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Abstract

This study extends a thick modelling tool for aggregated euro area real private consumption of de Bondt et al. (2019) to the four largest euro area countries. The suite of error correction models performs well in and out of sample. The ranges and averages of estimated elasticities are, however, sensitive to the exact model specification. We also show that decomposing disposable income into labour, property and transfer income is essential for understanding and forecasting consumption. Finally, substantial cross-country heterogeneity in marginal propensities to consume out of income and wealth components calls for caution when interpreting aggregate euro area developments.

JEL classification: C53, D12, E21, E27.

Keywords: private consumption, income, wealth, thick modelling

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Non-technical summary

This paper presents a thick modelling application of private consumption for the euro area as well as the four largest euro area countries. Thick modelling considers a multiplicity of model specifications rather than a single "best" one. This is in particular advantageous when facing model uncertainties, which is the case because euro area data typically start only in 1999, resulting in a comparatively short sample and the measurement of income and wealth is surrounded with ambiguity. Using this method, a large number of model specifications are tested and the best ones are then combined by giving equal weights to the selected equations. In our case, we keep those specifications that explain and forecast private consumption well using standard determinants from the consumption literature.

Private consumption is largely determined by expected lifetime income, which is typically proxied by disposable income and wealth. Nevertheless, the empirical literature provides ample evidence that other determinants, such as interest rates, uncertainty and consumer debt, might also play important roles. In addition, many studies have looked into the differential effects of wealth components, i.e. financial and non-financial wealth, on household consumption. However, income components can also be expected to have different effects on consumption and the marginal propensities to consume out of labour, transfer and property income are not necessarily the same. This disaggregation of income has remained comparatively unnoticed in the empirical literature.

We use quarterly sector accounts data to decompose disposable income into labour, transfer and property income as well as to split total wealth into financial and non-financial (mainly housing) wealth when modelling private consumption. In addition to income and wealth components, we consider a wide set of other potential determinants in the short run: interest rates and spreads, measures of consumer indebtedness, government debt measures capturing Ricardian equivalence effects, several measures of uncertainty and demographics. We generate multiple (6.5 thousand) single-equation error correction models for private consumption growth estimated by General Method of Moments (GMM) over the period 1999Q1 to 2018Q2. We then select a set of best performing equations by applying pre-determined in-sample and out-of-sample criteria, focusing on a final set of 50 equations that meet all criteria and have shown the best out-of-sample performance. Finally, we perform several robustness checks to account for various approaches of model specification and for various possibilities to define income and wealth variables.

Three main findings emerge. Firstly, our estimates show that it is not only essential to distinguish between components of wealth, but also between components of income when analysing private consumption. The estimated long-run elasticity of labour income is in all cases substantially larger than that of property income and transfer income. In terms of marginal propensities to consume (MPC), the differences between income components are less pronounced. Nevertheless, the

MPC out of property income is comparatively small in France, Italy and Spain. With respect to wealth, the average long-run elasticity of financial wealth is often found to be larger than of non-financial wealth. This finding is in line with the literature. The average marginal propensity to consume out of financial wealth is found to be up to 3 cents per euro (in Spain) while it is up to 0.2 cents for non-financial wealth (in Germany and Spain). The estimated short-run elasticities are also found to differ across income and wealth components.

Secondly, our thick model-based estimation results in wide ranges of elasticities of private consumption with respect to income and wealth components. In particular, we find that the elasticities of property income in France and Italy and the elasticity of transfer income in Spain can be significantly different from zero on both sides. The same finding holds for the estimated long-run elasticities of non-financial wealth in the euro area, Germany and France, and for financial wealth in Germany. A number of robustness checks also reveal that the sign of the estimated coefficients may depend on the model specification and the respective definition of wealth components.

Thirdly, our results show that aggregate euro area income and wealth effects mask striking cross-country differences. Property income is found to be essential for German consumption, whereas consumption in France, Italy and Spain is best explained by focusing on non-property income. Long-run MPCs out of financial wealth are on average estimated to be 1 to 3 cents on a euro in France and Spain, but less than 1 cent in Italy and close to zero in Germany. Long-run MPCs out of non-financial wealth are estimated to be on average close to zero in Germany, France and in Italy, whereas they are found to be significantly positive (on average 0.2 cents) in Spain.

1 Introduction

Economic theory links consumption expenditure of an individual to his/her lifetime resources that consist of human wealth, i.e. current and expected future income, and total net asset wealth. According to the life-cycle hypothesis, households adjust their total resources to ensure relatively stable and smooth consumption expenditure over the lifetime (Ando and Modigliani, 1963). Since the publication of that paper, the literature has augmented the basic consumption model in several ways. First, the adjustment of consumption to changes in income and wealth might be slow leading to an error correction representation. Second, different components of net worth might have different marginal propensities to consume (MPCs) leading to a decomposition of total net worth into financial and non-financial assets. Third, other determinants such as interest rates, household leverage, public indebtedness, uncertainty, or unemployment can also affect consumption. Our paper deviates from the existing work on consumption in two ways.

The first substantive contribution is an extension of a thick model application of euro area private consumption as reported in de Bondt et al. (2019) to the four largest euro area countries. This methodology is in the spirit of the early thick modelling pioneers Granger and Jeon (2004) and Aiolfi and Favero (2005) and considers a multiplicity of model specifications rather than a single "best" one to take into account model uncertainty. In particular we account for uncertainty about which short-term determinants other than income and wealth have an effect on private consumption. In more detail, our first step generates a large set of candidate error correction models by exploiting a vast number of potential explanatory variables for consumption including disposable income and wealth, the standard consumption determinants. The next section briefly reviews the empirical literature on income and wealth effects. Using both in-sample and out-of-sample model selection criteria, we identify a large number of well-specified equations for real private consumption, utilising an encompassing set of explanatory variables. We show the potential value added of the presented thick modelling tool in enhancing monitoring and forecasting private consumption in the four largest euro area countries. We also account for uncertainty about model specification and definition of income and wealth components by running a large number of robustness checks.

The second contribution is that we decompose disposable income into labour, transfer and property income by exploiting non-financial sectoral account data. While the idea that MPCs might differ across income types goes back to Taylor (1971), relatively few studies actually considered disaggregating income. Several studies for the United States compare the elasticities of transfer versus non-transfer income in estimated consumption functions (Davis and Palumbo, 2001; Benjamin et al., 2004; Aladangady and Feiveson, 2018) or split transfer income further into retirement transfers and non-retirement transfers and also look at capital income (Hawkins and Wallace, 2006). With respect to property income as a separate consumption determinant, several central banks, including the Federal Reserve, allow for property income to enter the consumption function in their models used for macroeconomic simulations and forecasting (Brayton and

Tinsley, 1996; Fagan and Morgan, 2005). Nevertheless, disaggregate income effects have not been well addressed in the empirical literature, especially with respect to euro area countries. The sectoral account data enable us to use wealth data from a single and consistent database, instead of creating proxies for wealth levels using equity or house prices indices. In particular, the financial accounts data enable us to split total wealth in various ways into financial and non-financial wealth, and we can use these accounts to calculate measures of household leverage and debt ratios as explanatory factors for private consumption.

Three conclusions emerge from the thick modelling of private consumption in the four largest euro area countries. First, it is essential to distinguish between components of both wealth and income, because estimated long-run elasticities do differ across income and wealth components. Secondly, the ranges of estimated elasticities with respect to income and wealth components are wide. Most striking is that property income elasticities in France and Italy and transfer income elasticity in Spain can be significantly different from zero on both sides in the long run. The same finding holds for the estimated long-run elasticities of non-financial wealth in Germany and France, and for financial wealth in Germany. A number of robustness checks also reveal that the sign of the estimated coefficients may depend on the model specification and the respective definition of wealth components. Finally, aggregate euro area income and wealth effects mask striking cross-country differences. Property income is found to be essential for German consumption, whereas consumption in France and Spain is best explained by focusing on non-property income. Long-run MPCs out of financial wealth are on average estimated to be 1 to 3 cents on a euro in France and Spain, less than 1 cent in Italy and close to zero in Germany. Long-run MPCs out of non-financial wealth are estimated to be on average close to zero in Germany, France and in Italy and significantly positive (on average 0.2 cents) in Spain.

