UNIVERSITA' DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI
"M. FANNO"

CORSO DI LAUREA MAGISTRALE IN
ECONOMICS AND FINANCE

TESI DI LAUREA

ARE ITALIAN HOUSEHOLD PORTFOLIOS EFFICIENT? AN ANALYSIS CONDITIONAL ON HOUSING WEALTH

RELATORE:

CH.MO PROF. GUGLIELMO WEBER

CORRELATORE:

PROF. NANCY ZAMBON

LAUREANDO/A: GRETA PESARESI

MATRICOLA N. 1182166

ANNO ACCADEMICO 2019 – 2020

Il candidato dichiara che il presente lavoro è originale e non è già stato sottoposto, in tutto o in parte, per il conseguimento di un titolo accademico in altre Università italiane o straniere.
Il candidato dichiara altresì che tutti i materiali utilizzati durante la preparazione dell'elaborato sono stati indicati nel testo e nella sezione "Riferimenti bibliografici" e che le eventuali citazioni testuali sono individuabili attraverso l'esplicito richiamo alla pubblicazione originale.

The candidate declares that the present work is original and has not already been submitted, totally or in part, for the purposes of attaining an academic degree in other Italian or foreign universities. The candidate also declares that all the materials used during the preparation of the thesis have been explicitly indicated in the text and in the section "Bibliographical references" and that any textual citations can be identified through an explicit reference to the original publication.

Firma dello studente

Abstract

Housing is the largest component of Italian household wealth. A non-negligible portion of Italian households owns second homes too. Using data from the Survey on Household Income and Wealth (SHIW) from the 2012-16 waves, we analyze how owning second homes influences risky financial assets ownership. We find that there is a positive and significant relationship between second homes holdings and investments in risky financial assets. Unrented second homes have, instead, a negative but insignificant effect on them.

Then, we try to assess whether Italian household portfolios are efficient. In particular, we treat housing (because of its illiquidity) as a constrained asset in the portfolio optimization problem when assessing portfolios efficiency. We perform a constrained efficiency test that differs from standard mean-variance analysis in which housing wealth is neglected. We do the analysis using Italian household data from SHIW 2012 and SHIW 2016 together with financial assets and regional house prices. Moreover, we consider both the case in which housing wealth is composed by main residence and second homes and the case in which housing wealth is composed by second homes only. What we find is that for both specifications, when we consider housing as an unconstrained asset, few portfolios are efficient. When we treat housing as a constrained asset, instead, many more portfolios become efficient, meaning that these households exploit hedging opportunities.

Table of contents

Introduction

Housing represents the main asset in household wealth in many developed countries. Italy is one of them, as almost three Italian households out of four own at least the house in which they live (i.e. the main residence). It is even more relevant that one out of five declares to own also one or more second homes. At the same time, however, still there is low participation in financial markets.

In this thesis we are going to address two issues on household portfolio decisions when housing is considered a risky asset.

The first issue is the relationship between homeownership and investment in risky assets. In particular, we focus on the effect of second homes on risky financial assets holdings. In our application, we use Italian household portfolio data from the Bank of Italy Survey on Household Income and Wealth (SHIW) for 2012-16 waves and we regress risky asset holdings on some demographic and economic controls, together with real estate controls. We find that households who own second homes invest more in financial assets and have more diversified portfolios compared to other households.

The second question regards the efficiency of Italian household portfolios once housing wealth is taken into account. This approach differs from the standard mean-variance efficiency analysis that considers financial assets only.

Pelizzon and Weber (2008), extending Flavin and Yamashita's (2002) paper, show that if there is correlation between financial assets returns and housing returns, household financial decisions are affected by the need to hedge some of the risks linked to their illiquid housing position, such as house price fluctuations over time and high transaction costs of buying and selling a house. Thus, they introduce housing stock (including only the main residence) as an additional constraint to the optimization problem. This constraint changes the investors' optimal strategy, in the sense that now they choose the standard Markowitz portfolio according to their risk aversion and use the risky financial assets to hedge their illiquid housing position.

We extend Pelizzon and Weber (2008) conducting the entire analysis for two different definitions of housing wealth: the first, broader definition includes both main residence and second homes wealth, while the second, narrower definition focuses on second homes wealth only. This choice derives from the fact that households may perceive their main residence as a pure consumption good since they have to live somewhere. Second homes, instead, are for sure durable investment goods, therefore households need to hedge their risks.

We use Gouriéroux and Jouneau (1999) efficiency test to formally assess whether Italian household portfolios are efficient once we account for housing wealth. This test, indeed, has the aim to analyze the performance of a portfolio of risky assets (in a mean-variance framework) when some constraints exist on a part of the portfolio.

To implement the test, we use data on Italian household from SHIW 2012 and 2016 and time-series data on financial risky assets as well as regional house prices, covering 2005-2018 period.

We perform the efficiency test for the two definitions of housing, analyzing portfolio efficiency only for homeowners that invest at least in one risky asset.

Our key finding is that, when we consider housing as an unconstrained asset, we obtain few efficient portfolios. When, instead, we consider the illiquid nature of housing investment, many more portfolios become efficient, and this suggests that many households exploit hedging opportunities.

This thesis is organized as follows. First, we present a review of the relevant literature. Then, in Chapter 1 we present features of Italian households related to financial markets participation and main residence and second homes owning. In Chapter 2 we present Pelizzon and Weber (2008) theoretical model on optimal portfolio choice in the presence of housing as a constraint and we describe the data used. Finally, in Chapter 3 we present Gourieroux and Jouneau efficiency test and report our results.

Literature review

In the vast literature on household portfolios allocation and mean variance analysis, few studies include housing equity in household wealth. Even if it is well known that households allocate their wealth into financial and real assets, the portfolio allocation problem has typically focused on financial assets only. However, in the last twenty years there has been an increased interest in the effect of housing on household portfolio choice. This is due to the fact that owner-occupied housing is the single most important asset in many investors' portfolios.

Flavin and Yamashita (2002), following Grossman and Laroque's (1990) model, introduce housing in their analysis and argue that real estate levels that are optimal from a consumption point of view, may be suboptimal from a portfolio optimization point of view. Also, they characterize the efficiency frontier for homeowners when the house cannot be changed in the short run and there are non-negativity constraints on all assets. They consider the case where there is zero correlation between financial returns and house returns, and, therefore, the main effect of housing is to change the background risk faced by investors.

Cocco (2005) investigates the effect of housing equity on stockholding. In particular, he finds that due to investment in housing, younger and poorer investors have limited financial wealth to invest in stocks, and this reduces the benefits of equity market participation. Also, he argues that house price risk crowds out stockholdings, and this crowding out effect is larger for low financial net-worth. Transaction costs are another aspect that he considers in his analysis. Indeed, costs such as searching, legal costs, costs of readjusting home furnishings to a new house reduce the frequency of house trades and lead households to reduce their exposure to stocks.

Flavin and Nakagawa (2008) extend Grossman and Laroque (1990) by allowing for the presence of two goods in the utility function. The authors assume that there is zero covariance between housing and financial assets and show that in this context housing wealth affects portfolio allocations only through the relative risk aversion of households.

Pelizzon and Weber (2008) extend Flavin and Yamashita's analysis to cover the case of non-zero correlation between housing and financial asset returns. Also, they extend Flavin and Nakagawa (2008) to show how efficient financial portfolios should be after allowance is made for the presence of a given housing stock. In these portfolios, housing wealth affects the optimal shares indirectly through risk aversion and directly through a hedge motive. In particular, Pelizzon and Weber (2008) find that all households will hold a single optimal portfolio of risky assets (the standard Markowitz optimal portfolio) and a hedge term covering house price risk under standard, if restrictive, assumptions on the investment opportunity set.

Moreover, if the housing stock is not frequently adjusted, they observe that the optimal portfolios (that include financial assets and housing wealth) should be conditionally mean-variance efficient, that is mean-variance efficient when housing wealth is treated as given. Finally they complement Cocco's (2005) analysis by proving how financial portfolios should be chosen at a given point in time, when housing wealth is given, and by investigating whether household portfolios are optimally chosen in the presence of housing wealth risk.

Bucciol and Miniaci (2011) study household risk tolerance including real estate wealth in their analysis. In particular, they assume that households choose the allocation of wealth conditional on their holdings of residential housing. The estimates obtained under constraints on portfolio composition show substantial heterogeneity across households. Also, they find that risk tolerance correlates negatively with age and positively with wealth and financial sophistication.

Arrondel and Savignac (2015) investigate the possible explanations of the stockholding puzzle focusing on housing and other uninsurable risks. They find that real estate risk is a key determinant of financial portfolio allocation since it is negatively correlated with both the probability of being a stockholder and the fraction of wealth invested in stocks.

Chetty, Sandor and Szeidl (2017) analyze the effect of housing on portfolio choice, distinguishing between the effect of home equity and property value (that is home equity minus mortgages). They find that an increase in mortgage debt (respectively, in home equity) reduces (respectively, raises) stockholding.

All the papers mentioned above use the value of the main residence as housing wealth measure, as it is usual practice. However, second homes should be taken into account since the share of households owning second homes is quite high in some countries. Indeed, Sierminska and Doorley (2018) report that more than 36 per cent of Spanish and more than 22 per cent of Italian households own residential and business property in addition to their principal residence.

The studies on second homes have mainly investigated problems arising from tourism homes and have focused on the demand side of holiday homes. For instance, Brunetti and Torricelli (2017) analyze the unprofitable use of second homes. In particular, they try to understand if second homes are profitable or they end up being an investment mistake. They find that the actual use of second homes is not connected with other financial decisions of the household. What really shapes the final use of second homes, instead, are specific real characteristics of the property, such as the value per square meter and the location, and the type of legal ownership of the second home.

1. Italian household financial market participation

This chapter analyzes the Italian households mainly from a descriptive point of view. In section 1.1 we investigate household participation in financial markets. In section 1.2 we focus on real estate ownership. Finally, in section 1.3 we run a regression to understand how owning a main residence and second homes affects the probability of risky financial assets ownership.

1.1 Data

The Bank of Italy Survey of Household Income and Wealth (SHIW) provides data on Italian households at a micro-economic level. This survey starts in the 1960s to collect data on incomes and savings of Italian families, to arrive at including more detailed information also on their wealth and their economic and financial behaviour[1]. In particular, in 1987 the SHIW began collecting data on household wealth more systemically, adding data on the main financial assets and liabilities held by households to information on real estate, which has been collected since 1977.

The SHIW consists of a biennial rotating-panel survey composed by a representative sample of around 8,000 households; it offers information on economic conditions, working status and many other demographic particularities of all the family members. Specifically, this survey is structured such that the head of the household is the person who is accountable for both economic and financial decisions.

