

Note that we do not need to base our analyses on yearly percentages of gross operating surplus, mixed income and consumption of fixed capital flowing to households, since this data is separately available for households at both the quarterly and monthly frequency. Nevertheless, in a first step, we follow the approach taken by VZ. We then compare the estimates based on yearly percentages with estimations relying on the actual quarterly data to see whether there are systematic differences.

4.3 Potential drawbacks of De Vries and Zenhorst's (2010) approach

One of the drawbacks mentioned by VZ related to their methodology is the missing assignment of several of the components of disposable income. Specifically, the items "net property income", "net social contributions and benefits other than social transfers in kind", "net current transfers" and "current taxes on income, wealth etc." are not distributed between stockholder and nonstockholder income. Moreover, no adjustment is made for the savings of households. The constructed income streams thus may not proxy too well for the final consumption streams.

A second drawback is related to the definition of disposable income in the national accounts. This figure appearing in the current accounts only represents the income from production. Capital gains, both realized and unrealized are disregarded. As argued for example by Bathia (1972), not only the income from production, but also capital gains, influence aggregate consumption. As a consequence an enlarged income definition may better capture the changes over time in consumption. Besides this important difference there is another discrepancy between actual income and income from production. Due to differences in business accounting and national accounting, the measures of company profits and net operating surplus (proprietors' income in the case of the U.S. NIPAs) are not identical. Especially the inventory valuation and the treatment of capital depreciation introduce differences[15]. We think, that this difference between company profits and net operating surplus is only minor

[14]We thus implicitly assume for the scenarios in which we replicate VZ's income definitions, that stockholders and nonstockholders consume a constant share of their income.

[15]For a more thorough discussion of this issue see Blades and Lequiller (2006).

and ignore it therefore in our analyses.

4.4 Assignment of additional items of disposable income and savings to stockholder and nonstockholder income

The remaining items from table 1 not assigned to stockholding and nonstockholding households are "net property income", "net social contributions and benefits other than social transfers in kind", "net current transfers" and "current taxes on income, wealth etc.". One possibility for an assignment of these items is to use household survey data. We specifically base the following argumentation on the U.S. Survey of Consumer Finances. This survey sponsored by the Federal Reserve Board in cooperation with the Department of the Treasury is conducted every three years to provide detailed information on the finances of U.S. families. Three stylized facts arise from the 2004 and 2007 survey.

First, there is a strong relation between net worth and asset holdings. The percentage of stockholding families is highest amongst the high net worth families. In the 75-90% and 90-100% quantile of net worth 39.1% and 62.9% of the families hold stock compared to percentages between 3.6% and 21.0% for the lower 75% of the net worth distribution[16]. Similarly, the median holdings of the upper 25% of the wealth distribution are relatively high. For the upper decile these median holdings amount to approximately 120800 2007-dollars, whereas the value reported for lower quantiles of the distribution varies from 2100 to 22000 2007-dollars. Note that the mean holdings of the upper decile are even higher, given that the mean holdings for the whole distribution amount to 176100 2007-dollars. Second, higher net worth is accompanied by higher income. In particular, the 75-90% quantile and the upper decile of the net worth distribution earn on average 96500 and 281400 2007-dollars respectively, while the lower quantiles earn between 27500 and 66500 per year. Third, the position in the distribution of net worth and the income composition are related. Whereas families in the lower 75% of the net worth distribution receive more than 90% of their income from wages, social security or retirement and transfers, for the upper 25% interest and dividends, business, farm and self-employment income, as well as capital gains play a major role. Transfers on the other hand are less important. Nevertheless wage income plays a significant role, representing 53% of overall income of families in the upper decile of the net worth distribution.

Combining these three data features we argue that the income composition of high net worth families can be applied to the group of stockholders, whereas the income of non-

[16]These results refer to the 2004 Survey of Consumer Finances. We report the 2004 results, since they refer to a more distant past and thus represent better the whole time span covered by the national account data. The figures from the 2007 survey differ however only slightly from the 2004 figures.

stockholders can be proxied by the income of families in the lower 75% of the net worth distribution. A drawback of this approach lies in the fact, that there might be systematic differences between the income composition of the high net worth families which hold stocks and those which do not. Direct estimations of income composition by net worth and stockholding status go beyond the scope of this paper and are thus disregarded. A second drawback is represented by the fact, that this income composition data is merely a picture of the 2004 and 2007 circumstances and may not apply to earlier decades.

Given the above arguments, we define labour income as the compensation of employees plus net transfers, i.e. personal current transfer receipts minus contributions for government social insurance. Capital income instead equals the sum of proprietors' income, rental income and income receipts on assets. Preliminary stockholder income is then defined as capital income plus a part of labour income. In our most realistic scenario we calculate for every quarter the share that is necessary to make the labour income of stockholders equalize their capital income. Afterwards we compute the mean of these percentages and assign the corresponding part of labour income to stockholders.[17] In order to show the effect of the amount of labour income allocated to stockholders we experiment also with smaller ratios of labour to capital income for stockholders. Whereas thus capital income and a part of the labour income form the preliminary income of stockholders, the remainder of labour income is assigned to nonstockholders. To better proxy for consumption rather than for income, we subtract both taxes and savings from the labour and capital income proportionally. As a result, the sum of stockholder and nonstockholder income equals aggregate consumption.

4.5 Enlargement of the income definition: accounting for capital gains

As argued for example by Shell et al. (1969), Bathia (1972) and Praet and Vuchelen (1979), the concept of income adopted by national accountants might be unsatisfactory since it only considers the income from production. Especially in our analysis this plays an important role given that capital gains may represent a non negligible share of stockholder income but not of nonstockholder income. To circumvent this deficiency one could add an estimate of realized capital gains to the production income. Poterba (1987) estimates such gains from individual tax returns. Odean (1998) instead uses trading records from brokerage accounts. However, the low frequency of the tax return data and representativity and time span issues of the brokerage data make these approaches unfeasible for our purposes. Moreover, Bathia (1972) points out, that not only realized but also unrealized capital gains

[17] This implies that roughly 50% of stockholder income is derived from labour.

are relevant. Also unrealized gains may be spent simply by augmenting the personal debt or reducing other savings. Following this argumentation, we use data from the U.S. financial accounts, i.e. the Federal Reserve Flow of Funds Accounts (FFA). From the holding gains on assets at market value contributing to the change in net worth, we take the items holding gains from corporate equities and mutual fund shares.[18] Since it is not clear how this additional income may influence consumption, we experiment with assigning different percentages of these capital gains to stockholder income and thus stockholder consumption as previously defined. The nonstockholder income instead remains unaffected.

4.6 Computation of standard errors and confidence intervals

To estimate the variance of the estimator of the coefficient of relative risk aversion, from the sample $X_i, i = 1, 2, \ldots, n$, m subsequent observations $X_j, X_{j+1}, \ldots, X_{j+m-1}, j = 1, 2, \ldots, N$ are deleted in each resample. This gives a total number of resamples $N = n - m + 1$. Each resample is used to estimate $\hat{\gamma}^{(j)}$. This value is then used to compute together with the estimated coefficient of relative risk aversion based on all observations, $\hat{\gamma}_n$, the j-th pseudovalue, $\tilde{\gamma}^{(j)}$, given by $[(n\hat{\gamma}_n - (n-m)\hat{\gamma}^{(j)})/m]$. The variance estimator of $\hat{\gamma}_n$ based on these pseudovalues is

$$S^2_{\hat{\gamma}_n} = \frac{m}{nN} \sum_{j=1}^{N} \left(\tilde{\gamma}^{(j)} - \frac{1}{N} \sum_{k=1}^{N} \tilde{\gamma}^{(k)} \right)^2, \tag{10}$$

where $\frac{1}{N} \sum_{k=1}^{N} \tilde{\gamma}^{(k)}$ is the mean of the pseudovalues. Around this mean a confidence interval can be constructed with the critical value taken from a t-distribution with $N-1$ degrees of freedom. Note that in this paper the number of omitted observations m in each resample equals four, and that the intervals are computed for the 95% confidence level.