This paper is structured as follows. Section 2 provides a literature review, focusing on income and wealth effects for the euro area and the four largest euro area countries. Section 3 describes the thick modelling of real private consumption. It introduces the basic consumption specification, followed by a description of the applied thick modelling selection process. Section 4 describes the data. Section 5 discusses the empirical results, focusing on the estimated income and wealth effects, the model validation in terms of out-of-sample performance, and the robustness of the empirical results. Section 6 concludes.

2 Literature

This section briefly reviews existing empirical evidence on income and wealth effects on consumption in the four largest euro area countries and the euro area as a whole. Table 1 provides an overview of empirical evidence on income and wealth effects in the long run based on macroeconomic studies. They all examine disaggregate effects with respect to wealth only.

Several observations emerge from the overview of the empirical evidence of the long-run income and wealth effects in the euro area and the largest countries. First, the empirical estimates for income elasticities exhibit a wide range, from 0.4 to 0.9 in the case of the euro area, being somewhat narrower and higher for Germany (0.8 to 1.0), somewhat lower for Spain and rather wide for France and Italy. The estimates for the MPC out of income are around 60 to 80 cents.[1]

Second, the evidence supports a significant financial wealth effect on consumption in the long run in the euro area and the major countries. The range of empirical estimates for financial wealth effects is wide, including cases of negative effects. This may reflect different samples, difficulties in the measurement of financial wealth (often approximated by equity price indices) and a lack of a common estimation framework. The long-run financial wealth elasticities mostly amount between -0.03 and 0.30, whereas the MPC range is again very wide (-3 to +15 cents). For Germany and Italy, financial wealth effects have been estimated to be negative in some cases. Third, the housing wealth effect tends to be weaker in the euro area and across countries and is sometimes statistically insignificant. The estimated long-run housing wealth elasticities vary between -0.07 and 0.18 and the MPCs between -7 and 8 cents. Spain is the only country for which only positive housing wealth effects have been estimated.

Finally, disaggregate wealth effects differ substantially across the largest euro area countries and sometimes the results are inconclusive for the same country across studies. The evidence of significant financial wealth effects is mixed for Germany while it is typically found that housing wealth does not have an impact on German consumption expenditure. Financial wealth is usually found to be an important long-run determinant of French consumption and some evidence is also supportive of a likely smaller but significant housing wealth effect. With respect to Italy, the long-run financial wealth effect is typically significant and positive but the evidence of housing wealth effect is rather mixed. It seems that both types of wealth are important for consumption expenditure in Spain.

The differences in the estimated elasticities and MPCs out of wealth components may reflect a number of aspects. In particular, non-financial (mainly housing), equity and non-equity financial wealth differ in terms of liquidity, risk and collateral characteristics (see Altissimo et al. (2005) and references therein). The MPC out of liquid assets (mostly financial assets) is likely to be greater than that out of illiquid (mostly housing) wealth. The MPC out of assets associated with strong bequest motive (housing wealth) is likely to be smaller. Assets with less volatile prices, such as non-equity wealth should have higher MPCs as price changes are likely to be perceived to be more permanent. Furthermore, the MPC out of wealth could also depend on the distribution of an asset across households. Some assets, such as equities, are concentrated at the top of the income distribution and wealthy households tend to have lower MPCs (Sierminska and Takhtamanova, 2012). Evidence of a decreasing MPC out of wealth across the wealth distribution in France is reported by Arrondel et al. (2015). Overall, non-equity financial assets

[1] Note that some studies report MPCs in terms of the US dollar.

should have the largest MPCs while the relative size of equity and housing wealth MPCs is somewhat ambiguous. The cross-country divergences in the estimated MPCs could be explained by different regulatory and institutional frameworks, demographic characteristics, or the degree of credit constraints of households (Cooper and Dynan, 2016).

Concerning the large range of estimated housing wealth effects, there are two forces acting in opposite directions as households both own housing assets and consume housing services derived from these assets (Catte et al., 2004; Cheng and Fung, 2008; Buiter, 2010; Aron et al., 2012). On the one hand, higher house prices could force potential first-time buyers to save more in order to buy a property in the future. On the other hand, higher house prices increase the wealth of those who already own a house. Housing assets can be used as collateral to obtain a loan or, alternatively, owners could sell a house and earn capital gains. Consequently, the size and sign of the overall MPC out of housing wealth depends on which effect dominates. This is subject to many factors, such as country's homeownership rate, the size of the rental and mortgage market, and the possibility to benefit from equity withdrawal (see also Cooper and Dynan, 2016).

3 Methodology

3.1 Basic specification

Our basic specification follows a conventional approach by exploiting co-integration between consumption, income and wealth. The most widespread estimation approach in the literature is either a single equation error correction model (ECM) or a vector ECM assuming long-run co-integration between consumption, income and wealth (Byrne and Davis, 2003; Catte et al., 2004; Al-Eyd, 2005; Hamburg et al., 2008; Kerdrain, 2011; Rodriguez-Palenzuela and Dees, 2016; Winkler, 2016). See also the pioneering work by Ludvigson and Steindel (1999), Lettau and Ludvigson (2001) and Fernandez-Corugedo et al. (2003) that impose co-integration between consumption, income and wealth. Nevertheless, several studies (Slacalek, 2009; Sousa, 2009; Chauvin and Damette, 2010; Barrell et al., 2015; Guerrieri and Mendicino, 2018) employ an alternative method, either exclusively or in addition to the standard ECM, developed by Carroll et al. (2011) based on consumption growth sluggishness. However, when comparing the estimates based on this approach it is important to note that the long-run ("eventual") MPC refers to the period after a few years. Others simply estimate level and/or first-difference equations of consumption expenditure (Rodil-Marzabal and Menezes-Ferreira-Junior, 2016).

The applied error correction model specification has the advantage that it distinguishes between short- and long-run elasticities. Our estimates indeed show that the estimated short- and long-run income and wealth elasticities do differ in almost all cases. At the same time, the significance

of the estimated error-correction coefficients, again consistently found for all countries, indicate that consumption, income and wealth are co-integrated as defined by Engle and Granger (1987).

Income and wealth variables are assumed to affect consumption in both the short and the long run. We use euro area sector accounts data to split real disposable income into labour income (*ly*), transfer income (*ty*), and property income (*py*). In addition, real wealth (nominal household total wealth deflated by the private consumption deflator) is split into non-financial wealth (*nfw*) and financial wealth (*fw*), i.e. financial assets less financial liabilities).

All other determinants of private consumption considered are assumed to affect private consumption in the short run only and have been checked on stationarity and are therefore typically included by taking a change (Δx_i). Appendix A provides an overview of the other determinants, the transformation considered and the unit root tests. Most variables are expressed in natural logarithms with the exception of interest rates, unemployment rate, leverage / debt ratios and survey measures. To ensure long-run homogeneity, the long-run parameters for income and wealth components are restricted to sum up to 1. This approach has also been applied by others (Barrell and Davis, 2007; Estrada et al., 2014). The basic equation for consumption growth is an error correction model presented in Equation (1):

$$\begin{aligned}\Delta c_t = {} & \alpha + \beta_0 \Delta ly_t + \beta_1 \Delta ty_t + \beta_2 \Delta py_t + \beta_3 \Delta fw_{t-1} + \beta_4 \Delta nfw_{t-1} - \\ & - \gamma \big[c_{t-1} - (1 - \theta_1 - \theta_2 - \theta_3 - \theta_4) ly_{t-1} - \theta_1 ty_{t-1} - \theta_2 py_{t-1} - \theta_3 fw_{t-2} - \theta_4 nfw_{t-2} \big] + \\ & + \delta_i [\Delta x_{i_{t-j}}] + \epsilon_t \end{aligned} \tag{1}$$

where Δ denotes quarter-on-quarter changes, γ is the error correction term (ECM) on the lagged log level of consumption, β_i and θ_i represent short-run and long-run income and wealth elasticities, respectively.