For our analysis, we use the 2012-2016 period, and we consider only households whose head is between 25 and 85 years old. Therefore, the surveys reduce to 7770, 7694 and 6897 observations, respectively.

Table 1.1 shows the fraction of households with given demographic and social characteristics through comparison between the three years analyzed. All the information refers to the head of the household. In this respect, we have decided to replace the female member of a couple indicated as the household head with the male one, since it is common practice in the literature.

Taking a brief look at the evolution of Italian society during 1977-2016 period, we can notice a considerable change in the main demographic characteristics. In particular, the population has aged, the size of households has reduced, and the level of education has increased together with the investment in financial markets. According to Istat[2], the portion of

[1] For more details search for https://www.bancaditalia.it/statistiche/tematiche/indagini-famiglie-imprese/bilanci-famiglie/index.html

[2] https://www.istat.it/it/archivio/197544

64plus reached 22,3% of the entire population in 2016, while the one under 14 has dropped to 13%. The SHIW16's sample reflects this pattern since it reports 32% of over 64 and 8% of over 14.

Table 1.1: Descriptive statistics of household heads

Characteristics	**SHIW 2012** (%)	**SHIW 2014** (%)	**SHIW2016** (%)
Age classes:			
< 34	4.5	3.8	3.7
35-44	13.9	11.6	10.2
44-54	21.4	20.3	19.1
55-64	21.4	21.5	22.1
>65	38.8	42.8	44.9
Education:			
Primary	25.4	25.3	23.9
Middle School	30.2	30.4	31.4
Training School	6.9	7.5	8.3
High School	25.9	25.1	25
College and PhD	11.6	11.7	11.4
Household size:			
1	25.1	27.4	31.7
2	31.6	32.1	32.9
3	19.9	19.1	17.4
4	17.2	15.6	13.4
5+	6.2	5.8	4.6
Working status:			
Employed:			
Blue-collar worker	18.9	17.4	17.2
Office worker	12.7	12.5	12.9
Manager executive	4.4	3.7	3.4
Total	36	33.6	33.5
Self-employed:			
Business owner	10.9	10.3	9.7
Total	10.9	10.3	9.7
Not employed:			
Pensioner	46.4	48.2	48.3
Other	6.7	7.9	8.6
Total	53.1	56.1	56.9

Source: own elaboration on SHIW data.

Also, since 1977 the surveys have registered a drop in the average size of households, guided by a substantial change in the types of households. Indeed, the share of single-person households tripled (from 9% to 34%), while the one of couples with children halved, going from 62.5% to 34% and the one of single-parent with children increases from 5% to 9%.[3]
All over these years, we can observe an evident change in the level of education too. In particular, the percentage of household head with primary school dropped consistently from 37.9% at the end of the twelfth century, to 24% in 2016. In parallel, the surveys registered an increase in the percentage of households with middle, training or high school diplomas, which augments by 10%, reaching almost 67%. Lastly, households with college or higher degree jumped from 7.7% in 1998 to nearly 12%.

Finally, table 1.1 reports the working status of the head of the household. What emerges is the vast unemployment shock due to the 2011-2012 European Sovereign debt crisis. This is more evident if we consider that in 2006-2008 waves the unemployment rate was 4.6%. Also, the impact of this crisis can be observed from the decreasing value of self-employed households, which settles at 9.7% in 2016.

Besides the demographic and social aspects of our sample, the SHIW provides us with extensive information on the allocation of households' wealth, both in real and financial terms. Indeed, this survey reserves an entire part out of six on the forms of saving. In this section, the interviewer asks to the head if his household has current accounts and wealth invested in government bonds, stocks, corporate bonds or other types of financial assets. In addition to this, he also asks the amount held in each class. Thus, portfolio data are plentiful and explanatory.

Historically we know that Italian households do not invest so much in the financial markets: in fact, they have held poorly diversified financial portfolios as stated in Guiso and Jappelli (2002).

In the past forty years, though, both direct and indirect participation in financial markets has increased considerably, changing the structure of household portfolios. Overall, the most significant change appears in the holdings of stocks, both directly and through mutual funds, and long-term bonds issued by private corporations. Also, households have acquired some knowledge in financial education and managing wealth, resulting in better-diversified investments.

[3] Based on data from the Historical Database for the SHIW, version 10.1, available here: https://www.bancaditalia.it/statistiche/tematiche/indagini-famiglie-imprese/bilanci-famiglie/risultati-indagine/index.html

Yet, in 2012, more than 60% of the sample has no financial assets, including both life insurances and pension funds. And another 10% invest only in highly safe financial instruments with low expected returns.

We can infer two main possible explanations for this little participation in financial markets. The first one is the still wider lack of financial education: indeed, the overall level of financial literacy in Italy is one of the lowest among G20 countries[4]. The second one is a faltering trust in the financial system since the period we are analyzing follows the 2001 Dotcom crisis, the 2007-2008 Global financial crisis and the already mentioned European Sovereign debt crisis.

Table 1.2 reports statistics over the form of savings chosen by households.

Table 1.2 Statistics on the participation in stock markets (percentage values)

Financial assets	**SHIW 2012**	**SHIW 2014**	**SHIW 2016**
Current and saving bank/postal accounts	92.8	93.2	93.3
Certificates of deposits	1.9	2.1	2.8
Postal saving certificates	5.8	6.1	5.3
Short term Italian government bonds [1]	4.9	5.6	3.7
Long term Italian government bonds [2]	4.1	4.3	3.3
Corporate bonds	8.5	8.0	5.6
Mutual funds	5.7	6.3	6.6
Italian listed stocks	4.5	4.2	3.1
Italian unlisted shares	0.8	0.8	0.7
Managed portfolios	2.3	1.0	1.0
Other assets [3]	2.9	2.5	2.3
Pension funds	13.2	11.6	10.1
Life insurance	9.8	7.9	7.2

Notes:

[1] Includes BOTs and CTZs

[2] Includes CCTs, BTPs, inflation-indexed BTPs and other (CTEs, CTOs etc.)

[3] Include foreign assets such as government securities, bonds, shares and equity, loans to cooperatives, other financial assets like options, futures et al.

Source: own elaboration on SHIW data.

[4] Source: Bank of Italy, 2018. "Measuring the financial literacy and inclusion among Italian adults: The experience of Banca d'Italia." *Questioni di Economia e Finanza*, Occasional Papers 435.

As we can see from table 1.2, bank current and saving accounts are the most widespread, though there is about 7% without one of them.

Short-term government bond presents one of the most interesting evolutions, considering that it has been traditionally the most common saving instrument chosen by Italian households. Indeed, Guiso and Jappelli (2002) report that in SHIW 1989, 25% of household owned some treasury bond. This high fraction was probably due to the high interest rates paid by the government during the ‘80s. However, over the years the participation rate has dropped, arriving at 3.7% in 2016.

We can see another relevant change in life insurances and pension funds. The first one was quite common in 1998, owned by one-fourth of the households. Though, it fell to 7.2% in 2016.

The latter experienced the opposite path, almost doubling from 8% in 1998 to 13.5% in 2012. This increase can be associated to the many reforms on the pension system adopted in Italy from 1992 on.

Finally, table 1.2 highlights also that direct stock market participation rate has lowered even more through years, with just 3% of households owning stocks in 2016. On the contrary, indirect participation through mutual funds has slightly increased from 2012 to 2016. However, if we compare these data to the one in the period 1998-2006, we clearly see a reduction in both.

To better understand the participation issue, in the next two paragraphs we focus on the relationship between household portfolios and three socio-demographic characteristics such as age, education, and wealth.

From now on, we group the financial assets presented in table 1.2 into two main categories, based on their degree of riskiness:

- *Safe assets* contains bank accounts, certificates of deposit, repos, post office accounts, life insurances and all Italian government securities except for BTPs and inflation-indexed BTPs.

- *Risky assets* contains both Italian and foreign corporate bonds and stocks, Italian investment fund units, ETFs, long-term Italian government bonds, Italian shares of unlisted companies, equity in partnership, managed portfolios, loans to cooperatives, other financial assets such as derivatives, futures etc. and pension funds

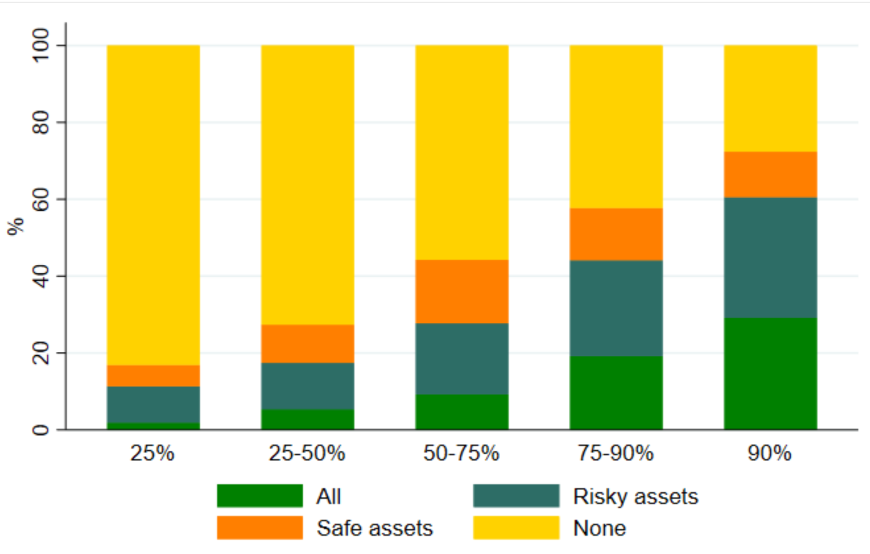
1.1.1 The Wealth-Investment Profile

We now examine the wealth-investment profile, and to this end we define the net wealth quintiles[5]. As one can expect, participation in financial markets increases with wealth, highlighting a clear positive correlation between them.

Figure 1.1 reports results for the 2012 wave.

Figure 1.1

Investment per Wealth quartiles



Source: own elaboration from SHIW 2012

Thus, we can see that wealthier households tend to invest a more significant portion of their wealth in risky assets – more than 40% in the fourth quintile and 60% in the top one. Moreover, portfolio diversification increases with wealth too. Indeed, the holding of both safe assets and risky assets goes from 2% in the bottom quintile to 30% in the top 10%.

The story is slightly different for 2016. Even though the portfolios allocation percentages follow the same path across quintiles, the overall participation (also considering investments in safe assets only) is lower. In particular, there is a reduction both in the bottom and top quintiles, with a 7% and a 51% investment in risky assets, respectively.