5 Data

The data for our analyses stems from several sources. All the U.S. NIPA series are publicly available at the BEA website. More specifically, we use the quarterly series for the household income components in table 2.1. To deflate the constructed consumption series of stockholders and nonstockholders we take the price index of consumption expenditures from table 2.3.4. Corresponding monthly data is taken respectively from the NIPA tables 2.6 and 2.8.4. In addition we use the net operating surplus for the whole economy from table 1.10 to

[18]See appendix A, FFA data, for more information.

replicate the assignment of yearly percentages to the quarterly series for the whole economy. The aggregate nondurables and services consumption is taken from table 1.1.5. Whereas the quarterly data reaches back to 1947, the monthly data is available from 1959 onwards. The monthly number of employees for the imputation of the labour income of the self-employed is from the U.S. Bureau of labour Statistics (BLS). Note that this data commences in 1948. The first year of the quarterly income series thus has to be disregarded. Finally, the two quarterly series on capital gains (FFA table R.100) covering the period 1952 to 2010 have been taken from the website of the U.S. Federal Reserve. For the return of stocks, we use the value weighted return on all NYSE, AMEX, and NASDAQ stocks available in Kenneth R. French's data library.[19] The 1-month Treasury Bill rate series originally compiled by Ibbotson Associates is also taken from there. For a robustness analysis we additionally use the 3-month Treasury Bill rate from the website of the U.S. Federal Reserve.

6 Empirical results

This section first presents the results of the replication of VZ's methodology. We then continue with describing the effects of assigning the remaining items of household disposable income to the consumptions streams. A description of the effects of considering an income definition enlarged by capital gains follows. Finally, we investigate the robustness of our results by several means.

Before starting to report the results, we would like to clarify our way of representing them. For each scenario we show estimates of the different terms in equation (9) to illustrate the source of the implied estimate of the RRA coefficient. We differentiate between results for stockholder, nonstockholder and aggregate consumption, where the latter is defined as the sum of the two former series. While the real mean equity premium, the standard deviation of stock returns and the number of observations are the same for all three groups, the standard deviation of consumption growth, the correlation between consumption growth and stock returns, as well as the implied covariance term and the RRA coefficient are reported separately for each group. Note that the RRA estimates for the aggregate and for nonstockholders are not consistent, as they result from the optimality condition for stock returns (equation (6)) valid only for stockholders. Nevertheless, we report the estimates for the whole population, because it shows the error related to using aggregate instead of stockholder consumption. In addition to comparing the RRA estimates of the aggregate and stockholders, we contrast the standard deviation of consumption growth and the correlation term of stockholding and

[19] The library is available on `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`.

nonstockholding households. If both of these terms are lower for nonstockholders than for stockholders, it follows that the covariance term, and thus the RRA-estimate for the aggregate lies between those of stockholders and nonstockholders. About the correlation term and the standard deviation of consumption growth of the aggregate a similar statement cannot be done, i.e. these estimates do not have to lie between those of stockholding and nonstockholding households.[20]

6.1 Replication of De Vries and Zenhorst's (2010) approach

As can be seen in the first three columns of table 4, our results are in line with VZ despite the modifications we were forced to introduce due to the concepts for the U.S. NIPAs being different from the SNA93. The real quarterly equity premium of 1.5%, the standard deviation of real log returns of the risky asset of 0.084, and a covariance between consumption growth and stock returns of 0.00039 together imply a coefficient of relative risk aversion of 46.8 for stockholders. If aggregate data, i.e. the sum of the computed stockholder and nonstockholder income, is used instead, the implied risk aversion amounts to 250.2. This result is driven both by the lower standard deviation of consumption growth and the lower correlation between consumption growth and stock returns of nonstockholders compared to stockholders. Consistent with the results for the U.S. of Pozzi et al. (2010) and VZ, the mean of the pseudovalues is smaller than the estimate of the coefficient of relative risk aversion, and the confidence intervals are quite large. Somehow puzzling is the fact, that the mean of the pseudovalues is smaller for the aggregate than for the group of stockholders. Given however the large uncertainty surrounding the estimation of the RRA coefficient for the aggregate, we attribute little emphasis to this result.

Since some studies, e.g. Vissing-Jorgensen (2002), compute the coefficients of relative risk aversion considering a 6-month investment horizon instead of the 3-month investment investigated by Pozzi et al. (2010) and VZ, we check how the imposed planning period affects the results. When moving to a 6-month investment horizon (table 4, columns 4 to 6), the RRA estimates for both stockholders and nonstockholders are lowered considerably. For the 12-month horizon this is even more true. The higher standard deviation of stock returns plays an ambiguous role in lowering the estimated RRA coefficients, since it influences the implied RRA coefficient both positively through the term $\frac{1}{2}\sigma_i^2$ and negatively through σ_{ic}, i.e.

[20] This is due to the fact that the variance of consumption growth of the aggregate does not equal the variance of the sum of stockholder and nonstockholder consumption growth. A similar argument applies to the covariance. For the standard deviation of consumption in levels, one could instead postulate that the estimate for the aggregate lies between the ones of stockholding and nonstockholding households, if stockholder and nonstockholder consumption were positively correlated.

Table 4: Replication of De Vries and Zenhorst's (2010) methodology for different investment horizons

Investment horizon	3 months			6 months			12 months		
Premium	–	0.015	–	–	0.029	–	–	0.056	–
σ_i	–	0.084	–	–	0.124	–	–	0.174	–
n	–	247	–	–	246	–	–	244	–
Group	stockholder (1)	nonstockholder (2)	aggregate (3)	stockholder (4)	nonstockholder (5)	aggregate (6)	stockholder (7)	nonstockholder (8)	aggregate (9)
σ_c	0.031	0.010	0.011	0.045	0.017	0.018	0.065	0.029	0.031
ρ_{ic}	0.150	0.026	0.078	0.216	0.078	0.131	0.278	0.218	0.254
σ_{ic}	0.00039	0.00002	0.00007	0.00120	0.00017	0.00030	0.00316	0.00111	0.00136
$\hat{\gamma}$	46.8	814.8	250.2	30.3	217.0	121.4	22.5	64.1	52.4
$\hat{\gamma}_{ps}$	38.8	-5488.5	21.4	22.3	-340.5	18.4	16.5	29.9	31.1
$95\% - CI$	[-15.3; 92.8]	[-26924.5; 15947.5]	[-522.2; 565.0]	[-15.0;59.6]	[-1353.7; 672.7]	[-244.0; 280.9]	[-11.9; 45.0]	[-76.9; 136.6]	[-46.1; 108.3]