Across different models, the number of additional short-run determinants other than income and wealth (i) can range between 1 and 3 and they might be included with lags (j) varying between 0 and 2. With respect to the ECM, a highly statistically significant γ parameter would be consistent with the cointegrating relation in the long-run vector. Typically, the absolute value of the t-statistic for γ is expected to be greater than 3 (Kremers et al., 1992; Banerjee et al., 1993; Al-Eyd et al., 2006; Barrell and Davis, 2007). Note that wealth variables are lagged by one period in the short and long run as they reflect stocks as of the end of the period. Hence, current consumption is assumed to be dependent on the stock of financial and non-financial wealth as recorded in the previous quarter.

The empirical literature offers various methods to estimate consumption functions. Using a log-linear specification as pursued here, we estimate elasticities directly and then calculate the respective MPCs based on average consumption-to-wealth/income ratios. Some issues may arise however due to time-variation in these ratios (Labhard et al., 2005; Chauvin and Damette,

2010). Alternatively, the MPCs can be estimated directly using a ratio specification. While many studies estimate the MPCs directly (Slacalek, 2009; de Bonis and Silvestrini, 2012; Guerrieri and Mendicino, 2018), the elasticity-based approach is at least equally popular (Bertaut, 2002; Catte et al, 2004; Pacheco and Barata, 2005; Al-Eyd et al., 2006; Bassanetti and Zollino, 2008; Sousa, 2009; Rodil-Marzabal and Menezes-Ferreira-Junior, 2016). Several studies provide and compare the results based on both approaches (Chauvin and Damette, 2010; Barrel et al., 2015; Winkler, 2016). As the third option, logged income and consumption variables are used by some in combination with unlogged wealth variables expressed as ratios to income (Byrne and Davis, 2003; Kerdrain, 2011; Aron et al., 2012).

Short-run determinants other than income and wealth components are grouped in five categories: (i) real interest rates and interest rate spreads, including several measures of the external finance premium; (ii) measures of consumer indebtedness; (iii) measures of government indebtedness capturing the Ricardian equivalence effects; (iv) uncertainty measures; (v) other variables. Table A1 in the Appendix provides a detailed list of variables in each category. Each estimated equation always includes one of the interest rate-based measures and, additionally, up to two other determinants each taken from a different category in various combinations.

These additional short-term determinants capture the effects of interest rates (de Bondt, 1999; Geiger et al., 2014; Premik and Stanislawska, 2017), fiscal stance and policy to capture Ricardian equivalence (Rohn, 2010; Estrada et al, 2014), consumer confidence, and demographic characteristics (Hufner and Koske, 2010). Many other empirical studies consider these and other variables, such as unemployment rate, consumer price inflation (Bachmann et al., 2015; Arioli et al., 2017) or uncertainty more general (Dees and Brinca, 2013; Bahmani-Oskooee et al., 2015; Gieseck and Largent, 2016, Lahiri et al., 2016; Rodil-Marzabal and Menezes-Ferreira-Junior, 2016; Premik and Stanislawska, 2017). A positive and/or negative impact of household debt on consumption is also analysed (Pacheco and Barata, 2005; Carroll et al., 2011; Dynan, 2012; Estrada et al., 2014; Albuquerque and Krustev, 2015; Arrondel et al., 2015; Kim and Setterfield, 2016; Guerreri and Mendicino, 2018). Furthermore, it is also common to include income and wealth effects not only in the long run but also in the short-run (Catte et al., 2004; Sousa, 2009, Časni, 2016).

3.2 Selection of equations

The starting point of our empirical methodology is the application of Generalised Method of Moments (GMM) estimation of a vast number of ECMs as in Equation (1) using data over the sample period 1999Q1 to 2018Q2. The GMM is chosen as an estimation method here in order to account for potential endogeneity among variables and possible measurement errors in particular in the income and wealth components. For every equation, 5 lags of the dependent and independent variables are used as instruments. After accounting for data transformation and lags the actual estimation sample begins in late 2001, albeit it varies slightly across specifications.

The sample period is short, but due to data constraints it is not possible to extend the sample backwards. Notwithstanding this important caveat, our sample has the advantage that it does not contain synthetic euro area data, given that it starts with Stage Three of the Economic and Monetary Union.

In addition, thick modelling considers the uncertainty stemming from model specification and is thus particularly useful for empirical applications using a short sample where model uncertainty is expected to play a role, because it does not rely on a single "best" model specification. Averaging over 50 models is in our view sufficiently thick in practice. Bayesian model averaging using the Occam's window reduce in many practical cases the number of models to fewer than 25 (Clyde, 1999). While the latter provides better predictive performance than selecting the single "best" model, averaging over a larger set of models often leads to better predictive performance. We therefore set the number of model equations at two times 25.

After generating around 6,500 consumption equations per country, we follow a four-step selection process to filter the best ECM specifications, with first three in-sample selection criteria, followed by one out-of-sample criterion:

1) the error correction coefficient (γ) should be statistically significant at the 1% level to ensure that consumption is co-integrated with income and wealth;

2) the F-statistic should be at the 5% level to ensure that short-term coefficients (δ) are jointly significant;

3) the P-value of the Ljung-Box Q-statistics should be above 0.05 for the lags 1-4 as well as 12, i.e. there should be no residual autocorrelation as a sign of model misspecification;

4) the out-of-sample root mean squared error (RMSE) should be at least as low as those from a AR(1) benchmark model and the focus is then on the 50 equations with the lowest RMSE.

Following the three in-sample selection criteria of the selection process, between 2089 (France) and 4876 (Spain) equations remain, i.e. between 32% and 75% of the original equations. For the fourth selection criterion, equations are estimated recursively with end-dates ranging from 2012Q4 to 2016Q2 to generate conditional forecasts for quarterly consumption growth for horizons between 1 and 8 quarters ahead, i.e. over the pseudo out-of-sample period spanning 2013Q1 to 2018Q2. RMSE are calculated over all horizons. For instance, if the forecast horizon is 4 quarters, the RMSE is calculated based on forecasts 1, 2, 3 and 4 quarters ahead. The ECM equations are sorted according to an average RMSE based on 8 horizons (from the lowest to the highest). In addition, the relative average RMSEs against a AR(1) benchmark model are computed and only specifications with a RMSE lower than the benchmark model are selected. The benchmark is an AR(1) model, which is known to be hard to beat and often used. The autoregressive benchmark in many cases outperforms in forecasting consumption growth for the current quarter for the euro area and the three largest euro area countries (Dreger and Kholodilin,

2013). Eventually, we select the top 50 equations out of the between 788 (Spain) and 2618 (Italy) pre-selected models that perform better than the AR(1) benchmark model in terms of RMSE.

4 Data

The source for all quarterly time series for the period 1999Q1 to 2018Q2 is the European Central Bank's Statistical Data Warehouse (SDW). Income, wealth and debt variables are taken from the integrated euro area accounts data for the household sector, while real private consumption, government consumption, public debt and deficit series are taken from Eurostat National Accounts. Rather than using financial and housing price indices (Ludwig and Sløk, 2004; Rodriguez-Palenzuela and Dees, 2016) we use quarterly sector accounts data on households financial balance sheets. With respect to survey-based measures, we use two surveys: the ECB's Survey of Professional Forecasters and the European Commission Consumer Survey. All series are seasonally adjusted either at the source or by applying Census X-13 method, the latter mainly refers to series from financial accounts such as wealth and loans for households that are not available as seasonally adjusted. Also, nominal series are deflated using the private consumption deflator.