Another aspect to take care of is the level of education of households, which is linked to wealth. From SHIW 2012, we find out that more than 50% of households with a college degree invest in risky assets. The percentage reduces a little for families with high school degree

[5] By definition, net wealth is the sum of real wealth and financial wealth minus the overall debt.

(40%) but drops consistently for the ones with primary school level (10%). This trend links indirectly with wealth since more years of education lead to higher income and wealth. Moreover, if we condition on the wealth quintile, this effect becomes more evident, since only 4% of households with primary school degree invest in risky assets in the bottom quintile of wealth, in contrast with over 25% with a college degree in the same quintile.

Analyzing deeply stockholding, Table 1.3 report direct participation in stock markets conditional on net wealth quintile and education.

Table 1.3 Education level and Net wealth quintiles conditional on direct stockholding (percentage)

	Education level					
Net wealth quintiles	Primary School	Middle School	Training School	High School	College or above	Total
25%	0.0	50.0	20.0	30.0	0.0	100
	0.0	8.1	7.1	1.8	0.0	2.6
25-50%	11.6	25.6	11.6	42.9	9.3	100
	19.2	17.7	17.9	1.6	3.8	11.1
50-75%	15.5	18.3	9.9	40.8	15.5	100
	42.3	21.0	25.0	17.2	10.6	18.2
75-90%	5.5	18.4	6.4	44.9	24.8	100
	23.1	32.3	25.0	29.0	25.9	28.0
90%	2.6	8.3	4.5	44.9	39.7	100
	15.4	21.0	25.0	41.4	59.6	40.1
Total	100	100	100	100	100	100
	6.4	15.9	7.2	43.4	26.7	100

Source: own elaboration from SHIW 2012.

Table 1.3 highlights a clear profile for stock owners. Indeed, in 2012 68% of households directly owning stocks belong to the fourth and top quintiles of net wealth. Moreover, their level of education is quite high since they mostly have at least a high school diploma. Conversely, there are no households with a primary school level owning stocks in the bottom quintile. It confirms theories which say that high education level lowers the cost of acquiring information, since highly educated investors are more capable of gathering, processing and using information in less time (Guiso and Jappelli, 2018). Also, the increasing participation with wealth is in line with theory too. Vissing-Jørgensen (2004) among others, stated that there are fixed costs to be faced in order to invest in stock markets, which explain why households in the bottom quintile do not own stocks. Further, these costs also justify the higher fraction of households owning mutual fund shares at low levels of wealth. This is probably due to the fact that mutual funds are a little bit more affordable than direct participation. It is worth pointing out that households owning mutual funds shares are highly educated at any level of wealth.

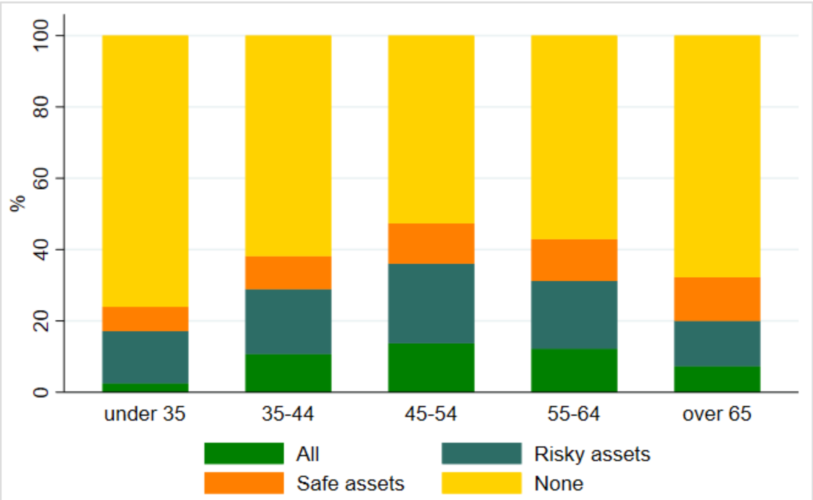
1.1.2 The Age-Investment Profile

Figure 1.2 illustrates the age pattern of participation in the financial market for the SHIW2012. We follow the division of Bank of Italy for the 25-85 age span. Thus, we have the subsequent five classes: younger than 35, between 35 and 44, between 45 and 54, between 55 and 64, and older than 65.

We find that over the life cycle, the participation has a clear hump-shaped profile. It increases early in life from 18% in the first age class to 46% in the 45-54 one and then returns to 20% in the retirement age.

Figure 1.2

Investment per Age classes



Source: own elaboration from SHIW 2012

A possible explanation for this shape is the presence of non-negligible information and transaction costs in purchasing risky assets, which are significant limiting factors. It also points out that households do not invest until they have accumulated enough wealth. Lastly, this effect is stronger for younger households, even if theory suggests that younger people have more incentive to invest in risky assets, particularly in stocks (Haliassos, 2002).

The next section of this chapter investigates on how Italian households behave on real assets investment, focusing on housing.

1.2 Primary residence and second homes in Italy

Until now, we have considered only financial assets and participation in financial markets. We said that there is little participation by Italian households, particularly at early stages of the life cycle, in poor economic condition and education level. The story changes when we look at investment in real assets, such as primary residence, secondary homes or businesses.

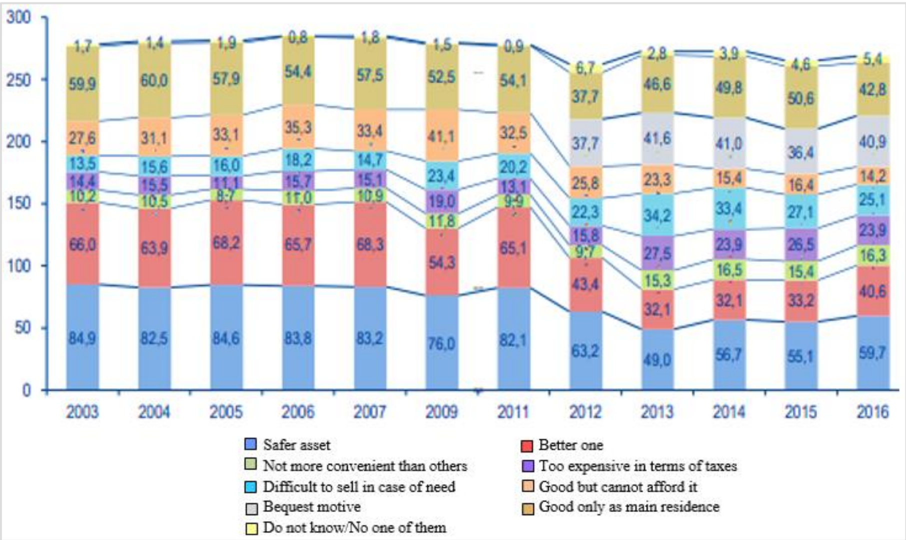
In the following two subparagraphs, we focus on primary residences and second homes, highlighting the relationship between home-owning and some peculiar characteristics such as wealth and age. Then, we'll analyze the linkage between owning one or more houses and investing in financial markets.

1.2.1 Primary residence features

Real Estate has always been the most widely held asset by Italian households. They have always perceived it as a safe investment, together with an essential consumption good and something to leave as a bequest, as we can see in Figure 1.3.

Figure 1.3

Household opinions on real estate investment



Source: Indagine sul Risparmio e sulle scelte finanziarie degli italiani (2016), *Centro di Ricerca e Documentazione Luigi Einaudi, Intesa San Paolo and Doxa*.

As pointed out by Centro di Ricerca e Documentazione Luigi Einaudi, Intesa San Paolo and Doxa (2016)[6], the perception of homes as the safest asset remains quite high, even after the 2007-2008 financial crisis.

This feature results from SHIW too, since from 1977 the homeownership rate has increased by 30%. Indeed, in 2012, 71% of households own the house in which they live, while 19% rent it and the remaining part live there under usufruct contract, free of charge or redemption agreement. These numbers appear to remain stable in 2014 and 2016 waves.
On average, homes used as main residence are worth 235.000 €[7], and the mean living space is 110 square meters.

There are two features to take care of when examining homeownership. First, in the bottom quintile of net wealth, few households own the house in which they live. Indeed, more than 65% of them are renters. The percentage of homeowners, instead, climbs to 88% in the second quintile, up to more than 97% in the remaining quintiles. Thus, the wealth-homeownership relationship has a similar trend compared to financial market participation. Second, the ownership rate increases with age as people save and manage to buy their primary home. SHIW 2012 confirms this statement since more than two-thirds of homeowners are older than 55, and the average age is 63 years. This is also in line with the already mentioned ageing problem of Italian society. Moreover, looking at under 35 households, we can notice that 42% owns their principal residence, and 40% are renters. What is interesting is that nearly one-third of them has partly or entirely inherited it. In general, in our sample the portion of inherited homes is 29% of homeowner households. This quite high percentage emphasizes how much the bequest motive is deep-rooted in Italian culture.

At this point, it is interesting to understand how Italian homeowners behave with respect to financial market participation.
SHIW 2012 reports that nearly 33% of homeowners invest at least in one risky asset. Of those who live under usufruct contract or free of charge, 23% invest in risky assets. Lastly, only 13% of renters own risky assets.
Moreover, looking at the stock market participation, of those who invest directly in stocks, 89% own at least the main residence, while 5% are renters. As regards to mutual funds, there is a little increase in renters share (7%) and a slight reduction in homeowners (85%).

[6] Doxa, together with Intesa San Paolo and Centro di Ricerca e Documentazione Luigi Einaudi, conducts this survey over 1.266 households, picked from the registry offices of 99 municipalities.
[7] Average value computed on the price declared by households to the question "[…] what price could you ask for it today?".

The 2016 wave is a little bit different, with a generally low level of participation. Particularly substantial is the 8% reduction in the share of investor-homeowners. Besides, 90% of stock owners are also homeowners, while the share of renters who invest in mutual funds is way higher (20%) with respect to SHIW 2012.

1.2.2 Second homes

The market for second homes (including holiday homes amd investmet homes) has been a distinctive feature in Italy for many years. It is probably due to several reasons. Among others, Italian households have invested their severance pay in second homes. Also, they have bought one or more dwellings in order to spend part of their retirement life away from their residence town, or to leave them as a bequest for their children.

According to ISTAT (2011), there are 5 million second homes in Italy, 17% of the national stock of properties. Making a comparison at European level, the average stock of second homes is 16%. However, Greece reaches 32% and Poland 25%[8]. It must be noticed that a medium-low level of income characterizes these countries. Conversely, the percentage consistently drops in high-income countries such as Germany and France, respectively 10 % and 7%.[9]

Our data reflect these numbers. In 2012, 19% of household declared to own at least another dwelling, and 7.5% own other buildings such as shops, offices, garages and boxes.