Notes: Table shows the results of replicating De Vries and Zenhorst's (2010) methodology with slight changes, i.e. not subtracting the estimated labour income of self-employed from mixed income and not considering rental income. Note however, that the above figures are computed relying on yearly percentages of net mixed income flowing to households. For each investment horizon "Premium" denotes the mean equity premium, σ_i *is the standard deviation of the risky asset and* n *is the number of observations.* σ_c, ρ_{ic} *and* σ_{ic} *are respectively the standard deviation of consumption growth rates, the correlation between consumption growth rates and the return of the risky asset, and the covariance between consumption growth rates and the return of the risky asset.* $\hat{\gamma}$ *is the implied coefficient of relative risk aversion, and* $\hat{\gamma}_{ps}$ *and "95%-CI" denote the mean of the pseudovalues obtained from the block jackknife and the corresponding 95% confidence interval.*

the covariance between stock returns and consumption growth.[21] The premium, the standard deviation of consumption growth and the correlation between consumption growth and stock returns all push the RRA estimate downwards. From a qualitative point of view the results show features similar to the 3-month horizon. The higher correlation with stock returns and the standard deviation of consumption growth of stockholders compared to nonstockholders leads to stockholding households having lower RRA estimates than the aggregate. At the twelve month horizon, in addition to more plausible levels of the RRA estimates, also the averages of the pseudovalues show the same pattern as the RRA estimates and the confidence intervals become narrower. With respect to the correlation between consumption growth and stock returns, two features are observed, when moving from the 6-month horizon to the 12-month horizon.

First, the correlation increases for stockholder consumption from 0.216 to 0.278. One source of this higher correlation might be related to the measurement of consumption growth and asset returns. Whereas consumption growth at time t is defined as the ratio between consumption in period t and period $t-1$, the asset return at time t is defined as the end of period return of period t. The two measures thus look at only partially overlapping periods. By increasing the investment horizon, automatically the amount of overlap is augmented, and as a result, the correlation between the two measures might increase. Another reason for the higher correlation at longer investment horizons may be that the actual planning period of households is longer than three months. Finally, the forward looking nature of stock markets might play a role. Whereas stock markets move already in the expectation of future events, these events only later influence income and consumption. Again by increasing the investment horizon, the lag of consumption with respect to stock markets is diminished.

Second, the correlation between consumption growth and stock returns differs less for the group of stockholders and nonstockholders, due to a sharp increase in the correlation figure for the latter group. Despite the decrease in this difference, we stick to computing the following scenarios with the same investment horizon of twelve months for several reasons. First of all, in the following scenarios the correlation between stock returns and consumption growth of stockholding and nonstockholding households does not differ much both for the 6-month and the 12-month investment horizon.[22] Second, the model should theoretically hold for all investment horizons. Finally, the above mentioned arguments relating to measurement problems in the consumption growth rates support the use of 12-month rates.

[21] Since for the covariance between consumption growth and stock returns it holds that $\sigma_{ic} = \rho_{ic} * \sigma_i * \sigma_c$, a higher standard deviation of stock returns leads ceteris paribus to a higher covariance term.

[22] The related results are omitted for reasons of space, but can be obtained upon request.

6.2 Assessing the effect of using yearly percentages

One of the drawbacks related to VZ's methodology is the use of yearly percentages to assign quarterly gross operating surplus, mixed income and consumption of fixed capital to the household sector. Table 5 compares the results of consumption streams based on yearly percentages with the actual quarterly series. As can be seen in columns 4 to 6, the difference between the two approaches is small. When using yearly percentages, the correlation between consumption growth and stock returns and the standard deviation of consumption growth are slightly higher. The last scenario in the table (columns 7 to 9) shows that this difference is due to the overall operating surplus being more highly correlated with stock returns and having a higher standard deviation than the operating surplus generated by household owned enterprises. The use of yearly percentages therefore seems justified in the absence of data at a higher frequency.

6.3 Extending the income definition: additional items of disposable income and savings

It remains however questionable, whether the compensation of employees and proprietors' income are a good proxy for the income of stockholding and nonstockholding households. Based on evidence from the U.S. SCF 2004 and 2007 it appears to us, that proprietors' income alone might insufficiently represent the income and thus the consumption of stockholders. Table 6 compares the RRA estimates resulting from our baseline specification, in which stockholder income equals proprietors' income and the compensation of employees is assigned to nonstockholders, with an income definition extended by the remaining income items defined in the U.S. NIPA table "Personal Income and Outlays". Note that the size of the sample used is slightly decreased from 244 to 230 observations. This is due to the fact, that the scenarios presented in table 7 are based on data from the U.S. FFA, which goes back only until the fourth quarter of 1951. The decrease in sample size is thus a mean of maintaining the comparability between the different scenarios. When contrasting the results in columns 1 to 3 of table 6 with the results in columns 4 to 6 of table 5, we note that the decrease in the sample size has only a marginal influence.

As discussed in section 4, a considerable part of stockholder income is derived from labour. To disentangle the effect of assigning the remaining income items to stockholder and nonstockholder income from the effect of allocating part of the labour income to stockholders, we compute two scenarios. In columns 4 to 6, we simply assign the remaining income items to capital and labour income and then attribute the income from capital to stockholders and the income from labour to nonstockholders. We note that the correlation term of stockholders

Table 5: Effect of using yearly percentages instead of actual quarterly data

Scenario	yearly percentages			actual series			overall operating surplus		
Premium	–	0.056	–	–	0.056	–	–	0.056	–
σ_i	–	0.174	–	–	0.174	–	–	0.174	–
n	–	244	–	–	244	–	–	244	–
Group	stockholder (1)	nonstockholder (2)	aggregate (3)	stockholder (4)	nonstockholder (5)	aggregate (6)	stockholder (7)	nonstockholder (8)	aggregate (9)
σ_c	0.065	0.029	0.031	0.062	0.029	0.030	0.060	0.029	0.034
ρ_{ic}	0.278	0.218	0.254	0.268	0.218	0.250	0.379	0.218	0.328
σ_{ic}	0.00316	0.00111	0.00136	0.00291	0.00111	0.00130	0.00398	0.00111	0.00195
$\hat{\gamma}$	22.5	64.1	52.4	24.5	64.1	54.7	17.9	64.1	36.6
$\hat{\gamma}_{ps}$	16.5	29.9	31.1	16.0	29.9	30.7	15.0	29.9	27.3
$95\% - CI$	[-11.9;45.0]	[-76.9;136.6]	[-46.1;108.3]	[-19.9;52.0]	[-76.9;136.6]	[-53.6;115.1]	[-2.6;32.7]	[-76.9;136.6]	[-15.7;70.2]

Notes: The scenario "yearly percentages" refers to the base scenario in which we replicate De Vries and Zenhorst's (2010) methodology (note that columns 1 to 3 correspond to columns 7 to 9 of table 4). In the scenario "actual series", we use the actual quarterly series for the income of unincorporated enterprises owned by households, instead of computing them by applying yearly percentages to quarterly overall net operating surplus. The last scenario "overall operating surplus" shows the results, when instead of the income of unincorporated enterprises owned by households, the overall net operating surplus forms stockholder income. Note moreover, that the investment horizon in each scenario is 12 months. For each scenario "Premium" denotes the mean equity premium, σ_i *is the standard deviation of the risky asset and* n *is the number of observations.* σ_c, ρ_{ic} *and* σ_{ic} *are respectively the standard deviation of consumption growth rates, the correlation between consumption growth rates and the return of the risky asset, and the covariance between consumption growth rates and the return of the risky asset.* $\hat{\gamma}$ *is the implied coefficient of relative risk aversion, and* $\hat{\gamma}_{ps}$ *and "95%-CI" denote the mean of the pseudovalues obtained from the block jackknife and the corresponding 95% confidence interval.*