Total disposable income is decomposed into labour, transfer and property income. Labour income is calculated as the sum of total compensation of employees and gross mixed income (i.e. income of self-employed) less net social security contributions and labour income share of direct taxes. The share of taxes paid on labour income is approximated by the share of labour income (compensation and mixed income) in the pre-tax income of households before taking into account social security contributions. Property income, from which direct taxes are also deducted on a pro rata basis, is the sum of gross operating surplus excluding mixed income, net interest income and net other property income. Transfer income is then the remaining component, i.e. total disposable income less labour and property income. It is calculated as the sum of social benefits and net other current transfers minus imputed transfer taxes. Appendix B provides further details on how the income and wealth splits are calculated.

Concerning our choice of variables, we choose to model total consumption expenditure as a function of total disposable income. Empirical studies differ substantially in how key variables in the consumption function are defined. In line with theory, some define consumption expenditure as that of non-durable goods (Hamburg et al., 2008; Chauvin and Damette, 2010). Nevertheless, the vast majority of studies uses total consumption expenditure. It is also argued that total consumption is the important variable when analysing wealth effects (Mehra, 2001; Ludwig and Sløk, 2004; Sousa, 2009; Guerrieri and Mendicino, 2018). Similarly, non-property income is theoretically a preferred measure of income (Benjamin et al., 2004; Catte et al, 2004; Labhard et al, 2005; Slacalek, 2009; Kerdrain, 2011; Aron et al., 2012). However, many others still utilise total disposable income (Byrne and Davis, 2003; Ludwig and Sløk, 2004; Časni, 2016;

Rodriguez-Palenzuela and Dees, 2016; Winkler, 2016; Guerrieri and Mendicino, 2018). Finally, the measures of wealth components also vary. Instead of the stock of wealth, equity and house price indices may be used (Ludwig and Sløk, 2004; Rodriguez-Palenzuela and Dees, 2016). Total net worth may be split into its components by either keeping one of them in gross terms or expressing all in net terms (Sousa, 2009). In line with most of the existing literature our specification looks at gross non-financial wealth and financial net worth. The robustness section considers alternative definitions and disaggregation of wealth found in the literature.

Table 2 presents descriptive statistics for the income and wealth components. Labour income accounts for about half of total disposable in the euro area, Germany, France and Italy. In Spain the labour income share in total disposable income has been comparatively high at 64%. Transfer income has been consistently the second most important income component for the euro area, France and Spain, while for Germany and Italy transfer and property income has been of similar importance. Property and transfer income are more volatile than labour income and the differences across countries are substantial. The large share of property income in total disposable income justifies its inclusion in the regression and the difference in volatilities justifies allowing for different elasticities.

The major component of total wealth has always been non-financial wealth. Its share has been on average about two-third in all cases with the exception of Spain where its share has been between 70% and 90% since 1999 (see Table 2). Non-financial wealth consists almost entirely (89% and 100%) of housing wealth in all five cases. Around one third (Spain lower with on average 18%) of total wealth consists of financial wealth, of which, in turn, about half relate to pension wealth in the euro area, Germany and France and about one quarter in Italy and Spain. The wealth to income ratio has been most of the time on a rising path. This ratio has been on average about 700% in the euro area, France and Italy, lower in Germany (525%) and higher in Spain (862%). Turning to the household leverage ratio, it has varied a lot across countries. The loans to income ratio has been comparatively low in Italy (53%) and high in Spain (108%) and has predominantly declined in Germany (10% of all observation has seen a negative annual change) and rising in France (94% of all observations).

5 Empirical results

5.1 Estimates

Two main conclusions emerge from Table 3 that summarises the estimation results. It reports the average estimated income and wealth elasticities in the long and short run based on the selected top 50 equations, the long-run MPCs out of income and wealth as well as the range and average of the estimated error-correction coefficient (speed of adjustment towards the co-integration relationship).

The first conclusion is that the thick model estimates confirm that a split of income as well as wealth is indeed required. The long-run labour income elasticities are always greater than those of transfer and property income. In addition, their average estimates are outside the range of those of transfer and property income for the euro area aggregate and Spain and outside the range of property income for Germany and Italy. The estimated transfer income elasticities are typically larger than those of property income. Based on the ranges of the estimates, the difference between transfer and proper income is more apparent in France and Italy. Similarly, a wealth split has value added for the euro area, France and Spain. Here, the long-run elasticities with respect to financial wealth are outside (for France mostly) the range of those with respect to non-financial wealth. Consequently, it is important to split disposable income and wealth.

Secondly, euro area estimates mask striking cross-country differences. For the income split, most marked country difference relates to the role of property income. It plays on average a limited role for consumption in France, Italy and Spain, whereas property income is estimated to be essential for German consumption developments. The MPC out of transfer income is estimated to be on average close to 100 cents in Germany, France and Italy, more than twice as large as in Spain. The thick model estimates show on average small wealth effects, albeit in most cases significantly different from zero. The MPC out of non-financial wealth for Spain is estimated to be on average about 0.2 cents on the euro, whereas for Germany, France, Italy and the euro area the MPCs are not significantly different from zero. The long-run as well as short-run MPCs out of financial wealth are estimated to be larger than those with respect to non-financial wealth in all cases except in the long-run for Germany where both MPCs are estimated to be on average close to zero. Another cross-country difference is that the estimated speed of adjustment towards equilibrium is quicker in Germany and Italy (around 0.3) compared to France and Spain, where the average estimated adjustment coefficient is about 0.2. It is difficult to provide a definitive explanation for this difference, but it could relate to the more prominent role of property income in Germany and of transfer income in Italy.

Overall, our results are in line with the consumption literature for the euro area as a whole and for individual countries. The finding that the long-run MPCs out of financial wealth are greater than that out of non-financial wealth is also reported in Guerrieri and Mendicino (2018) for France and Spain. Similarly, they do not find evidence of a wealth effect for Germany.[2] Hamburg et al. (2008) show that permanent shocks to income rather than to wealth have played the predominant role for German private consumption. For the euro area, Sousa (2009) finds that the long-run MPC to consume out of financial wealth is between 1.4 and 1.9 cents per euro, while the MPC to consume out of gross housing wealth is much smaller (at most 0.3 cents per euro). In both cases the pre-Great Recession estimates are a bit higher than the thick model-based averages. Slacalek

[2] See page 14 at the bottom: *"(i) both financial and housing wealth effects are remarkable for Spain, with financial wealth effects larger than housing; (ii) Italy displays sizable financial wealth effects and not significant housing wealth effects; (iii) for France the two wealth effects are quite similar, although the MPC out of financial assets tends to be higher compared with the effect of housing assets; (iv) Germany reports not significant effects of changes in either types of wealth."*

(2009) also shows that financial wealth is associated with higher MPCs as compared to non-financial wealth in the euro area as well as for France and Italy. With respect to France, Arrondel et al. (2015) find that the MPC out of financial wealth tends to be higher compared with the effect of housing wealth except in the top of the wealth distribution. Navarro et al. (2015) report for Spain that the main long-run wealth effect is coming from financial wealth followed by residential wealth.

An explanation for the low and, in the case of Italy, on average negative non-financial wealth elasticity is that housing has the dual functions as both an investment asset yielding a flow of capital income and a commodity yielding a flow of housing services. Consequently, a rise in housing price has a positive impact on wealth caused by an increase in capital income and a negative effect due to an increase in the cost of housing services (Cheng and Fung, 2008). Interestingly, Cheng and Fung also link the dual impact of housing wealth to the leverage ratio, with a low (like in Italy) and or declining leverage ratio, like in Germany, resulting in a dominant or large role for the negative impact. Moreover, the on average negative estimated long-run MPCs out of non-financial wealth for Italy is in line with empirical evidence reported by Slacalek (2009).