The average living space of these second homes is 105 square meters, but if we consider dwellings up to 200 square meters (which share is 94%), the mean drops to 75 square meters. This points out that, on average, second homes are smaller than main residences.

This feature is valid for their value too, since they are worth on average 175.000€ (140.000€ for houses smaller than 200 sqm.)

Households who own these dwellings are mostly older than 55, with an average age of 65 years, and they belong to the third or higher wealth quintiles.

Focusing our attention on the way households have acquired these dwellings, we find validation of what we already said at the beginning of this paragraph, since one second home out of two has been inherited. This statistic is even more remarkable in comparison to the portion of inherited-main residences (29%). A good question would be why these inherited homes do not become the household's main residence. One plausible explanation could be that

---

[8] Intesa San Polo, Centro di Ricerca e Documentazione L.Einauidi, *Indagine sul Risparmio e sulle scelte finanziarie degli italiani* (2016)

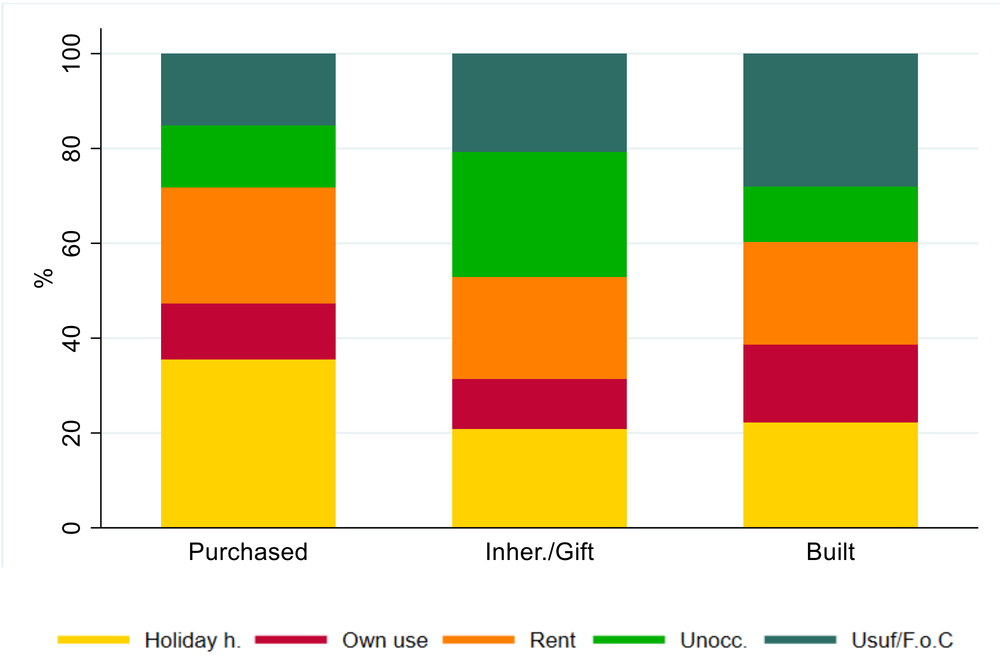
[9] OECD (2011), "Housing Markets and Structural Policies in OECD countries", Dan Andrews, Aida Caldera Sánchez, Asa Johansson, OECD Economics Department, Working Papers No. 836, January 2011

these dwellings do not match the families' housing needs. For instance, they could be located in a different town with respect to the one in which the family members work.

Looking at the main use conditional to the acquisition, we again confirm this tendency (Figure 1.4).

Figure 1.4

Second homes' main use conditional to acquisition



Source: own elaboration on SHIW 2012.

Figure 1.4 shows that 47% purchased-second homes are used by households, mostly as holiday homes, 25% are rented, and the remaining part is unoccupied or under usufruct. Conversely, inherited second homes exhibit a significantly different pattern. Indeed, the percentage of vacant or free of charge second home raises to 46%, while only 20% uses them as holiday homes.

Only 11% of built-second homes, however, remains mainly vacant. On the contrary, the portion of dwelling under usufruct contract or free of charge stands out, particularly if compared to the other two way of acquisitions.

Moreover, in order to investigate this phenomenon deeply, we can divide second homes according to whether they are placed inside or outside residency region. Second homes located outside residency regions are mostly used as holiday homes, especially if households have purchased them.

However, 33% of inherited dwellings result vacant or free of charge, against a way smaller fraction for purchased one (15%).

On the contrary, 28% inherited-second homes located inside residency regions are unoccupied, and 24% are under usufruct contract or free of charge.

Another useful step is to divide the Italian regions into macro-areas, to understand where inherited second homes are vacant with respect to the purchased one.

We split the country in the following standard way: North West (NW) includes the three large industrial cities of Milan, Turin and Genoa, the North East (NE) includes many middle-sized cities and towns, such as Bologna, Venice, Verona, Padova, the Centre (C) includes the capital city, Rome, and many medium-sized towns such as Florence, Perugia and Ancona, and the South-Islands (S-I) includes Naples and Palermo.

From this further analysis, we can notice that the principal use for both purchased and inherited second homes follows almost the same distribution in North West and Center. North East, instead, presents the highest fraction of vacant inherited second home (31%), against 11% for purchased homes. Moreover, one purchased dwelling out of two located in South-Islands area is used as holiday homes, while 27% of inherited ones are unoccupied.

Lastly, Figure 1.5 reports graphically the main use of second homes with respect to the area in which dwellings are located.

Figure 1.5

Inside and Outside Second Homes per Main Use

Source: own elaboration on SHIW 2012.

Second homes outside residency regions account for 18% of the total second homes reported in our sample. It is quite clear from Figure 1.5 that dwellings located in other regions are mainly used as holiday homes. Also, households seem to not rent them, except for the Center, which has the highest share. This difference could be caused by the fact that the Center includes Rome and Florence, which are two highly attractive cities.

At the same time, in the areas in which there are a few dwellings rented, the portion of unoccupied homes is relatively huge.

Instead, second homes located inside residency regions are mainly rented in the North, while they are mostly used as holiday homes in the South. Also, the Center presents the highest fraction of homes under usufruct contract or free of charge.

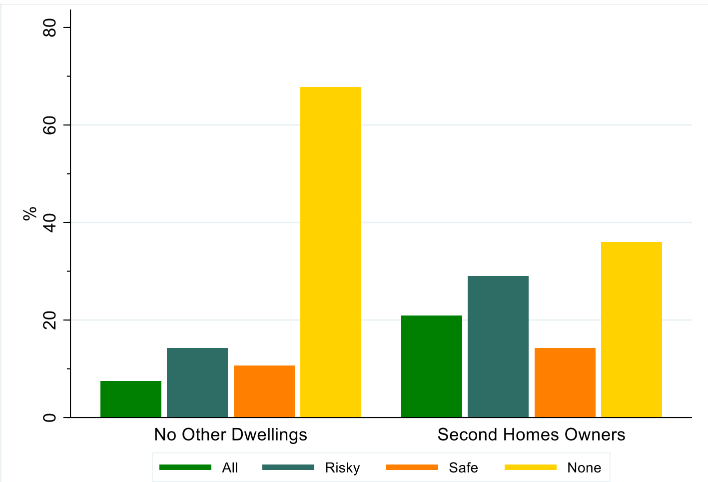
1.3 The effect of housing wealth on Italian households' investments

In this last section of the first chapter, we want to investigate the effect of housing wealth on the investment decisions of Italian households. More specifically, our aim is to understand if owning one or more second homes affects the decision to invest in risky assets. Also, we give an insight into the possible effect of an unprofitable use of second properties over investment decisions.

Figure 1.6 shows the relationship between owning second homes and investing in financial markets. [10]

Figure 1.6

Investments per Other Dwellings



Source: own elaboration on SHIW 2012.

[10] Same results for SHIW 2016.

It gives us a clear result: second homeowners invest more in financial assets with respect to other households. Also, they have more diversified portfolios, since 21% has both risky and safe assets.

Figure 6 seems to highlight a positive relationship between owning second homes and investing in financial markets.

To exploit further this positive relationship, we run a regression using the following linear probability model:

$$P(Risky\ assets_i = 1 \mid \boldsymbol{X_i}, \boldsymbol{Z_i}) = \alpha + \beta_j \boldsymbol{X_{ij}} + \gamma_k \boldsymbol{Z_{ik}} \tag{1.1}$$

where the binary dependent variable *Risky assets$_i$* takes value 1 when household i invests in risky assets, and 0 otherwise. Thus, this decision is modelled as a function of the following sets of controls:

- Vector $\boldsymbol{X_i}$ contains the standard *demographic and economic controls*, traditionally associated with household portfolio decisions, namely: age and age squared, the level of education of the household head, the marital status, the area of residence, being a pensioner, as well as the family size, the disposable household income (both in natural logarithm), and the net real wealth quintiles (calculated as real assets minus mortgages);

- Vector $\mathbf{Z_i}$ contains information specific to owning real estate properties, namely: owning the main residence, owning second homes, other buildings or land, and dummies for unrented dwellings and buildings.

Table 1.4 collects the results for five different specifications.

In the first column, we control only for demographic and economic variables. Results are totally in line with what we have seen in the first paragraph of this chapter. Thus, the coefficients of age and age squared imply the hump-shaped participation profile in age. Education, income, and wealth strongly and positively correlate with participation. Also, the household size negatively correlates with risky investments. This result is in accordance with theories of precautionary saving, as these households need a greater portion of savings to face unexpected shocks. Finally, participation is higher in the North, especially in the North East, and lower in the Center, the South and in the Islands.