Table 6: Effect of assigning remaining income items to stockholder and nonstockholder income

Scenario	base scenario			0% of labour income assigned to stockholders			50% of labour income assigned to stockholders		
$Premium$	–	0.051	–	–	0.051	–	–	0.051	–
σ_i	–	0.178	–	–	0.178	–	–	0.178	–
n	–	230	–	–	230	–	–	230	–
Group	stockholder	nonstockholder	aggregate	stockholder	nonstockholder	aggregate	stockholder	nonstockholder	aggregate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
σ_c	0.060	0.028	0.028	0.031	0.021	0.020	0.021	0.021	0.020
ρ_{ic}	0.265	0.174	0.216	0.334	0.320	0.392	0.406	0.320	0.392
σ_{ic}	0.00285	0.00086	0.00107	0.00185	0.00122	0.00138	0.00154	0.00122	0.00138
$\hat{\gamma}$	23.4	77.7	62.1	35.9	54.7	48.4	43.3	54.7	48.4
$\hat{\gamma}_{ps}$	13.1	4.6	18.2	21.5	39.8	34.7	29.6	39.8	34.7
$95\% - CI$	[-25.3;51.4]	[-179.0;188.2]	[-107.6;144.0]	[-32.4;75.4]	[-25.5;105.1]	[-25.1;94.4]	[-27.3;86.6]	[-25.5;105.1]	[-25.1;94.4]

Notes: Table compares De Vries and Zenhorst's (2010) definitions of stockholder and nonstockholder income with our extended income definitions where also the items rental income, net asset income, net transfers, taxes and savings are included. "base scenario" refers to the case in which we define stockholder income as proprietors' income (actual quarterly series) and nonstockholder income as the compensation of employees. Note that this scenario (columns 1 to 3) corresponds to the columns 4 to 6 of the previous table. In the scenario "0% of labour income assigned to stockholders", the above listed income items are assigned to stockholder and nonstockholder income. From the labour income allocated to nonstockholders, 0% is assigned to stockholders. Finally, in columns 7 to 9, 50% of the previously defined nonstockholder, i.e. labour income, is assigned to stockholder income. Note moreover, that the investment horizon in each scenario is 12 months. For each scenario "Premium" denotes the mean equity premium, σ_i is the standard deviation of the risky asset and n is the number of observations. σ_c, ρ_{ic} and σ_{ic} are respectively the standard deviation of consumption growth rates, the correlation between consumption growth rates and the return of the risky asset, and the covariance between consumption growth rates and the return of the risky asset. $\hat{\gamma}$ is the implied coefficient of relative risk aversion, and $\hat{\gamma}_{ps}$ and "95%-CI" denote the mean of the pseudovalues obtained from the block jackknife and the corresponding 95% confidence interval.

and nonstockholders increases, whereas the standard deviation of consumption growth decreases. Moreover the difference in these figures between stockholding and nonstockholding households is diminished, leading to the RRA estimates of stockholders and the aggregate moving closer together. In columns 7 to 9, we add to the previously defined stockholder income 50% of labour income. As a result, the correlation term for stockholders increases and the standard deviation of consumption growth decreases. Compared to the case in which 0% of labour income is allocated to stockholders, the correlation terms of stockholders and nonstockholders now are more reasonably different. The standard deviations of consumption growth of the groups however are almost identical, a finding in contrast to the previous literature. The total effect of these changes is to further decrease the difference in RRA estimates between stockholding households and the aggregate.

In summary, enlarging the definition of stockholder and nonstockholder income to be more realistic leads to a decrease in the differences between the RRA estimates of stockholders and the aggregate. At this point it is interesting to review the assumption that the defined consumption streams are equal to stockholder and nonstockholder income minus a proportional amount of savings and taxes. The reality might be more complex. For instance, stockholders may account for a larger part of taxes, since they can be considered high net worth individuals. In the same way one could argue, that savings have to be distributed differently. Also one has to consider, that the savings item in the U.S. NIPA is a residual item being calculated as the difference between disposable income net of taxes and consumption. Moreover, as already mentioned in section 4, there might be systematic differences between the income composition of high net worth families which hold stocks and those which do not. If this was true, the allocation of income components based on the income composition of high net worth and low net worth families applied in this paper would be incorrect.

6.4 Extending the income definition: capital gains

In section 4 we pointed out, that the primary and secondary distribution of income accounts only measure the income from production, but do not take capital gains into consideration. To account for this deficiency, in table 7 we enlarge stockholder income by capital gains. When assigning 25% of capital gains to stockholders (columns 4 to 6), the correlation term gets slightly larger. Moreover the standard deviation of consumption growth increases drastically, due to the high variance of the capital gains series. Were it not for this high standard deviation of consumption growth, one might lean back in the light of an RRA estimate for stockholders of 7.9. This high standard deviation however is carried over to the consumption growth of the aggregate, lowering the corresponding RRA estimate to 14.2.

Table 7: Effect of assigning capital gains to stockholder income

Scenario	50% of labour income assigned to stockholders			25% of capital gains assigned to stockholders			50% of capital gains assigned to stockholders		
Premium	–	0.051	–	–	0.051	–	–	0.051	–
σ_i	–	0.178	–	–	0.178	–	–	0.178	–
n	–	230	–	–	230	–	–	230	–
Group	stockholder (1)	nonstockholder (2)	aggregate (3)	stockholder (4)	nonstockholder (5)	aggregate (6)	stockholder (7)	nonstockholder (8)	aggregate (9)
σ_c	0.021	0.021	0.020	0.110	0.021	0.055	0.229	0.021	0.109
ρ_{ic}	0.406	0.320	0.392	0.431	0.320	0.478	0.400	0.320	0.421
σ_{ic}	0.00154	0.00122	0.00138	0.00846	0.00122	0.00469	0.01629	0.00122	0.00815
$\hat{\gamma}$	43.3	54.7	48.4	7.9	54.7	14.2	4.1	54.7	8.2
$\hat{\gamma}_{ps}$	29.6	39.8	34.7	7.2	39.8	12.9	3.8	39.8	7.5
$95\% - CI$	[-27.3;86.6]	[-25.5;105.1]	[-25.1;94.4]	[0.9;13.6]	[-25.5;105.1]	[1.3;24.5]	[0.5;7.0]	[-25.5;105.1]	[1.0;14.0]

Notes: Table assesses the effect of assigning different percentages of capital gains to stockholder income. The scenario "50% of labour income assigned to stockholders" forms our reference scenario and is identical to columns 7 to 9 from the previous table. In the following two scenarios (columns 4 to 9), first 25% and then 50% of holding gains from corporate equity and mutual fund shares is assigned to stockholder income as defined in the reference scenario. Note moreover, that the investment horizon in each scenario is 12 months. For each scenario "Premium" denotes the mean equity premium, σ_i is the standard deviation of the risky asset and n is the number of observations. σ_c, ρ_{ic} and σ_{ic} are respectively the standard deviation of consumption growth rates, the correlation between consumption growth rates and the return of the risky asset, and the covariance between consumption growth rates and the return of the risky asset. $\hat{\gamma}$ is the implied coefficient of relative risk aversion, and $\hat{\gamma}_{ps}$ and "95%-CI" denote the mean of the pseudovalues obtained from the block jackknife and the corresponding 95% confidence interval.