5.2 Out-of-sample validation

A closer look at the out-of-sample performance of the 50 selected equations from the thick modelling tool shows a clear improvement compared to the forecasting properties of the AR(1) benchmark model. Table 4 reports the out-of-sample performance of the top 50 thick model equations and the AR(1) benchmark model. The models are recursively estimated with end-dates between 2012Q4 and 2016Q2 and are then used to produce conditional forecasts for 1 up to 8 quarters ahead over the period 2013Q1 to 2018Q2. The ratio between the thick model based root mean squared errors (RMSE) and the AR(1) model based RMSE is in all cases below 1. The forecast gain is the strongest in Italy and the euro area, with a RMSE ratio of about 0.4 to 0.5, thus gaining 60% to 50% even at the longer ahead forecast horizons. The RMSE ratio is about 0.6 to 0.8 for Germany and Spain and around 0.9 for France. With the exception of France, there are 2 to 4 out of the 8 forecast horizons where the out-of-sample forecast accuracy from the thick model significantly differ from AR(1) model based forecasts according to the Diebold-Mariano test at the 10% significance level. For the euro area, there is a consistent significant forecast gain for 2 to 5 quarters ahead. This promising finding suggests valued added in the use of this thick modelling approach in forecasting private consumption growth, given the AR(1) model is in practice hard to beat.

Figure 1 plots mean forecasts for quarterly growth rates in consumption together with actual real private consumption growth for the period 2016Q3 to 2018Q2 based on equations estimated up to 2016Q2 and all explanatory variables available up to 2018Q2. The shaded areas denote the range between the 5th and 95th percentiles of the forecast range (darker shade) as well as the top and bottom 5% percent (lighter shade). Overall, the thick model-based mean forecast

broadly tracks the actual data in the short-term (forecast horizon, h, is 1 to 4), while being more inaccurate over the longer horizon (h=5 to h=8).

With a couple of exceptions, the actual growth rate series are within the forecast range between the lowest and highest forecast values and it also tends to fall within the middle 90% of the forecast range. Some of these differences can in part be explained by (one-off) factors not captured by the model determinants like the impact of terror attacks (France 2016Q3), reluctance to buy new cars due to diesel emission issues (Germany) and weather conditions. In addition, the forecast errors can be revised away with the release of new data vintages as the real-time errors in private consumption growth can be sizeable. The absolute average real-time revision in quarterly real private consumption growth between 2003 and 2013 has been 0.2 percentage points in the euro area, 0.3 in France and Italy, 0.4 in Spain and 0.5 in Germany. The thick-model based ranges are about 0.2 percentage points for the euro area, about 0.4 percentage points for Germany and Italy and much larger for France.

5.3 Robustness

Given the various options shown in the literature to estimate consumption functions, we have run a set of robustness checks. First, we estimate the equations based on non-property income to address the possibility of double-counting of wealth effects. Non-property income is typically preferred from the theoretical point of view (Catte et al., 2004; Kerdrain, 2011). Second, we change the decomposition of wealth by calculating net financial wealth excluding housing related debt, which is in turn deducted from non-financial assets to compute net non-financial assets. Sousa (2009) shows that this choice may affect the magnitude of the estimates. Third, we estimate the equations with the debt to income ratio as a third wealth variable in the long-run equation. Fourth, we exclude pension wealth from net financial wealth. As discussed in the methodology section, several alternatives to the log-level estimation exist. Hence, the fifth and six robustness checks estimate the models using income ratios and per capita ratios, respectively. Finally, we compare the estimated wealth and income elasticities from the top 50 equations with those from all accepted models using only the in-sample criteria. This way, we check whether we experience loss of information or forecast accuracy if only top 50 models are considered.

The seven robustness checks all show that the two main findings remain: (i) a split of total disposable income and total wealth is essential; and (ii) cross-country heterogeneity in income and wealth effects exists. The thick model-based estimates for the long-run income and wealth MPCs are generally robust, but they also illustrate that the treatment of debt is crucial for the estimated non-financial wealth effects. Similarly, the out-of-sample performance can differ on whether property income is included (in particular key for Germany and the euro area) or excluded. In more detail, the outcomes of the robustness checks are as follows.

Firstly, the exclusion of property income results in similar estimates as in the basic specifications that include it for France, Italy and Spain. The exclusion of property income results for Germany in only 12 selected equations (mainly due to residual autocorrelation) with often implausible long-run MPCs out of transfer income. Consequently, the estimated long-run MPCs for the euro area, all outside the estimated range from the top 50 selected basic specifications, have to be treated with caution. The out-of-sample performance deteriorates a lot for the euro area (1.04 versus 0.64 for the basic specification) and improves a bit for France, Italy and Spain. All three countries have close to zero long-run property income elasticities for the basic specifications. For this reason, Banque de France (2018) decided to exclude property income in their consumption model.

Secondly, the exclusion of debt from household liabilities results in similar long-run MPCs as estimated from the selected basic specifications. They are all within the estimated range for the basic equations, with the exception of the long-run MPC out of non-financial wealth in Spain. Instead of on average 0.2 cents per euro it becomes -0.2 cents. This finding is as expected, because due to the different treatment of debt the wealth measure used differs and household debt in Spain is known to have shown large swings since 1999. The negative effect from the cost of housing on average dominates if household debt (capturing the positive housing wealth channel from collateral and capital income) is taken into account.

The third robustness check includes the debt to income ratio into the analysis. The non-financial wealth effect turns negative in the long run in two cases, Germany and Italy (these findings are in line with some studies discussed in Section 2). It may be due to the fact that the negative impact of non-financial wealth (higher housing services costs) dominates the positive impact (from higher capital income out of housing). For Germany and France the average debt to income ratio is estimated to be negative. For Italy and Spain in all 50 cases positive debt to income ratio coefficients have been estimated. Household leverage has thus over the sample period been positively associated with consumption in Italy and Spain and negatively in Germany and France. With respect to income and wealth effects, the estimates are broadly similar for the euro area, Italy and Spain, while for Germany and France they differ somewhat more.

Fourthly, the exclusion of pension wealth from financial wealth has not changed the estimated long-run wealth and income effects much. The three cases where the average estimated MPC lies outside the estimated range from the basic specifications is financial wealth and transfer income for the euro area and transfer income for Spain. This notwithstanding, the long-run MPCs out of transfer income are consistently larger than those in the basic specification. A likely explanation is that transfer income in part includes pension related transfer income. Similarly, the average estimated MPCs out of non-financial wealth are consistently larger than those in the basic specifications. The MPCs remain, however, small. They are at most 0.6 cents per euro.

The fifth robustness check is to estimate income ratio specifications, i.e. the change in the ratio between private consumption and total disposable income as dependent variable and the

respective income and wealth components also expressed in terms of total disposable income. This specification has the advantage that the propensities to consume are directly estimated. In order to avoid non-singularity we removed in the short run the change in the property income ratio. Unit elasticity with respect to income and wealth is no longer imposed. The thick model estimates for the long-run MPCs out of income mostly remain within the range as estimated with the basic specification, but those out of wealth typically become larger. The latter applies in particular to France and Spain and to both wealth components. For France, Italy and Spain the estimated speed of adjustment is quicker than the range estimated from the basic specification. The out-of-sample performance of the income ratio specification is, however, poor for Italy and Spain with no improvement compared to the benchmark AR(1).

The sixth robustness check is the basic specification where all the variables are expressed in per capita terms. Overall, as shown in Table 5 the estimated income and wealth effects are again broadly unchanged, especially so for France, Italy and Spain. The final and seventh robustness check shows the income and wealth effects from the top 50 selected equations hardly deviate from the selected much larger pool of equations (between 2089 (France) and 4876 (Spain) equations) that fulfil the in-sample criteria.

6 Conclusion

This study applies a thick model methodology to real private consumption in the four largest euro area economies and compares the outcomes with those for the euro area. Our thick model considers multiple error correction model specifications rather than only a single "best" one. Thick modelling is particular of use in the context of model uncertainty where it is hard to decide which model to use, which is here the case due to our short sample. All specifications incorporate the two most important macro determinants of private consumption, i.e. disposable income and wealth, in the short and long run. In addition, they include an interest rate measure as well as up to two other variables from a rich set of explanatory variables in the short run: consumer leverage, government indebtedness, various uncertainty measures, and demographics. In addition, we split total wealth into financial and non-financial wealth and disposable income into labour, property and transfer income. Overall, our results stress the importance to decompose not only household wealth but also disposable income for analysing private consumption as well as the usefulness of thick modelling for forecasting private consumption in the largest euro area countries. They also show cross-country heterogeneity in disaggregated income and wealth effects. This finding stresses the need for caution when interpreting income and wealth effects estimated directly from euro area data.