Table 1.4 LPM regression for Risky assets ownership

Risky assets ownership	(1)	(2)	(3)	(4)	(5)
Demographic and economic controls:					
Age	0.0676***	0.0673***	0.0553***	0.0552***	0.0581***
	(0.0177)	(0.0177)	(0.0177)	(0.0177)	(0.0177)
Age squared	-0.0112***	-0.0111***	-0.00973***	-0.00973***	-0.00919***
	(0.00228)	(0.00229)	(0.00227)	(0.00227)	(0.00228)
Education	0.0140***	0.0140***	0.0136***	0.0136***	0.0133***
	(0.00151)	(0.00151)	(0.00151)	(0.00151)	(0.00152)
Ln(Family size)	-0.0653***	-0.0654***	-0.0623***	-0.0618***	-0.0655***
	(0.0140)	(0.0140)	(0.0139)	(0.0139)	(0.0141)
Married	0.0330**	0.0330**	0.0245*	0.0243*	0.0263*
	(0.0141)	(0.0141)	(0.0140)	(0.0140)	(0.0140)
Area of residence					
North East	0.0832***	0.0833***	0.0827***	0.0828***	0.0824***
	(0.0154)	(0.0154)	(0.0154)	(0.0154)	(0.0154)
Center	-0.0145	-0.0146	-0.0134	-0.0134	-0.0130
	(0.0154)	(0.0154)	(0.0153)	(0.0153)	(0.0153)
South and Islands	-0.117***	-0.117***	-0.119***	-0.119***	-0.120***
	(0.0135)	(0.0135)	(0.0134)	(0.0134)	(0.0134)
Ln(Income)	0.176***	0.176***	0.174***	0.174***	0.174***
	(0.00951)	(0.00952)	(0.00947)	(0.00947)	(0.00946)
Net real wealth quintiles:					
25-50%	0.0931***	0.110***	0.0587**	0.0590***	0.0583**
	(0.0133)	(0.0227)	(0.0229)	(0.0229)	(0.0229)
50-75%	0.146***	0.165***	0.0969***	0.0973***	0.0975***
	(0.0144)	(0.0253)	(0.0257)	(0.0257)	(0.0257)
75-90%	0.202***	0.221***	0.127***	0.127***	0.127***
	(0.0178)	(0.0275)	(0.0288)	(0.0288)	(0.0288)
90%	0.251***	0.270***	0.123***	0.123***	0.122***
	(0.0208)	(0.0296)	(0.0330)	(0.0330)	(0.0330)
Pensioner					-0.0284*
					(0.0160)
Real Estate controls:					
Main residence		-0.0204	0.0233	0.0231	0.0243
		(0.0220)	(0.0221)	(0.0221)	(0.0221)
Second homes			0.116***	0.121***	0.122***
			(0.0157)	(0.0169)	(0.0169)
Other buildings			0.0674***	0.0613***	0.0592***
			(0.0206)	(0.0218)	(0.0218)
Land			0.0801***	0.0812***	0.0815***
			(0.0179)	(0.0180)	(0.0180)
Unprofitable dwellings				-0.0241	-0.0241
				(0.0273)	(0.0273)
Unprofitable buildings				0.0496	0.0496
				(0.0500)	(0.0500)
Constant	-1.630***	-1.630***	-1.581***	-1.580***	-1.583***
	(0.0859)	(0.0859)	(0.0858)	(0.0858)	(0.0858)
Observations	7,693	7,693	7,693	7,693	7,693
R^2	0.227	0.227	0.238	0.238	0.238

Source: own elaboration on SHIW 2012.
Linear probability model estimated by OLS. Robust standard errors in parentheses.
Significant at 10 per cent.; **Significant at 5 per cent; ***Significant at 1 per cent.

These results remain quite stable along with the five specifications, except for the net real wealth which almost halves in any quintile once we add real estate controls.
Adding up the main residential property, it seems to be meaningless. However, it changes sign, turning positive in the last three columns.

In column 3, we control for other properties owning. In all the three cases, second homes owning, other buildings and other land owning, the effect is positive and significative at 1% level. In particular, owning second homes increases the probability to invest in risky assets by 11.6%. This result confirms what we see in figure 8.
The magnitude of second homes owning increases a little bit when we add dummies for unprofitable[11] dwellings and buildings owned. Conversely, the effect of owning other buildings reduces a little. Still, both remain highly significant.

In column 4, we add two dummies to control for unprofitability. In both cases, owning an unrented second home or unoccupied other buildings seems not to affect investment in risky assets. However, the negative sign of unprofitable dwellings is in line with expectations.

Finally, in column 5, we add a dummy for being a pensioner. It appears to have a negative effect, but it is significant just at 10% level. This could be due to the fact that the dependent variable contains life insurance and pension funds.
We have chosen to include them in the dependent variable because, in this way we model 38% of the sample, while without them the percentage reduces to 28%. Also, there is no relevant variation between the two regressions. Thus, for brevity, we do not report the table. There are two differences with respect to Table 1.4. First, the magnitude of every variable is a little bit greater in each specification. Second, the dummy for being a pensioner positively affects the decision to invest in risky assets, with a magnitude of 4 percentage points, and it is significant at 1%. One reason for this result could be the severance pay that a pensioner receives once he retires.

Table 1.4 refers to SHIW 2012. In the Appendix, we report Table A1 which refers to regressions for SHIW 2016.

Again, there are not so many relevant differences. In general, every demographic control has the same sign but a lower magnitude. In particular, being married is no longer significative and changes in sign, becoming negative, even if the effect is approximatively null. Meanwhile, being a pensioner has the same magnitude but loses significance.

---

[11] In this analysis, we define as "unprofitable" only those dwellings and buildings classified as unrented. Thus, in these cases the owner does not receive any rent from second homes or other buildings, however, he still faces the fixed costs of homeownership, including utilities and property taxes, which in some cases are substantial, as well as liquidation costs should they be forced to sell on unfavorable terms.

Regarding the economic controls, income registers a slight decrease, together with the last two net real wealth quintiles. On the contrary, the second and the third quintile observe a tiny increase.

Lastly, analyzing real estate controls, owning the main residence has a little higher effect, but remains not significant. Owning second homes has a huge higher effect with respect to 2012. Indeed, it increases the probability to invest in risky assets by 15% in the last specification. On the contrary, the magnitude of owning other buildings decreases a little and loses significance, while the effect of owning land reduces by more than a half. Finally, unprofitable second homes triple their negative effect and becomes significant at 10% level, while unprofitable other buildings halve.

2. Empirical analysis on portfolio allocation conditional on housing

This chapter investigates how housing wealth affects the mean-variance efficiency of portfolio allocations of Italian households. In the first section we present the theoretical model, while in the second section we report its empirical application. In particular, we focus our attention on the portion of housing wealth related to second home investments.

2.1 A theoretical model

We use Pelizzon and Weber's (2008) model which has the following framework: there is a market with a riskless asset, *n* unconstrained and one constrained risky asset, respectively financial and house asset.

The standard mean-variance analysis implies that the vector of asset holding should satisfy:

$$\boldsymbol{X_o^*} = \left[-\frac{\frac{\partial U}{\partial FW}}{\frac{\partial^2 U}{\partial^2 FW}}\right]\boldsymbol{\Sigma^{-1}\mu} \tag{2.1}$$

where FW is financial wealth, Σ is the variance-covariance matrix of returns on *n* risky assets, and μ is the column-vector of expected excess returns[12]. The sum of the X's is the total wealth invested in risky assets. U(W) is the utility function – in the simplest case, investors are assumed to maximize the expected utility of end-of-period wealth and returns are normally distributed.

This standard analysis applies even in the presence of illiquid real assets over those periods when they are not traded. However, it fails to capture the presence of a hedge term when housing returns correlate with financial returns.

At this point, Pelizzon and Weber introduce the hedge term in the following way. First, they denote the first two moments of asset return as $\boldsymbol{m} + r_f$ and $\boldsymbol{\Omega}$[13], where $\boldsymbol{m}=\begin{pmatrix}\boldsymbol{\mu}\\ \mu_H\end{pmatrix}$ and $\boldsymbol{\Omega}$ is the new variance-covariance matrix for excess returns.

$\boldsymbol{\Omega}$ can be decomposed into four blocks, corresponding to the *n* unconstrained risky assets and the constrained one as follows:

$$\boldsymbol{\Omega} = \begin{bmatrix}\boldsymbol{\Sigma} & \boldsymbol{\Gamma_{b,P}}\\ \boldsymbol{\Gamma_{b,P}^T} & \sigma_P^2\end{bmatrix} \tag{2.2}$$

[12] Expected excess return are the difference between the financial asset returns and the risk-free rate.
[13] Variables in bold represent vectors or matrices.

where $\boldsymbol{\Gamma}_{\boldsymbol{b,P}}$ denotes the vector of covariances between the return on housing and on risky financial assets.

Second, they consider investors with non-zero position in housing whose portfolio allocation is:

$$\boldsymbol{Z} = \begin{pmatrix} \boldsymbol{x_o} \\ h_o \end{pmatrix} \tag{2.3}$$

where $\boldsymbol{x_o} \equiv \frac{\boldsymbol{X_o}}{Wo}$ and $h_o \equiv \frac{H_o P_o}{Wo}$,

and (1-$\mathbf{Z}$)$^{\mathrm{T}}\mathbf{1}$[14] in the riskless asset.

At this point, assuming that these investors behave according to the mean-variance model, but they are constrained in their h_o, the investor optimization problem becomes:

$$\begin{cases} \quad min_Z\ \boldsymbol{Z^T \Omega Z} \\ s.t.\ \begin{cases} \boldsymbol{Z^T m} + r_f = \boldsymbol{m}*, \\ h_0 = \overline{h_0} \end{cases} \end{cases} \tag{2.4}$$

where $\boldsymbol{m}*$ is a given level of expected return.

By defining the Lagrangian:

$$\Lambda = \left(\boldsymbol{x_o \Sigma x_0^T} + h_0^2 \sigma_P^2 + 2h_0 \boldsymbol{x_0 \Gamma_{b,P}}\right) - 2\gamma \left[\boldsymbol{x_0 \mu} + h_0 \mu_H + r_f - \boldsymbol{m}^*\right] \tag{2.5}$$

where γ is the Lagrange multiplier of the constraint on the expected return and has the standard relative risk aversion interpretation defined in Samuelson (1970).

The first-order conditions are:

$$\frac{\partial \Lambda}{\partial \boldsymbol{x_0}} = \left(2\boldsymbol{\Sigma x_0^T} + 2h_0 \boldsymbol{\Gamma_{b,P}}\right) - 2\gamma\,[\,\boldsymbol{\mu}\,] = \mathbf{0} \tag{2.6}$$

$$\frac{\partial \Lambda}{\partial \gamma} = \boldsymbol{x_0 \mu} + \boldsymbol{h_0} \mu_H + r_f - \boldsymbol{m}^* = \mathbf{0} \tag{2.7}$$

With solution:

$$\boldsymbol{x_0} = \gamma \boldsymbol{\Sigma^{-1} \mu} - h_0 \boldsymbol{\Sigma^{-1} \Gamma_{b,P}} \tag{2.8}$$

Equation (2.8) reveals that the optimal portfolio is the sum of a standard Markowitz portfolio and a hedge term. The first term is multiplied by the relative risk aversion, while the latter is

[14] $\mathbf{1}$ is an n+1 vector of ones.

not. This implies that risk-averse investors should hedge housing return risk in the same way, for a given net housing position.

2.2 The allocation of household portfolios conditional on housing

In our work, we extend Pelizzon and Weber's analysis in two directions. First and foremost, we focus on second homes, either by including them in housing wealth, or by neglecting the main residence altogether (on the assumption that it is not considered an investment good by its owners). Secondly, we use recently released house price data to update the empirical analysis to more recent years (2012 and 2016).