Moreover, in contrast to the previous literature the correlation between consumption growth and stock returns is higher for the aggregate than for stockholders. What remains positive, is that in relative terms, the RRA estimate for stockholders still differs a lot from the one of the aggregate, 7.9 being roughly 45% lower than 14.2. An assignment of more than 50% of capital gains to stockholders (columns 7 to 9) seems unrealistic. The standard deviation of consumption growth now rises to the unreasonable value of 0.229, markedly different from estimates reported by the previous literature. In summary, our way of assigning capital gains to stockholder consumption even though generating some good results, seems to be too crude. It introduces unreasonably high variability into the consumption stream. Lowering this standard deviation by decreasing the percentage of capital gains assigned to stockholder income would on the other hand only come at the expense of a higher RRA estimate. A solution for this problem might be to estimate from household survey data how holding gains influence consumption, and then use the estimation results to assign in each period part of the holding gains to stockholder consumption. Alternatively, aggregate consumption data might be used to stabilize a relationship between holding gains and consumption. However, the results in this case might be biased due to the inclusion of nonstockholder consumption in aggregate consumption.

6.5 Robustness analysis

We check the robustness of our results along several lines. First, different asset return data is used. Instead of taking the 1-month TBill rate compounded over twelve months, we base the computations on the 3-month TBill rates. As can be seen in columns 4 to 6 of table 8, this only affects the the RRA estimates through the equity premium. The premium is slightly lowered due to the higher risk premium of 3-month Tbills. The resulting decrease in the RRA estimate of stockholders from 43.3 to 42.6 remains however negligible. In a second robustness scenario (columns 7 to 9), the analysis is based not on quarterly, but on monthly income data. In this case we see a more pronounced change in estimated parameters. Due to higher correlation terms, the RRA estimates of both stockholders and nonstockholders decrease. As argued already earlier, the higher correlation might have its origin in the greater overlap between the consumption growth measure and stock returns compared to quarterly data. However, since the monthly data goes back only until 1959, also the different sample might be responsible for the changes.

Third, instead of computing consumption growth rates directly from the computed income streams, we constrain the consumption of stockholders and nonstockholders to equal aggregate nondurables and services consumption. Specifically, we compute the income share

Table 8: Robustness analysis: 3-month TBill rates and monthly data

Scenario	50% of labour income assigned to stockholders			3-month TBill rates			monthly data		
Premium	–	0.051	–	–	0.050	–	–	0.038	–
σ_i	–	0.178	–	–	0.178	–	–	0.172	–
n	–	230	–	–	230	–	–	605	–
Group	stockholder (1)	nonstockholder (2)	aggregate (3)	stockholder (4)	nonstockholder (5)	aggregate (6)	stockholder (7)	nonstockholder (8)	aggregate (9)
σ_c	0.021	0.021	0.020	0.021	0.021	0.020	0.022	0.020	0.020
ρ_{ic}	0.406	0.320	0.392	0.406	0.320	0.392	0.443	0.330	0.419
σ_{ic}	0.00154	0.00122	0.00138	0.00154	0.00122	0.00138	0.00169	0.00114	0.00141
$\hat{\gamma}$	43.3	54.7	48.4	42.6	53.9	47.7	31.4	46.5	37.6
$\hat{\gamma}_{ps}$	29.6	39.8	34.7	29.2	39.2	34.1	27.9	41.2	33.5
$95\% - CI$	[-27.3;86.6]	[-25.5;105.1]	[-25.1;94.4]	[-27.2;85.5]	[-25.4;103.9]	[-25;93.3]	[-0.3;56.0]	[0.4;82.0]	[0.6;66.4]

Notes: Table assesses the effect of using 3-month TBill rates instead of 1-month TBill rates. In addition, our main scenario in which 50% of stockholder income is derived from labor is recomputed using monthly data. Note moreover, that the investment horizon in each scenario is 12 months. For each scenario "Premium" denotes the mean equity premium, σ_i is the standard deviation of the risky asset and n is the number of observations. σ_c, ρ_{ic} and σ_{ic} are respectively the standard deviation of consumption growth rates, the correlation between consumption growth rates and the return of the risky asset, and the covariance between consumption growth rates and the return of the risky asset. $\hat{\gamma}$ is the implied coefficient of relative risk aversion, and $\hat{\gamma}_{ps}$ and "95%-CI" denote the mean of the pseudovalues obtained from the block jackknife and the corresponding 95% confidence interval.

of each group as its income divided by the sum of the income of both stockholders and nonstockholders, and multiply this income share with aggregate nondurable and services consumption. As already noted earlier, this procedure has the advantage of the sum of the estimated consumption streams being exactly equal to aggregate nondurables and services consumption. Moreover, it leads to more conservative estimates of the RRA parameter, since consumption is usually smoother than income. A disadvantage of this method is however that consumption growth rates of one group might change merely due to changes in the other group's income. Moreover, since the resulting consumption growth rates also mirror changes in savings and possibly disregarded income components, the effect of changes in income cannot be isolated.

We compute three robustness scenarios using the above outlined procedure. First, the base scenario (table 6, columns 1 to 3), in which merely net mixed income and the compensation of employees is used to construct (non)stockholder income, is recomputed. The results displayed in table 9 show, that the differences in RRA estimates obtained from the original and the robustness scenarios are not too large. In particular, the RRA estimate for the stockholding households increases only slightly from 23.4 to 25.1. The increase in the estimated RRA coefficient for the aggregate is more pronounced due to a relatively larger drop in the standard deviation of consumption growth, but the overall qualitative picture is comparable to our earlier results. Note moreover that, as expected, forcing the consumption streams to equal aggregate nondurables and services consumption leads to lower values for the standard deviation of consumption growth and thus higher implied RRA estimates.

Second, the scenario in which all income components are classified as either belonging to capital or labour income and 50% of labour income is allocated to stockholders is evaluated. When comparing the original results (table 6, columns 7 to 9) with the results of this robustness scenario (table 9, columns 4 to 6), we again observe an increase in RRA estimates. Note that the difference between the original and the robustness scenario lies in aggregate durables consumption. Whereas the consumption streams underlying the results in table 6 (columns 7 to 9) perfectly add up to aggregate consumption, the robustness scenario only considers aggregate nondurables and services consumption. Consistent with the finding that growth rates of durables consumption have a higher standard deviation, the exclusion of durables consumption in the robustness scenario leads the consumption streams of (non)stockholders to show less variability. Despite the increase in RRA-estimates, the qualitative result of the difference between estimated RRA coefficients decreasing due to the inclusion of additional items of disposable income and savings has not changed.