Against the background of recent attempts to link micro and macro data on household income and wealth (see, among others, Fesseau et al., 2013; Honkkila and Kavonius 2013; Arrondel et al. 2015), most promising for future work is to consider also distributive information on income

and wealth for private consumption at the aggregated macro level. More generally, an important avenue for future consumption research is to further improve the micro-macro link.

Table 1. Empirical estimates of long-run income and wealth elasticities and MPCs

Paper	Sample	Methodology	Country	Long-run [MPC] and (elasticity)		
				Income	*FW*	*HW*
Bertaut (2002)	Depends on a country	First-diff. equations, ECM	**FR**	(0.80)	(0.10) [2.7]	-
Byrne and Davis (2003)	1972-1998	ECM	**DE**	(0.85-0.97)	(0.09) [2-2.3]	-
			FR	(0.81-1.07)	(0.16) [2.9-3]	-
			IT	(0.90-1.14)	(0.10) [1.3-2]	-
Catte et al (2004)	Depends on a country	ECM	**DE**	(0.91)	(0.03) [2]	-
			FR	(0.86)	(0.03) [2]	-
			IT	(0.42)	(0.04) [1]	(0.09) [1]
			ES	(0.42)	(0.07) [2]	(0.15) [2]
Pacheco and Barata (2005)	Depends on a country	ECM	**DE**	(0.83)	(-0.03)	-
			FR	(0.07)	(0.08)	-
			IT	(0.44)	(0.03)	-
Al-Eyd et al. (2006)	1974 - 2002	Single-country and panel ECM	**DE**	(0.93-0.97)	(0.03-0.07)	-
			FR	(0.89-1.00)	(0.01-0.11)	-
			IT	(-0.84-0.85)	(0.15-1.84)	-
			ES	(0.35-0.95)	(0.05-0.65)	-
			EA	(0.58-0.87)	(0.02-0.12)	-
Bassanetti and Zollino (2008)	1980-2006	VECM	**IT**	(0.76-1.1) [60-70]	(0.09-0.19) [4-6]	(0.05-0.08) [1.5-2]
Slacalek (2009)	1980-2008 (EA)	Country- and group-level regressions: Carroll et al. (2011) approach	**DE**	-	[14.2]	[2.9]
			FR	-	[2.9]	[2.3]
			IT	-	[10.3]	[-1.1]
			ES	-	[5.3]	[6.2]
			EA	-	[1-3.8]	[-1.3-2]
Skudelny (2009)	1981(95) -2006	Long-run equations; ECM	**EA**	-	[0.6-3.6]	[0.7-2.5]
Sousa (2009)	1980-2007	ECM, Carroll et al. (2011) approach	**EA**	(0.65-0.91) [55.5-77.7]	(0.12-0.15) [1.4-1.9]	(-0.07-0.05) [-0.47-0.3]
Chauvin and Damette (2010)	1987-2006	VECM, long-run equations	**FR**	(0.53-0.92)	(0.08-0.12) [4.4-11.9]	(0.05-0.08) [0.8-4.3]
Kerdrain (2011)	Depends on a country	ECM	**EA**	-	[5-7]	[0-2]
De Bonis and Silvestrini (2012)	1997 - 2008	Panel ECM, country-level ARDL	**DE**	-	[-0.4]	[-0.8]
			FR	-	[3.4]	[-1.6]
			IT	-	[-0.7]	[0.3]
			ES	-	[2.8]	[0.2]
Barrell et al. (2015)	1972-2012	Long-run equations, Carroll et al. (2011) approach	**IT**	(0.36-0.4)	(0.23) [2.4-2.8]	(0.09) [-0.3-0.7]
Rodil-Marzabal and Menezes-Ferreira-Junior (2016)	2000-2010	Panel long-run and first-diff. equations	**EA**	(0.55-0.90)	(0.29)	(0.04)
Rodriguez-Palenzuela and Dees (2016)	2000-2013	Panel ECM	**EA**	(0.43-0.58)	(0.01-0.03)	(0.05-0.09)
Winkler (2016)	1995-2013	VECM	**DE**	(0.77) [61.2]	-	(0.18) [3.6]
			IT	(0.87) [69.6]	-	(0.10) [1.9]
Guerrieri and Mendicino (2018)	1999-2017	Country- and group-level regressions: Carroll et al. (2011) approach	**DE**	-	[-2.9 to -2.8]	[-7.3 to -4]
			FR	-	[4.1-4.2]	[3-3.1]
			IT	-	[5.8-6.1]	[6.3-7.3]
			ES	-	[9.6-14.6]	[4.1-7.7]
			BIG 5	-	[4.1]	[3.3]

Table 2. Income and wealth components

(1999Q1 - 2018Q2; in % total disposable income, respectively, total wealth, unless stated other wise)

	Euro area		Germany		France		Italy		Spain	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Labour income	53	1.26	51	1.30	51	1.30	47	1.21	64	0.91
Transfer income	27	1.77	26	2.16	32	1.10	24	1.07	22	1.46
Property income	21	2.23	23	3.79	17	1.88	28	1.57	14	4.20
Non-financial wealth	68	1.06	68	0.96	68	1.02	62	0.98	82	1.16
Housing wealth	64	1.13	61	1.04	65	1.07	57	1.04	82	1.17
Financial wealth	32	1.94	32	2.60	32	1.72	38	2.09	18	1.88
Pension wealth	14	1.00	17	0.75	15	0.99	8	1.12	5	0.74
Wealth to income ratio	674		525		693		756		862	
% increasing	76		80		76		60		67	
Loans to income ratio	90		94		74		53		108	
% increasing	63		10		94		70		49	

Notes: Non-financial wealth, housing wealth financial wealth and pension wealth in % of total net-worth. % increasing is number of observations with a positive 4-quarter change in the ratio. Financial wealth refers to net financial wealth, pension wealth to net pension wealth. Wealth to income ratio is the ratio of total wealth (net worth) to total disposable income. Std refers to standard deviation in the change relative to the standard deviation in the change of total disposable income, respectively, wealth.