2.2.1 Data

We use financial asset returns that cover four major assets: short-term government bonds (three-month BOT), long-term government bonds (BTP), corporate bonds, and equity. We treat short-term government bond as risk-free.
Specifically, we use the following total returns time-series data[15]:

- Short-term government bond: FTSE MTS Italy Monetary;
- Long-term government bond: FTSE MTS Italy BTP;
- Corporate bond: FTSE EuroBIG Corporate Index;
- Stock: HAFiX Europe Index

Regional house returns are, instead, computed on house prices dataset, which are collected by an agency of the Ministry of Finance (*Osservatorio del Mercato Immobiliare*) for each Italian region (except for Trentino Alto Adige). [16][17] The *Osservatorio Mercato Immobiliare dell'Agenzia del Territorio* (OMI) is the most comprehensive and detailed source of information on house prices in Italy because it collects data for each Italian municipality.
We compute return on housing by assuming that rent minus maintenance costs is a fixed proportion *k*, as in Flavin and Yamashita (2002). We set k=5%, as in Pelizzon and Weber (2002), but we underline that the choice of k does not affect the constrained case analysis. It is important, instead, when we treat housing as an unconstrained asset since it has a direct effect on its expected return.

[15] Source: Eikon dataset.
[16] OMI reports house prices data for both regional capitals and all other municipalities. Given our focus on second homes, we decided to use price data relative to other municipality since second homes are usually located outside of regional capitals.
[17] Source: Agenzia delle Entrate – Territorio – Osservatorio del mercato immobiliare

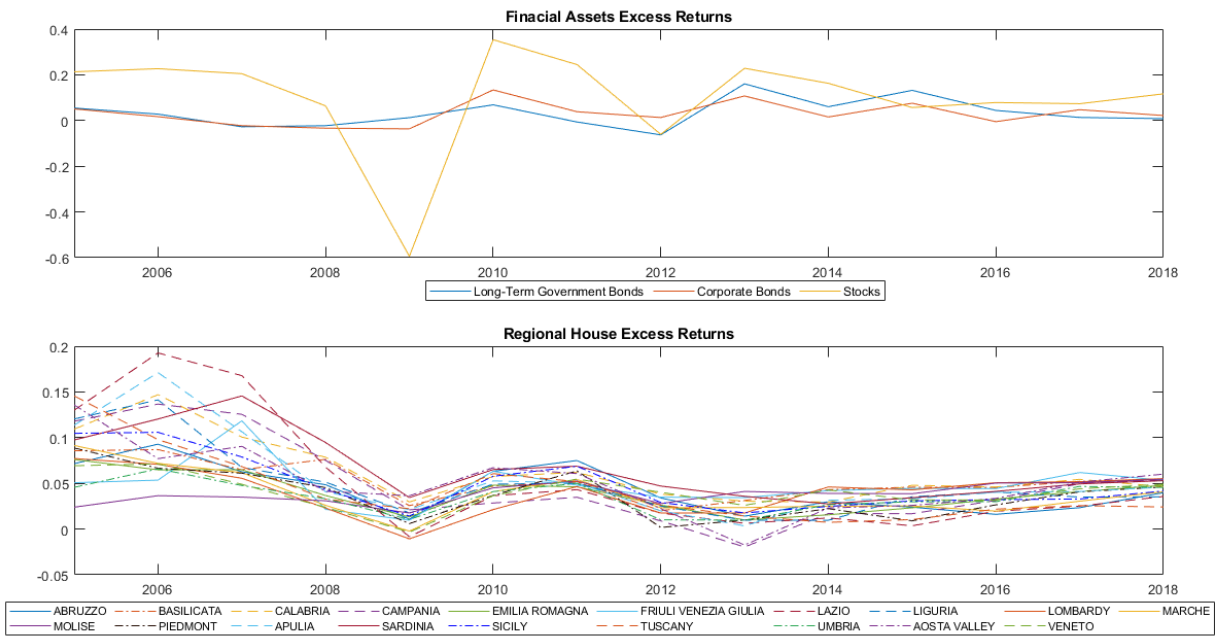
Since *Osservatorio del Mercato Immobiliare* records data on house prices on a yearly basis, we consider annual returns for all assets.

Figure 2.1 shows annual excess returns for both financial assets and house. It reports the effect of the two main crises registered over these 14 years. Stocks excess returns fell to -60% in 2009 because of the 2007-2008 Global Financial Crisis. Then, it recovered but dropped again during the 2011-2012 European Sovereign Debt crisis, until it stabilizes around 10% during the last four years. Therefore, stock excess returns are the most volatile.

We can see the effect of the Global Financial Crisis in house excess returns too. In particular, during the 2005-2007 period, almost all the excess returns are positive and exhibit an increasing trend. They, however, decreases and never recover, fluctuating quite steadily around their mean almost in any region. It is worth stressing that these returns are augmented by a 5% annual dividend. Prices, however, reflects the negative trend of the real estate market in Italy over the last ten years. One of the main reasons behind this outcome is the weak economic recovery, together with the ageing population and other structural factors that partly affect the weakness of the house prices trend.

Figure 2.1

Assets excess returns (2005-2018)



Source: own elaboration on Eikon and OMI datasets.

Table 2.1 reports the first and second moments of the excess returns data we use. Obviously, outcomes are in line with Figure 2.1. Indeed, stocks have a higher expected return and a higher standard deviation than all other risky assets. Also, we can see that both long-term government bonds and corporate bonds have a fairly high correlation coefficient (0.68), while the one between stocks and corporate bonds is a little bit lower (0.55).

Table 2.1 Sample First and Second Moments of Asset Excess Returns (2005-2018)

	Sample First and Second Moments of Asset Excess Returns (2005-2018)			
	Short-term Gov. Bonds	**Long-Term Gov. Bonds**	**Corporate Bonds**	**Stocks**
Descriptive Statistics				
Expected Excess Return %	1.3	3.3	3.0	9.8
Standard Deviation %		1.6	1.3	6.0
Correlation Coefficients				
Long-Term Gov.Bonds		1		
Corporate Bonds		0.68	1	
Stocks		0.25	0.55	1

Source: own elaboration on Eikon data.

At this point, however, we need to compute first and second moments of house returns, and correlations between housing and the three financial assets. This is useful to understand if there are non-zero correlations between the two risky asset classes. Table 2.2 reports these data for house excess returns for each region.

Again, descriptive statistics for regional house expected excess returns reflects the trend we see in Figure 2.1.

Table 2.2 shows mainly negative correlations between house returns and long-term government bond, while most of them are positive with respect to corporate bonds and stocks. In particular, it shows some fairly high correlations between house returns and stock returns.

Since housing is the dominant asset in most household portfolios, even small correlations between financial assets and house returns would significantly change the portfolio choice.

For this reason, we need to understand whether the correlations reported in Table 2.2 are negligible, especially partial correlations since we are in a multiple asset setting. To do it, we simply have to estimate the coefficients of the hedge term ($\boldsymbol{\Sigma^{-1}\Gamma_{b,P}}$) in equation (2.8).

Roon, Eichholtz and Koedijk (2002) suggest running a linear regression of housing excess returns on financial assets excess returns.

Table 2.2 Expected Excess Returns and Correlation Matrix of Housing (2005-2018)

Expected Excess Returns and Correlation Matrix of Housing (2005-2018)				
	Descriptive Statistics	Correlation Coefficients		
	Expected Excess Return % (Standard Deviation %)	**Long-Term Government Bonds**	**Corp. Bonds**	**Stocks**
ABRUZZO	4.3 (0.69)	-0.29	0.05	0.56
AOSTA V.	5.0 (0.98)	-0.32	-0.09	0.27
APULIA	5.5 (1.20)	-0.18	-0.13	0.37
BASILICATA	5.2 (0.54)	-0.11	-0.13	0.47
CALABRIA	6.3 (0.93)	-0.21	-0.14	0.39
CAMPANIA	4.9 (1.27)	-0.37	-0.35	0.26
EMILIA R.	3.9 (0.55)	-0.32	-0.02	0.49
FRIULI V. G.	4.8 (0.63)	-0.15	0.09	0.55
LAZIO	5.3 (1.70)	-0.27	-0.21	0.41
LIGURIA	4.9 (1.03)	-0.14	-0.05	0.36
LOMBARDY	4.0 (0.65)	0.001	0.03	0.61
MARCHE	3.8 (0.65)	-0.08	0.16	0.63
MOLISE	4.0 (0.3)	0.15	0.36	0.55
PIEDMONT	3.7 (0.70)	-0.24	-0.06	0.52
SARDINIA	6.5 (0.96)	-0.4	-0.26	0.37
SICILY	4.8 0.80	-0.19	0.02	0.51
TUSCANY	4.3 (1.04)	-0.13	0.06	0.36
UMBRIA	3.5 (0.45)	-0.19	0.02	0.56
VENETO	4.0 (0.51)	-0.13	0.17	0.70

Source: own elaboration on OMI and Eikon dataset.

The results of this regression are reported in Table 2.3.

As we can see, in all regions (except for Aosta Valley and Tuscany) stock coefficients are statistically significant at least at 10% level. Also, almost in all regions, the slope coefficients are jointly significantly different from zero at least at 5% level or lower.