Finally, we reconsider the scenarios in which the income definition is enlarged by capital gains. Whereas the variation of the share of capital gains allocated to stockholder income

Table 9: Robustness analysis: assigning nondurables and services consumption proportionally to income

Scenario	base scenario			50% of labour income assigned to stockholders			5% of capital gains assigned to stockholders		
Premium	–	0.051	–	–	0.051	–	–	0.051	–
σ_i	–	0.178	–	–	0.178	–	–	0.178	–
n	–	230	–	–	230	–	–	230	–
Group	stockholder (1)	nonstockholder (2)	aggregate (3)	stockholder (4)	nonstockholder (5)	aggregate (6)	stockholder (7)	nonstockholder (8)	aggregate (9)
σ_c	0.052	0.014	0.014	0.016	0.016	0.014	0.018	0.020	0.014
ρ_{ic}	0.289	0.265	0.362	0.366	0.257	0.362	0.542	0.019	0.362
σ_{ic}	0.00266	0.00067	0.00088	0.00104	0.00072	0.00088	0.00173	0.00007	0.00088
$\hat{\gamma}$	25.1	100.1	75.6	63.8	92.4	75.6	38.6	997.3	75.6
$\hat{\gamma}_{ps}$	16.5	52.9	49.3	38.3	60.1	49.3	31.1	2476.8	49.3
$95\% - CI$	[-19.3;52.3]	[-107.9;213.7]	[-55.0;153.5]	[-57.6;134.2]	[-63.6;183.8]	[-55.0;153.5]	[-9.5;71.6]	[-42193.9;47147.6]	[-55.0;153.5]

Notes: Table assesses the effect of computing consumption growth rates based on consumption streams resulting from assigning nondurables and services consumption proportional to the computed income streams. The scenario "base scenario" is comparable to the "base scenario" in table 6 (columns 1 to 3), in that it computes (non)stockholder income based on the allocation of net mixed income and the compensation of employees. The consumption growth rates in this robustness scenario are though not based on these income streams but on the consumption streams resulting from the assignment of nondurablse and services consumption in proportion to the income streams. Similarly the second scenario is comparable to the scenario "50% of labour income assigned to stockholders" (table 6, columns 7 to 9). The scenario "5% of capital gains assigned to stockholders" (columns 7 to 9) is instead not directly comparable to the scenarios of table 7, since the capital gains share differs. Note moreover, that the investment horizon in each scenario is 12 months. For each scenario "Premium" denotes the mean equity premium, σ_i is the standard deviation of the risky asset and n is the number of observations. σ_c, ρ_{ic} and σ_{ic} are respectively the standard deviation of consumption growth rates, the correlation between consumption growth rates and the return of the risky asset, and the covariance between consumption growth rates and the return of the risky asset. $\hat{\gamma}$ is the implied coefficient of relative risk aversion, and $\hat{\gamma}_{ps}$ and "95%-CI" denote the mean of the pseudovalues obtained from the block jackknife and the corresponding 95% confidence interval.

does not have any influence on the consumption streams of nonstockholders under the original setup, within the framework of this robustness analysis, a change in the income of stockholding households always leads to a change in the consumption of nonstockholding households even if the income of nonstockholders does not change. In particular, we observe that increasing the share of capital gains allocated to stockholder income results in a decrease of the correlation between consumption growth of nonstockholders and stock returns. If more than 10% of capital gains are added to stockholder income, this correlation term becomes negative. We thus report only the results pertaining to the case where 5% of capital gains are added to stockholder income in order to guarantee the correlation term to be positive and at the same time obtain a somewhat more reasonable estimate for the RRA coefficient.[23] Adding an increasing share of capital gains to stockholder income when we stick to the methodology of this robustness analysis results in changes of the correlation between consumption growth and stock returns. Whereas this correlation decreases monotonically until becoming highly negative for nonstockholders, it first increases and then decreases for nonstockholders. Specifically, the correlation for the latter group increases up to a capital gains share of 5% and decreases afterwards. Moreover it can be noted, that there is a sharp decrease in the standard deviation of consumption growth rates for all groups. Finally, the difference between the correlation terms of stockholders and the aggregate increases when the capital gains share rises. The latter two features clearly represent an advantage compared to our original setup. However, as can be seen from the results in table 9 (columns 7 to 9), the effect on the correlation term for nonstockholders is quite large. Even if only 5% of capital gains are assigned to stockholders, this figure drops to 0.019.[24] This clearly shows, that adding a constant share of capital gains to stockholder income and constraining afterwards consumption of stockholding and nonstockholding households to be equal to aggregate nonsurables and services consumption is also not the ultimate solution, if we want to obtain reasonable RRA estimates. An alternative might be represented by scaling stockholder income. Stockholder income might be scaled by a constant in such a way that the squared percentage deviations between actual aggregate consumption and the sum of the income of both groups are minimized. In this way, the standard deviations of stockholder consumption growth may be lowered without affecting the correlation between consumption growth rates and stock returns for nonstockholders.

A great advantage compared to Zenhort's (2010) analysis is the long time span of our dataset. The data underlying both table 6 and 7 spans almost over 60 years. This allows

[23]The results of robustness scenarios where 1%, 2%, 3%, 4%, 10%, 25% or 50% of capital gains are added to stockholder income can be obtained upon request.

[24]If only 1% of capital gains are allocated to stockholder income, the correlation between consumption growth of nonstockholders and stock returns amounts instead to 0.201.

us to investigate how the estimates behave for subsamples of our bigger sample and how these estimates change over time. In particular, we select a window size of 115 observations, i.e. half of the sample size of our main scenarios. We then start to estimate the RRA coefficient for the first half of the whole sample, and afterwards move forward the window by one observation. Estimations are repeated, until we arrive at the second half of our original sample. This leads to a series containing 116 elements, each being the result of estimating the RRA coefficient for the corresponding subsample. The first subsample in the series ranges from the fourth quarter of 1952 to the second quarter of 1981, whereas the last subsample goes from the third quarter 1983 to the first quarter 2010. Note, that we choose the to us most realistic scenario, in which 50% of labour income is assigned to stockholders. When looking at the behavior of the RRA estimates over time (see fig. 1), we note that they are quite unstable and exhibit a sharp decrease followed by an evenly distinct decrease in the second half of the series. More striking however is the fact, that the RRA-estimate for stockholders is lower than the one of nonstockholders for most of the elements in the series. It can be seen, that the estimated RRA coefficient for stockholders is only lower for the first observations of the series, and thus for the first half of the whole sample, and for the last observations, i.e. the second half of the original sample. Our previous results are thus not contradicted by this robustness analysis. Nevertheless it is clear, that cutting the whole sample from both sides would lead the RRA estimate of nonstockholding households to be lower than the one of stockholding households. This casts doubt on the way we define stockholder and nonstockholder income and consumption. To obtain a better understanding of the underlying factors leading to the changes in the RRA estimates we analyze both the mean equity premium and the standard deviation of stock returns of each subsample (see fig. 2). These two series suggest, that part of the strong change in the last part of the RRA series is partly due to a lower standard deviation of stock returns and a higher mean equity premium for that period. Besides this, the correlation between consumption growth and stock returns plays a decisive role as can be observed in figure 3. The standard deviation of consumption growth (see fig. 4) instead appears – besides exhibiting a slight downward trend – pretty stable over time.

Since the series for stockholders and nonstockholders move closely together over time, the origin of the changes has to lie in the asset market data. In fact, when taking a closer look, the increase in the mean equity premium can be observed when moving the sample from the period 1974-2002 to the period 1976-2004. This coincides with deleting from the sample the highly negative stock returns seen around the first oil crisis and adding quite high positive returns of the recovery period from the bear market following the burst of the dot-com bubble. Since the deleted values are more below average than the included values