Table 3. Estimation results

	Short run		Long run			
	Elasticity	MPC	Elasticity		MPC	
	Average	Average	Range	Average	Range	Average
	euro area					
Labour income	0.30 ***	50	0.35 - 0.51	0.47 ***	58 - 85	79
Transfer income	0.08 ***	27	0.21 - 0.31	0.26 ***	69 - 100	83
Property income	0.09 ***	41	0.17 - 0.31	0.20 ***	73 - 131	85
Non-financial wealth	0.00	-0.26	-0.02 - 0.03	0.01	-0.08 - 0.15	0.04
Financial wealth	0.06	0.30	0.05 - 0.07	0.06 ***	0.53 - 0.73	0.66
Speed of adjustment			0.37 - 0.65	0.49 ***		
	Germany					
Labour income	0.29 ***	49	0.30 - 0.71	0.47 ***	50 - 120	79
Transfer income	0.14 ***	46	0.13 - 0.38	0.24 ***	45 - 126	80
Property income	0.14 ***	54	0.20 - 0.29	0.24 ***	73 - 105	87
Non-financial wealth	-0.10	-0.64	-0.20 - 0.20	0.04	-1.19 - 1.26	0.23
Financial wealth	0.06	0.76	-0.07 - 0.09	0.00	-0.90 - 1.23	0.06
Speed of adjustment			0.15 - 0.54	0.29 ***		
	France					
Labour income	-0.01	-2	0.16 - 0.75	0.51	28 - 127	86
Transfer income	0.15 **	42	-0.01 - 0.61	0.35 **	-4 - 164	95
Property income	0.00	1	-0.17 - 0.20	0.01	-87- 99	7
Non-financial wealth	0.14 **	0.67	-0.05 - 0.08	0.00	-0.22 - 0.38	0.03
Financial wealth	0.07 ***	0.74	0.07 - 0.17	0.11 *	0.70 - 1.72	1.13
Speed of adjustment			0.12 - 0.27	0.20 ***		
	Italy					
Labour income	0.02	4.3	0.31 - 0.79	0.49 ***	57 - 145	91
Transfer income	0.04	14	0.28 - 0.44	0.35 ***	103 - 161	127
Property income	0.11 ***	37	-0.10- 0.21	0.09	-0.30 - 68	25
Non-financial wealth	-0.03	-0.17	-0.04 - 0.00	-0.01	-0.20 - 0.03	-0.06
Financial wealth	0.01	0.10	-0.02 - 0.14	0.08 **	-0.17 - 1.14	0.61
Speed of adjustment			0.20 - 0.36	0.28 ***		
	Spain					
Labour income	0.05	6	0.48 - 0.65	0.55 **	68 - 92	78
Transfer income	0.00	21	-0.15 - 0.19	0.12	-61 - 78	49
Property income	0.00	2	-0.01 - 0.12	0.05	-12 - 82	31
Non-financial wealth	0.09	0.28	0.06 - 0.11	0.07 **	0.18 - 0.38	0.23
Financial wealth	0.05 ***	0.80	0.14 - 0.33	0.20 **	2.20 - 5.19	3.12
Speed of adjustment			0.14 - 0.25	0.20 ***		

Notes: Ranges and averages based on selected top 50 equations using GMM estimation. Marginal propensity to consume (MPC) is reported in euro cents (100*elasticity*C/X, where C is the average level of real consumption level and X is the average level of relevant income/wealth over 1999Q1 to 2018Q2. *, **, *** denote significantly differently from zero in at least 90%, 95%, respectively, 99% out of the 50 selected equations.

Table 4. Relative average RMSE ratio of top 50 thick model against AR(1) benchmark model

h	Euro area	Germany	France	Italy	Spain
1	0.72	0.85	0.79	0.45	0.87
2	0.56 **	0.74	0.89	0.36 ***	0.91
3	0.52 *	0.60	0.96	0.38 ***	0.90
4	0.42 **	0.54 *	0.94	0.40 **	0.89 **
5	0.42 *	0.52	0.81	0.43 **	0.77
6	0.49	0.60 **	0.89	0.52	0.73
7	0.54	0.68	0.93	0.62	0.78 *
8	0.59	0.64	0.88	0.68	0.74

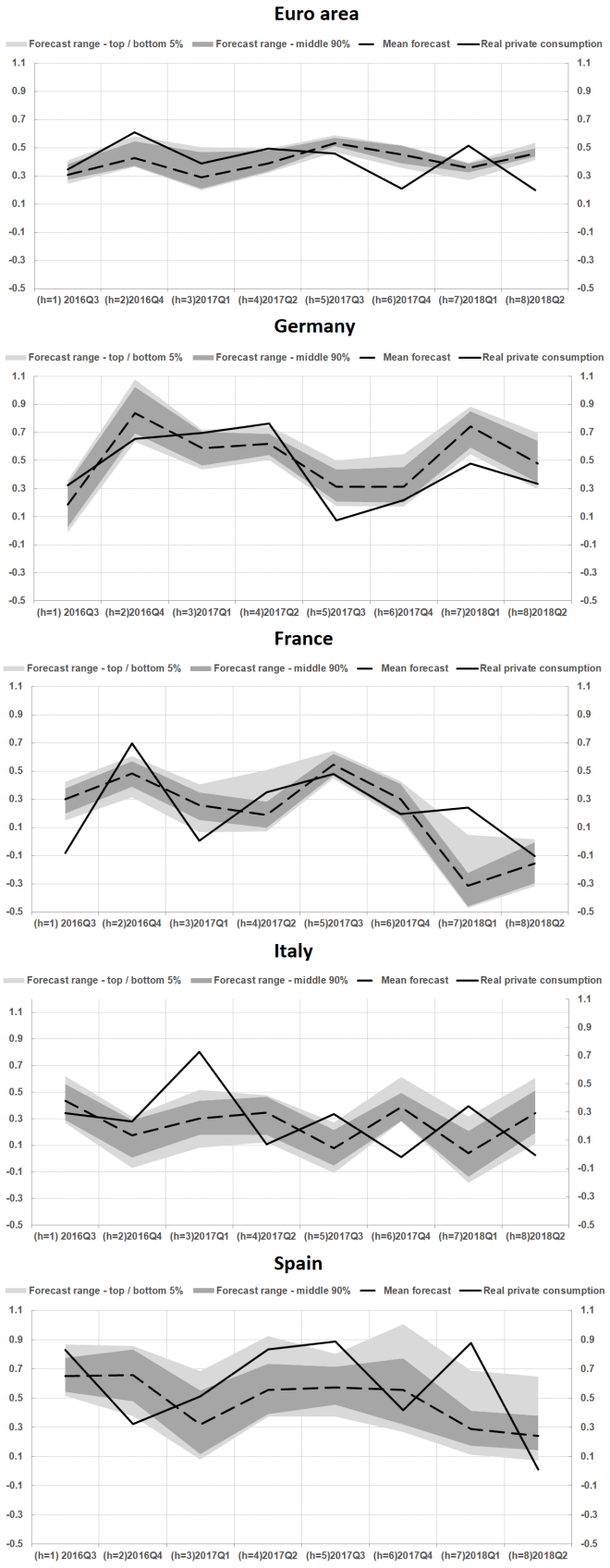
Notes: RMSE ratio is RMSE averaged of thick model selected top 50 equations in terms of RMSE from AR(1) for the out-of-sample period 2013Q1 to 2018Q2. h = forecast horizon h quarters ahead. ***, **, * denote Diebold-Mariano test at 10%, 5% and 1% significance level, respectively.

Table 5. Robustness in thick model long-run estimates and out-of-sample performance

	Basic	Check 1	Check 2	Check 3	Check 4	Check 5	Check 6	Check 7
	Euro area							
Labour income	79	111	81	71	61	76	72	74
Transfer income	83	59	78	90	109	92	88	86
Property income	85		85	87	95	106	79	95
Non-financial wealth	0.04	0.28	-0.04	0.16	0.08	0.09	0.20	0.02
Financial wealth	0.66	1.00	0.66	0.66	1.11	0.66	0.75	0.70
Debt to income ratio				-0.05				
Speed of adjustment	0.49	0.25	0.47	0.51	0.56	0.55	0.51	0.46
RMSE relative to AR(1)	0.64	1.04	0.62	0.64	0.57	0.68	0.57	0.82
	Germany							
Labour income	79	NA	80	114	74	81	55	87
Transfer income	80	NA	80	109	81	84	80	65
Property income	87	NA	88	98	89	96	85	89
Non-financial wealth	0.23	NA	0.56	-1.46	0.55	0.41	1.40	0.32
Financial wealth	0.06	NA	0.06	-0.46	-0.47	-0.73	-0.41	-0.13
Debt to income ratio				-0.24				
Speed of adjustment	0.29	NA	0.29	0.48	0.31	0.31	0.37	0.37
RMSE relative to AR(1)	0.79	NA	0.79	0.68	0.81	0.77	0.61	0.96
	France							
Labour income	86	103	98	33	66	106	88	101
Transfer income	95	66	80	139	119	59	73	54
Property income	7		-7	51	31	18	28	23
Non-financial wealth	0.03	0.08	-0.01	0.16	0.11	0.34	0.14	0.02
Financial wealth	1.13	1.24	1.08	1.46	1.62	3.87	1.19	1.50
Debt to income ratio				-0.12				
Speed of adjustment	0.20	0.22	0.17	0.31	0.21	0.43	0.38	0.17
RMSE relative to AR(1)	0.87	0.83	0.87	0.83	0.83	0.83	0.80	1
	Italy							
Labour income	91	102	93	118	96	107	61	91
Transfer income	127	110	128	104	135	109	170	128
Property income	25		29	41	18	23	52	27
Non-financial wealth	-0.06	-0.01	-0.14	-0.62	-0.04	0.59	-0.18	-0.06
Financial wealth	0.61	1.16	0.57	0.57	0.58	0.07	0.52	0.61
Debt to income ratio				0.33				
Speed of adjustment	0.28	0.26	0.29	0.23	0.28	0.45	0.32	0.29
RMSE relative to AR(1)	0.53	0.57	0.52	0.52	0.56	1.06	0.78	0.81
	Spain							
Labour income	78	76	87	88	77	71	77	79
Transfer income	49	69	32	50	101	99	64	50
Property income	31		11	12	2	-59	18	32
Non-financial wealth	0.23	0.26	-0.17	0.09	0.26	1.29	0.34	0.24
Financial wealth	3.12	3.31	3.44	3.21	2.99	7.32	2.66	3.13
Debt to income ratio				0.05				
Speed of adjustment	0.20	0.18	0.17	0.23	0.18	0.32	0.27	0.16
RMSE relative to AR(1)	0.87	0.80	0.88	0.92	0.78	1.56	0.83	1.19