Table 2. 3 Linear regression: regional house excess returns on financial assets returns (2005-2018)

Regression of Excess Return of Housing on Financial Asset Excess Returns

VAR	ABR	AOS	APU	BAS	CAL	CAM	EMR	FRV	LAZ	LIG	LOM	MAR	MOL	PIE	SAR	SIC	TUS	UMB	VEN
L-T Gov.B	-0.194	-0.236	-0.020	0.0522	-0.0349	-0.0793	-0.144	-0.095	-0.095	-0.0407	0.0676	-0.0755	-0.0113	-0.086	-0.145	-0.112	-0.150	-0.061	-0.085
	(0.114)	(0.234)	(0.194)	(0.116)	(0.153)	(0.242)	(0.107)	(0.079)	(0.079)	(0.170)	(0.099)	(0.083)	(0.054)	(0.162)	(0.161)	(0.129)	(0.157)	(0.123)	(0.056)
Corp. Bonds	-0.0035	-0.032	-0.410	-0.278*	-0.320	-0.591*	-0.035	-0.058	-0.058	-0.237	-0.270	-0.0611	0.0284	-0.180	-0.345	-0.120	-0.0025	-0.078	-0.034
	(0.164)	(0.234)	(0.311)	(0.139)	(0.237)	(0.313)	(0.125)	(0.216)	(0.216)	(0.250)	(0.156)	(0.136)	(0.075)	(0.169)	(0.272)	(0.179)	(0.206)	(0.126)	(0.128)
Stocks	0.077**	0.063	0.126*	0.073**	0.102**	-0.132**	0.0584**	0.074*	0.074*	0.0940*	0.093***	0.081***	0.025**	0.089**	0.111**	0.091**	0.072	0.056*	0.069***
	(0.032)	(0.044)	(0.061)	(0.021)	(0.043)	(0.024)	(0.0215)	(0.036)	(0.036)	(0.0483)	(0.048)	(0.023)	(0.0094)	(0.031)	(0.046)	(0.036)	(0.048)	(0.019)	(0.135)
Const.	-0.008	0.003	0.006	0.0017	0.0135	0.0073	-0.011**	-0.004	-0.004	-0.0015	-0.013**	-0.016**	-0.014***	-0.013*	0.0197*	-0.0028	-0.0085	-0.016***	-0.012
	(0.006)	(0.010)	(0.012)	(0.005)	(0.010)	(0.012)	(0.0049)	(0.009)	(0.009)	(0.0097)	(0.005)	(0.005)	(0.0031)	(0.007)	(0.009)	(0.007)	(0.013)	(0.005)	(0.004)
Obs.	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
R^2	0.506	0.235	0.296	0.451	0.335	0.421	0.454	0.389	0.389	0.223	0.520	0.470	0.31	0.46	0.479	0.386	0.179	0.45	0.592
p-value	0.022	0.205	0.199	0.013	0.061	0.032	0.011	0.007	0.007	0.166	0.0004	0.006	0.010	0.010	0.039	0.047	0.224	0.011	0.000

Source: own elaboration on Eikon and OMI dataset.
Linear regression estimated by OLS.
Robust standard errors in parentheses.
P-value refers to the F-test of joint significance of all slope parameters.
Significant at 10 per cent.; **Significant at 5 per cent; ***Significant at 1 per cent.

In the light of this results, we can conclude that housing excess returns present significant correlations with financial asset returns in Italy, and this allows us to introduce a hedge term in homeowners-household portfolios.

We use SHIW 2012 and 2016 to conduct our analysis on household portfolios.
In this second part of our work, however, we adopt a different classification for financial asset with respect to the one we use in the first chapter.

Table 2.4 shows the classification for all the asset we use in the mean-variance analysis. The first four assets (current and saving bank/postal accounts, certificates of deposits, Postal saving certificates and short-term government bonds) are all classified as risk free. BTP, and other government bonds are classified as Long-term Government bonds. Italian listed and unlisted stocks, together with loans to cooperatives are classified as Stocks. Mutual funds, managed portfolio, foreign assets and other financial assets are partly corporate bonds and partly stocks. Life insurance is split 80% in Long-term Government bonds and 20% in Corporate bonds, while pension funds follow the categories in which they are invested. Lastly, we treat mortgages as negative holdings of Long-term Government bonds and other debt as negative amounts of Corporate bonds.

Table 2.4 Asset classifications.

Assets	Categories
Current and saving bank/postal accounts	Riske-free
Certificates of deposits	Riske-free
Postal saving certificates	Riske-free
BOT, CCT	Riske-free
BTP, BTPi, Other Italian government debt	Long term gov. bonds
Corporate bonds	Bonds
Mutual funds	Bonds (1/2) Stocks (1/2)
Italian listed stocks	Stocks
Italian unlisted shares	Stocks
Managed portfolios	Bonds (1/2) Stocks (1/2)
Foreign assets (government securities, bonds, shares)	Bonds (1/2) Stocks (1/2)
Loans to cooperatives	Stocks
Other financial assets like options, futures et al.	Bonds (1/2) Stocks (1/2)
Pension funds	Split according to the type of fund
Life insurance	L-T gov. bonds (80%) Bonds (20%)
Main residence	House
Second homes	House
Mortgage	L-T gov. bonds (neg. position)
Debt	Bonds (neg. position)

At this point we are ready to empirically analyze portfolio allocations.

In section 2.2.2 we exploit the case in which housing wealth is composed by both the main residence and second homes, while section 2.2.3 shows how the analysis changes once we use only second homes in the housing wealth.

In both cases, we consider only households that hold at least one risky financial asset.

2.2.2 Empirical analysis conditional on primary residence and second homes

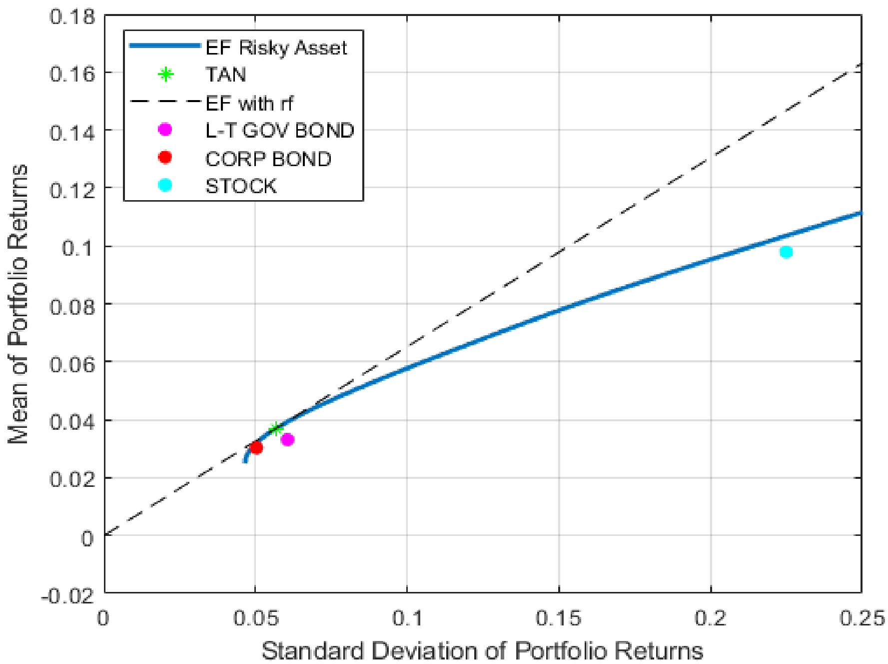
We start this analysis showing the mean-variance frontier for only financial assets, using returns and standard deviation reported in Table 2.1. Therefore, we do not consider housing wealth and mortgages here.

SHIW 2012 reports a subsample of 1294 households (17% of the entire sample) owning at least one risky asset. Graph A of figure 2.2 shows both the efficient frontier with risky asset and with the risk-free.

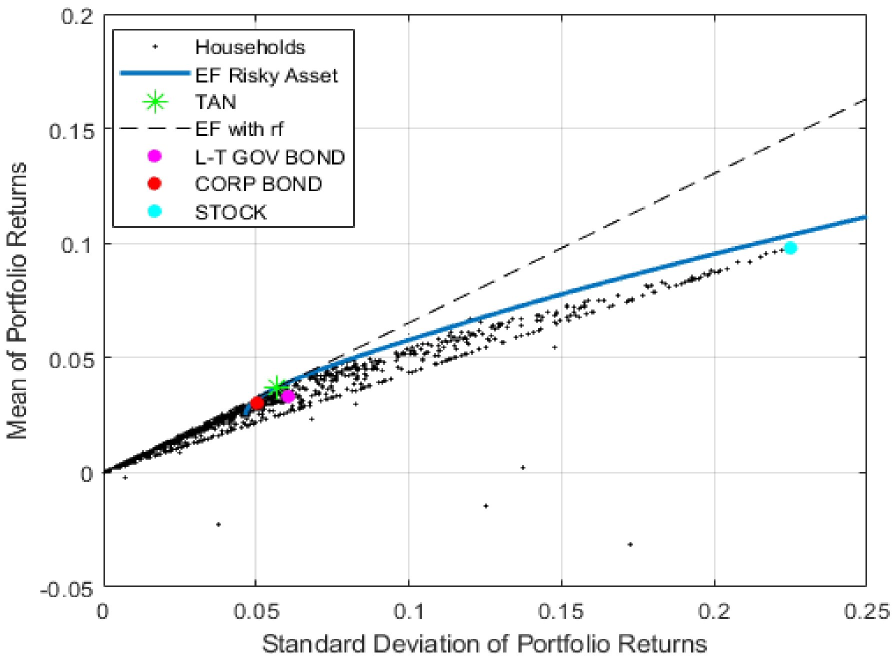
Figure 2.2

Financial Assets Efficient Frontiers

Graph A



Graph B



Source: own elaboration on Eikon dataset and SHIW 2012.

Graph A displays individual assets too: we can notice that all the three assets are on or close to the mean-variance efficient frontier. Stocks, instead, appear at the right of the mean variance space, since they have the highest risk, as we have already seen in Table 2.1.

Graph B, instead, shows all households portfolios. From this second graph we can see that a portion of households holds a combination of risk-free and stocks in their portfolio.

Now we introduce housing as a liquid and freely tradeable asset in the market, and mortgages as negative holdings of Long-Term Government bonds.

The number of households reduces to 1196 (15% of the entire sample), since owning at least the main residence a requirement.

In this case, we can notice three main aspects. First, the tangent portfolios (Table 2.5) report a high long position in housing and a short position in stocks for each region. This could be due to the positive correlation between stocks and housing. Moreover, the high percentage in housing probably derive from our assumption of 5% annual dividend added to the housing returns.[18] Second, housing almost always lies on the efficient frontier in each region. Third, the risky asset efficient frontier flattens in each region.

[18] For the sake of comparison with the case in which housing wealth is composed by second homes only, we decided to use price data for other municipalities. We have run the analysis with comprehensive regional prices, with basically unchanged results.