Figure 1: RRA estimates

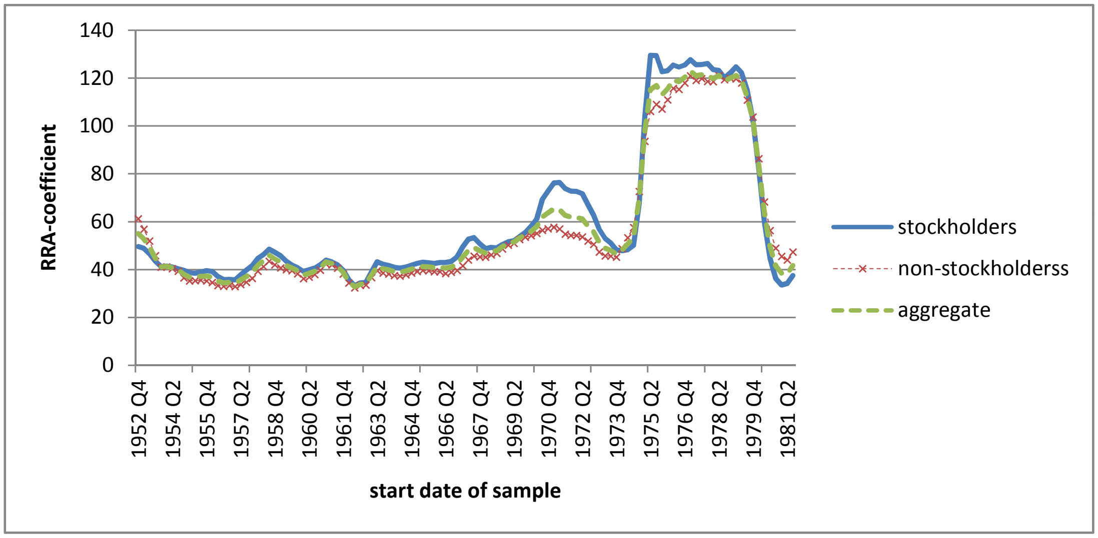


Figure 2: Mean equity premium and standard deviation of stock returns

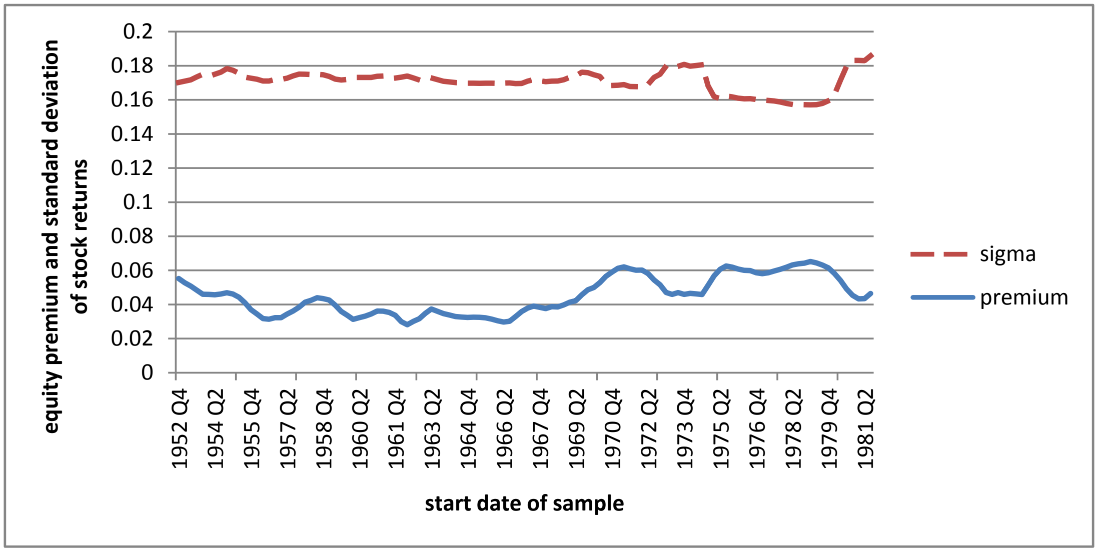


Figure 3: Correlation between consumption growth and stock returns

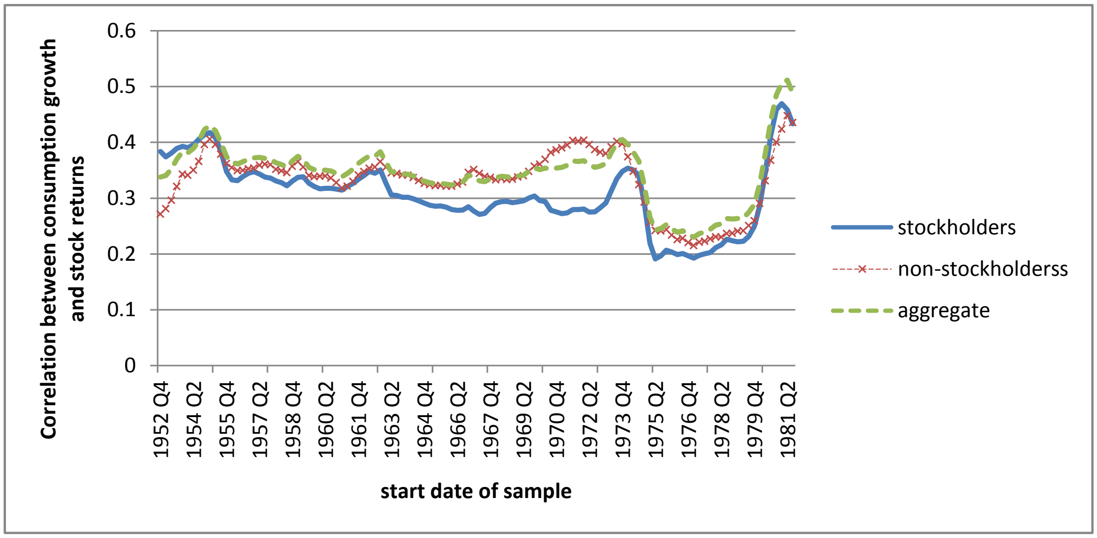
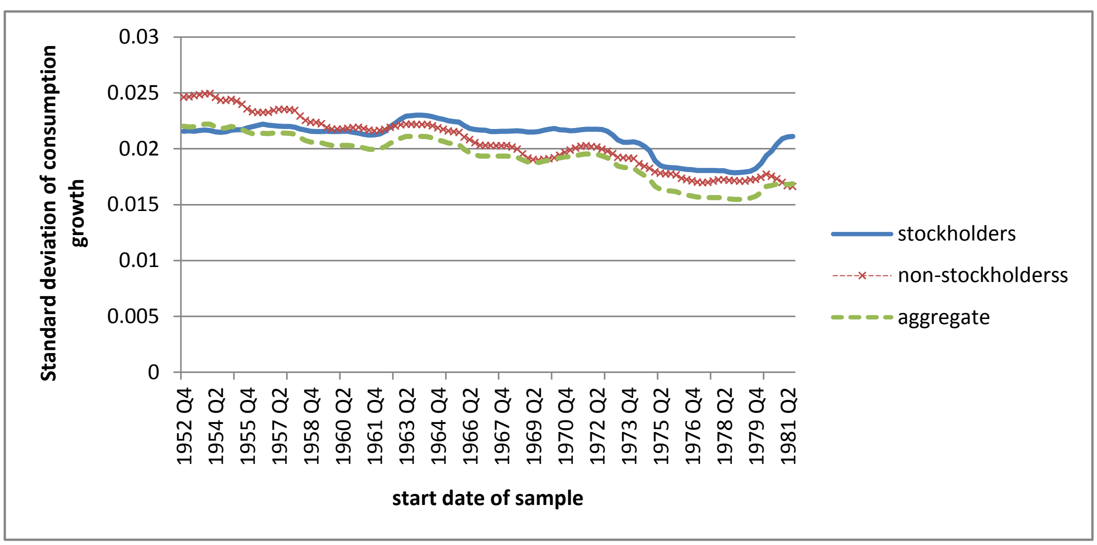


Figure 4: Standard deviation of consumption growth



are above it, the standard deviation of stock returns is increased. Moreover, since during the first oil crisis also consumption growth was very low, the exclusion of these values leads to a decrease in the correlation between consumption growth and stock returns. Similarly, the decrease in the RRA estimates is related to the exclusion of highly positive returns following the second oil crisis and the inclusion in the sample of the recent financial crisis.