Notes: Long-run MPC averaged over the top 50 equations. RMSE average across i) forecast horizon (up to eight quarters); ii) recursive sample ending in 2012Q4 to 2016Q2; and iii) the 50 selected equations. RMSE from the AR(1) benchmark model are 0.0020 (EA); 0.0037 (GE); 0.0038 (FR); 0.0032 (IT); 0.0039 (SP). NA = not available, only 12 equations selected for Germany mainly due to residual autocorrelation. Underlined is outside the range of the basic specification or more than 10 pp. change in out-of-sample forecast performance. *, **, *** denote significantly differently from zero in at least 90%, 95%, respectively, 99% out of the 50 selected equations. Check 1: Property income excluded; Check 2: Debt excluded from liabilities; Check 3: Debt to income ratio included as long-run determinant; Check 4: Pension wealth excluded from financial wealth; Check 5: Income ratio specification; Check 6: Per capita specification; Check 7: In-sample selected equations only.

Figure 1. Pseudo out-of-sample consumption growth forecasts: thick model versus AR(1)



Notes: this figure plots quarter-on-quarter growth rates of actual real private consumption (solid line) together with the mean forecast (dashed line) based on the top 50 selected equations over the sample period 2016Q3 to 2018Q2. The darker shaded area denotes the range between the 5th and 95th percentiles of the overall forecast range while the lighter shaded areas denote the top and bottom 5% of forecast range.

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Appendix A

Table A1. Additional short-run consumption determinants add unit root / integration order tests

Description	Transformation	Integration order
Long-run variables		
Private consumption, chain linked volume	Log	I(1)
Financial net worth	Real, log, 1-period lagged	I(1)
Gross non-financial assets	Real, log, 1-period lagged	I(1)
Real labour income net of taxes	Real, log	I(1)
Real property income net of taxes	Real, log	I(1)
Real transfer income net of taxes	Real, log	I(1)
Interest Rates		
10-year government bond yield	Real	I(0)
Interest rate on loans to households for consumption	Real	I(0)
Interest rate on households deposits	Real	I(1)
Interest rate on loans to households for house purchases	Real	I(1)
3-month Euribor	Real	I(1)
10-year government bond yield (-) 3-month Euribor	Real	I(1)
Interest rates on loans for house purchases (-) deposit rate		I(1)
Interest rateson loans for house purchases (-) 3-month Euribor		I(1)
Interest rates on consumption loans (-) deposit rate		I(1)
Interest rate on consumption loans (-) 3-month Euribor		I(1)
Consumer indebtedness		
Loans to Households (amounts outstanding)	Log, 1-period lagged	I(1)
Loans to households (/) 4-quarter moving sum of nominal GDP	1- and 2-period lagged	I(1)
Interest income paid (/) nominal GDP	4-quarter moving sum, 1- and 2-period lagged	I(1)
Interest Income paid (-) received (/) nominal GDP	4-quarter moving sum, 1- and 2-period lagged	I(1)
Outstanding loans to households / total disposable income	1- and 2-period lagged	I(1)
Government indebtedness		
Government deficit		I(1)
Government deficit	Yearly change	I(0)
Government deficit (/) nominal GDP	Four-quarter moving sum	I(1)
Government debt (/) 4-quarter moving sum of nominal GDP		I(1)
Government final consumption	Log	I(1)
Government debt outstanding	Log	I(1)
Uncertainty		
Consumer Inflation Expectations, EC survey		I(0)
Consumer confidence, EC survey		I(1)
Consumers' financial expectations, EC survey		I(1)
General economic situation, EC survey		I(1)
Economic sentiment, EC survey	Log	I(0)
Expected Major Purchases, EC survey		I(1)
Consumer savings expectations, EC survey		I(1)
Unemployment expectations, EC survey		I(1)
1-Year ahead inflation expectations (SPF)	Shifted three quarters	I(1)
2-Year ahead inflation expectations (SPF)	Shifted seven quarters	I(1)
Aggregate uncertainty (mean)		I(0)
Aggregate uncertainty (first principal component)		I(0)
Economic policy uncertainty		I(0)
Forecast uncertainty		I(0)
Forecast disagreement		I(0)
Conditional volatility measure of uncertainty		I(0)
Financial market uncertainty		I(0)
Macroeconomic uncertainty		I(0)
Survey-based uncertainty		I(1)
Total unemployment		I(1)
HICP excluding food and energy	Yearly change	I(0)
HICP	Yearly change	I(0)
CPI deflated effective exchange rate against 38 trading partners	Log	I(1)
CPI deflated effective exchange rate against 18 trading partners	Log	I(1)
Real effective exchange rate against 38 trading partners	8-period backward moving standard deviation	I(0)
Real effective exchange rate against 18 trading partners	8-period backward moving standard deviation	I(0)
1-Month forward price of Brent oil	Log	I(0)
Others		
Old age dependency ratio (older than 65 / working age 15 to 64)		I(1)
Population	Log	I(1)

Notes: Short-run variables enter the equation in differences according to their integration order.

Appendix B

Income and wealth split definitions

Total disposable income (Y) is decomposed into labour, transfer and property income.

Labour income (LY) is defined as the sum of total compensation received (D1R) and gross mixed income (B3G, i.e. remuneration of work done by self-employed and their families) and deduct social security contributions (D61) and imputed labour taxes (i.e. current taxes paid (D5P) weighted with the labour share in taxable income). In other words, we define net labour income as total labour income (out of dependent and independent activity) after social security contributions and taxes.

Transfer income (TY) is defined as the sum of social benefits (D62) and net other current transfers (D7) minus imputed transfer taxes, i.e. net transfer income after taxes.

Property income (PY) is defined as the sum of gross operating surplus (B2G, mostly: imputed rents of home-owner occupiers in providing services to themselves) and net property income (D4, i.e. net interest earnings plus net other property income such as dividends paid by companies) minus imputed property taxes, in other words: net capital income after taxes.

LY = D1R + B3G – D61 – D5P * (D1R+B3G) / (D1R+B3G+B2G+D4+D62)

TY = D62 + D7 - D5P * (D62) / (D1R+B3G+B2G+D4+D62)

PY = B2G +D4 – D5P * (B2G+D4) / (D1R+B3G+B2G+D4+D62)

Wealth is split for the basic specification into:

Non-financial wealth = gross non-financial wealth;

Net financial wealth = total financial assets – total financial liabilities.

For robustness check no. 2 the wealth split is as follows:

Net non-financial wealth= non-financial wealth minus loans to households;

Net financial wealth = total financial assets – total financial liabilities (excluding loans to households).

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