7 Concluding remarks

In this paper we take a different look at the consumption of stockholders and nonstockholders, and thus at the equity premium puzzle. Whereas the previous literature accounting for limited stock market participation based its estimations on household data, we construct consumption series for stockholders and nonstockholders from national account data, offering the advantage of a much longer data sample and better data availability for a range of countries.

This approach has been recently introduced by De Vries and Zenhorst (2010). In our reference scenario we replicate their methodology. We then extend their approach along several lines. When moving towards an income definition enlarged by other components besides the compensation of employees and the operating surplus of household owned unincorporated enterprises, results worsen compared to the reference scenario. The RRA estimate of stockholders increases, whereas the one of nonstockholding households decreases. The decrease in the difference between the two is higher, the more stockholders derive their income from labour. In particular, when 50% of aggregate labour income is assigned to stockholders, the RRA estimates based on stockholder consumption and on the sum of stockholder and nonstockholder consumption are respectively 43.3 and 48.4. Clearly, the difference between the two does not suggest that accounting for heterogeneity in asset market participation leads to considerable improvements. To arrive at an even more complete income picture of stockholders, we also account for capital gains, which are excluded from the income concept of national accounts. The RRA estimate for stockholders resulting from the addition of a constant percentage of capital gains to stockholder income is lowered to the reasonable value of 7.9. The implied RRA coefficient based on the sum of stockholder and nonstockholder consumption amounts to 14.2 instead. However, including a simple percentage of capital gains into the income definition of stockholders does not seem a feasible approach, since the resulting standard deviation of stockholder consumption growth is unreasonably high and the correlation between consumption growth and stock returns for stockholders is lower than the corresponding figure based on the consumption aggregated over stockholding and nonstockholding households.

Even if the extensions introduced in this paper do not represent a solution to the equity premium puzzle, they give us a better understanding of how to use macroeconomic data in the framework of limited participation in the stock markets. First of all, since the computed consumption streams are based on the definition of (non)stockholder income, the latter strongly influences the results. Moreover, as we have shown in our robustness analyses, the method used for the transition from income to consumption can lead to different outcomes based on the income definition which is used. Two additional results obtained along the way regard the sensitivity of RRA estimates to the investment horizon and the stability of RRA estimates over time. With respect to the first issue, we have shown, that the correlation between consumption growth rates and excess stock returns increases, if the investment horizon is increased, implying thus lower RRA estimates. Regarding the second issue, the series of RRA estimates obtained from a moving window estimation seems to be quite unstable due to the the inclusion of several economic crises in our sample.

Future research may overcome the issues raised in this paper by obtaining a better picture of the composition of (non)stockholder income and of savings. Whereas this paper relies on the income composition of high net worth families, it might be preferrable to obtain estimates of the composition of stockholder income on the basis of household data. Moreover, such data can be employed for estimating the effect of stock market movements on the savings of (non)stockholding households. In fact, the link between consumption and income might be different for stockholders and nonstockholders and a clearer understanding of it should thus support future analyses.

A Appendix

SNA93 definitions

Compensation of employees Compensation of employees is the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period. Its main components are a) wages and salaries payable in cash or in kind and b) the value of the social contributions payable by employers.

Operating surplus and mixed income The operating surplus measures the surplus or deficit accruing from production before taking account of any interest, rent or similar charges payable on financial or tangible nonproduced assets borrowed or rented by the enterprise, or any interest, rent or similar receipts receivable on financial or tangible nonproduced assets owned by the enterprise. For unincorporated households, this component is called "mixed income". The surplus arising from own-account housing services is instead recorded as operating surplus in the household account, since it can clearly be classified as originating from the use of capital.
Figures are reported either gross or net of the consumption of fixed capital.

Consumption of fixed capital Consumption of fixed capital represents the reduction in value of fixed assets used in production during the accounting period resulting from physical deterioration, normal obsolescence or normal accidental damage.

Net property income Property income is the income receivable by the owner of a financial asset or a tangible nonproduced asset in return for providing funds or to putting the tangible nonproduced asset at the disposal of another institutional unit. It consists of interest, the distributed income of corporations (i.e. dividends and withdrawals from income of quasi-corporations), reinvested earnings on direct foreign investment, property income attributed to insurance policy holders, and rent.

Net social contributions and benefits other than social transfers in kind Social contributions are actual or imputed payments to social insurance schemes to make provision for social insurance benefits to be paid. Social benefits other than social transfers in kind consist of all social benefits except social transfers in kind. In other words, they consist of (a) all social benefits in cash (both social insurance and social assistance benefits) provided by government units, including social security funds, and NPISHs, and (b) all social insurance benefits provided under private funded and unfunded social insurance schemes, whether in cash or in kind.

Net current transfers Other current transfers consist of net premiums and claims for non-life insurance, current transfers between different kinds of government units, usually at different levels of government and also between general government and foreign governments, and current transfers such as those between different households.

Current taxes on income, wealth, etc. Most current taxes on income, wealth, etc consist of taxes on the incomes of households or profits of corporations and taxes on wealth that are payable regularly every tax period (as distinct from capital taxes levied infrequently).

U.S. NIPA definitions

Compensation of employees Compensation of employees consists of wage and salary disbursements and supplements to wages and salaries, i.e. employer contributions for employee pension and insurance funds, as well as for government social insurance.

Proprietors' income Proprietors income is the current-production income (including income in kind) of sole proprietorships and partnerships and of tax-exempt cooperatives.

Rental Income Rental income of persons is the net current production income of persons from the rental of real property, the imputed net rental income of owner occupants of farm and nonfarm dwellings, and the royalties received by persons from patents, copyrights, and rights to natural resources.

Net income receipts on assets Net income receipts on assets consist of personal interest and dividend income minus personal interest payments.

Personal current taxes Personal current taxes include taxes on income, including realized capital gains, and on personal property.

Personal saving Personal saving is personal income less the sum of personal outlays and personal current taxes.

FFA data

The U.S Flow of Funds Accounts, i.e. the U.S. financial accounts summarize the financial flows between sectors as defined by the U.S. Federal Reserve. In addition the oustanding balances of assets and liabilities are reported. The change in net worth of households and nonprofit organizations is calculated as a residual amount from total figures and the amounts computed for the remaining sectors. As can be seen from table 10, the change in net worth is the sum of net investment, holding gains on assets at market value, holding gains on assets at current cost and other volume changes. Note that holding gains on assets at market value is by far the largest component in the change of net worth.

Table 10: **Change in net worth of households and nonprofit organizations**

	(1)	Net investment
	(1.1)	Net physical investment
	(1.2)	Net financial investment
+	(2)	Holding gains on assets at market value
	(2.1)	Real estate
	(2.2)	Corporate equities
	(2.3)	Mutual fund shares
	(2.4)	Equity in noncorporate business
	(2.5)	Life insurance and pension fund reserves
+	(3)	Holding gains on assets at current cost
+	(4)	Other volume changes
=	(5)	Change in net worth

Notes: Synthetized version of the U.S. FFA table R.100. All series are computed as a residual, i.e. as the difference between aggregate amounts and actual amounts for the other FFA institutions. Both the corporate equities and the mutual fund shares series include foreign shares.

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