Table 2.5 Tangency Portfolio Weights

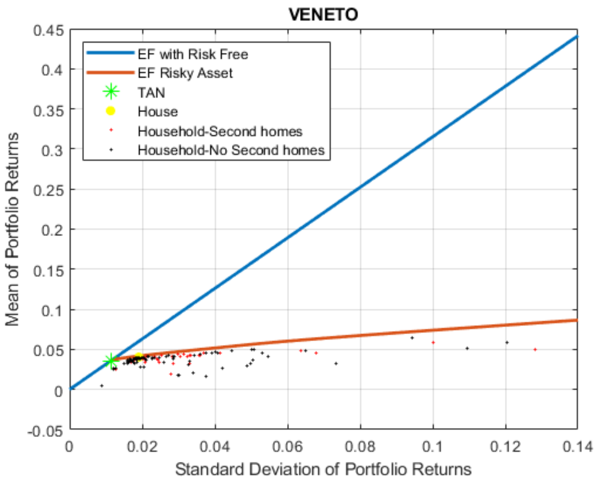
Tangency Portfolio Weights				
	Long-Term Government bonds	Corporate Bonds	Stocks	House
Financial Assets	0.436	0.485	0.079	—
Financial Assets and Housing				
Abruzzo	0.193	0.039	-0.058	0.826
Aosta Valley	0.233	0.099	-0.032	0.700
Apulia	0.093	0.346	-0.064	0.625
Basilicata	-0.025	0.252	-0.058	0.831
Calabria	0.070	0.280	-0.065	0.715
Campania	0.107	0.400	-0.062	0.555
Emilia Romagna	0.145	0.057	-0.044	0.842
Friuli Venezia Giulia	0.116	0.088	-0.056	0.852
Lazio	0.132	0.463	-0.084	0.489
Liguria	0.109	0.254	-0.049	0.686
Lombardy	-0.026	0.260	-0.073	0.837
Marche	0.105	0.097	-0.063	0.861
Molise	0.024	-0.015	-0.023	1.014
Piedmont	0.106	0.183	-0.061	0.772
Sardinia	0.130	0.268	-0.069	0.671
Sicily	0.134	0.146	-0.063	0.783
Tuscany	0.210	0.120	-0.031	0.701
Umbria	0.074	0.091	-0.045	0.880
Veneto	0.096	0.051	-0.060	0.913

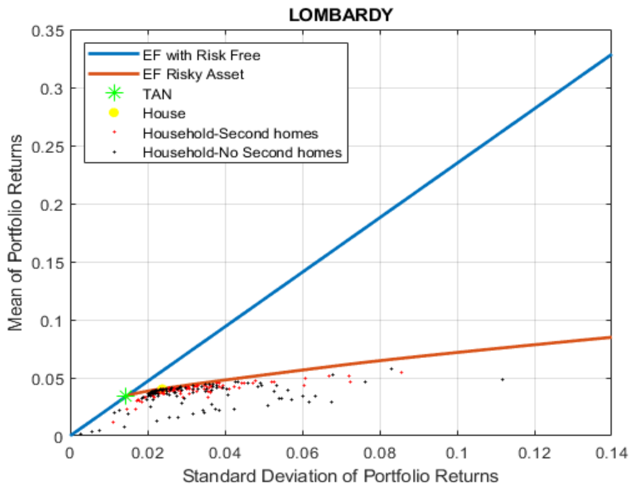
Source: own elaboration on Eikon and OMI dataset.

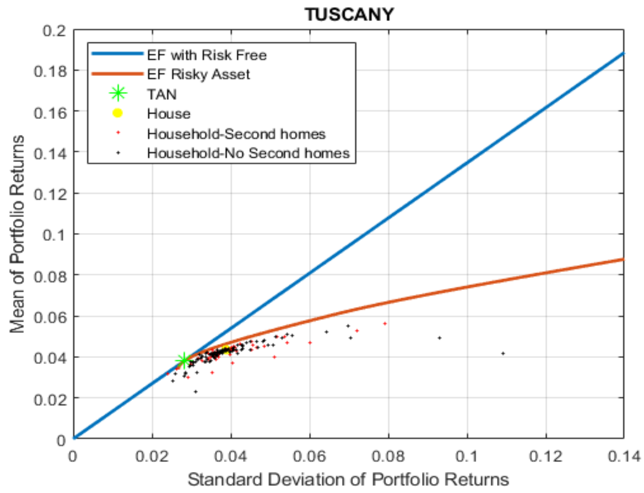
Figure 2.3 reports Veneto, Tuscany and Lombardy, as examples, while the remaining sixteen regions are reported in the Appendix (A2). In the graphs, we divide households in two groups: red dots represent households who own second homes, which account for 43.7% of our subsample (522 households), while black dots represent households who own just their main residence.

Figure 2.3

Efficient Frontiers with Housing







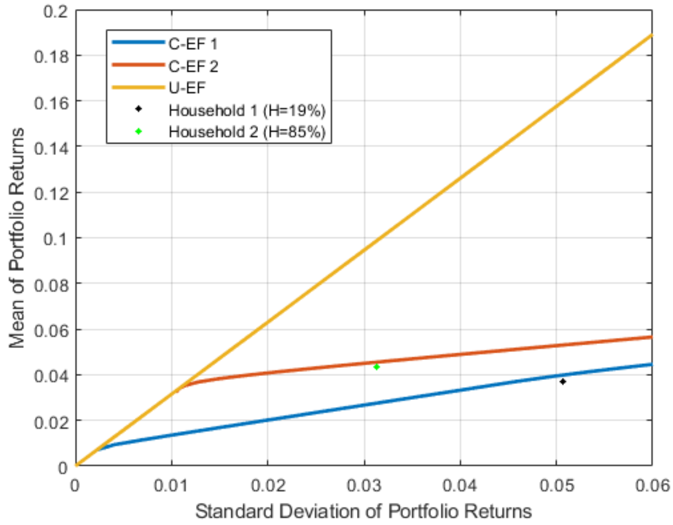
Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

The issue arises from the fact that housing should not be considered as an unconstrained asset since it is illiquid, and it cannot be traded frequently due to its high transaction costs. Moreover, as we already said, households should hedge their housing risks. Therefore, we compute specific conditional efficient frontiers, treating housing as constrained, for households with a positive housing wealth. Figure 2.4 shows the case of two random Venetian households. In this figure we plot the unconstrained efficient frontier with risk-free and the two constrained efficient frontiers corresponding to two different portions of housing wealth. More specifically, the first efficient frontier has 19% of wealth into housing, while the second one has 85% of wealth into housing. These two frontiers correspond to two household portfolios with same housing weights.

As we can see from Figure 2.4, both frontiers lie to the right of the unconstrained efficient frontier. Also, they do not touch the vertical axes since the housing constraint does not allow to achieve a riskless position.

Figure 2.4

Efficient Frontiers Conditional on Housing



Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.
Note: household 1 and 2 represent two random Venetian households.

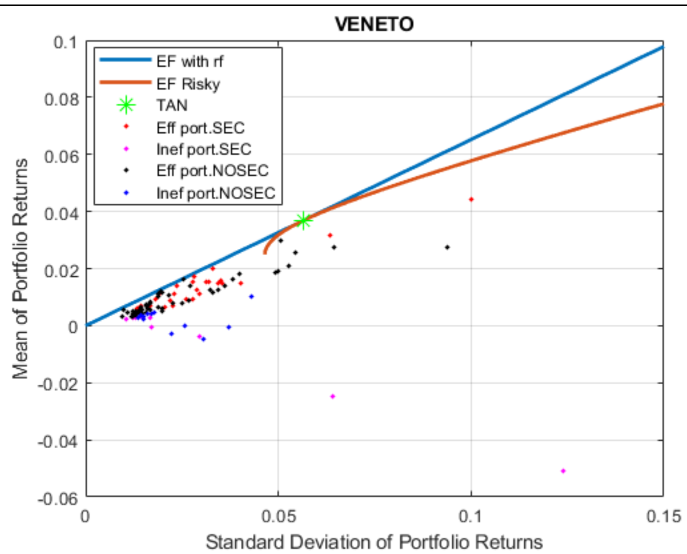
To better understand how housing affects the efficiency of household portfolios, we finally introduce the hedge term described in section 2.1.

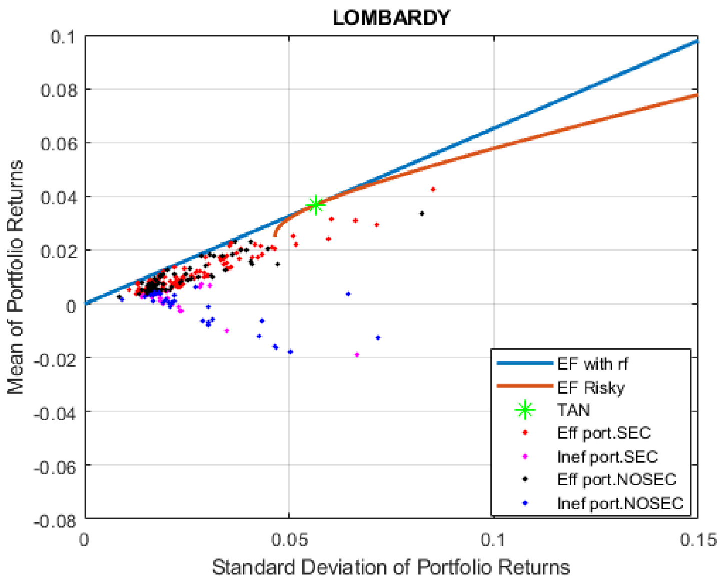
Once we follow equation (2.8) we end up having the usual mean-variance framework displayed in Figure 2.2 (therefore, housing in not included). However, the portfolio weights of households change since they account for the hedge term. This implies that household portfolios will appear in a different position with respect to the case in which housing is an unconstrained asset.

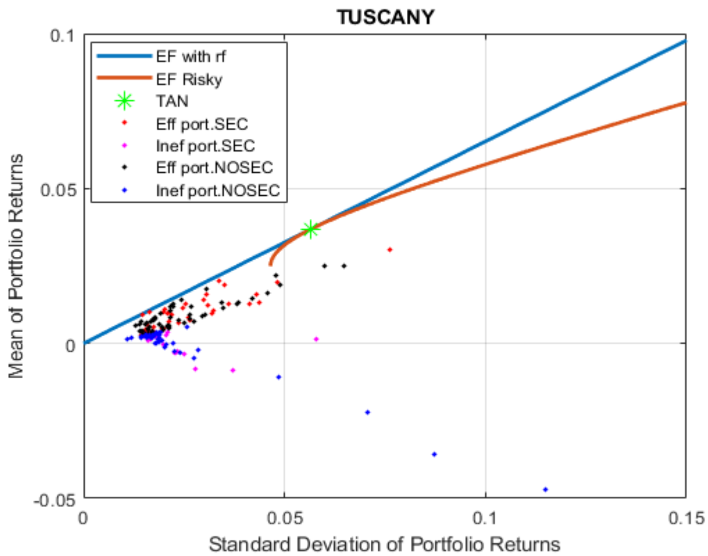
We graphically represent this framework taking as examples Veneto, Tuscany, and Lombardy. We report all the other sixteen regions in the Appendix (A3).

Figure 2.5

Household Portfolios Net of the Hedge Term







Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3. “SEC” states for second home owners, while “NONSEC” for main residence owners.

We conduct this entire analysis for SHIW 2016 too. In this section, however, we have chosen to analyze in detail SHIW 2012 for two main reasons. First, SHIW 2012 has a greater subsample. Indeed, the 2016 wave records 1168 households owning at least the main residence and a risky financial asset. In particular, only 399 (34%) of these homeowners own second homes too. Second, results are quite similar between the two periods, thus we report all the efficient frontiers in the Appendix. More precisely, Appendix A4 contains the efficient frontiers for the case in which housing is treated as unconstrained, while Appendix A5 relates to the household portfolios once we account for the hedge term.

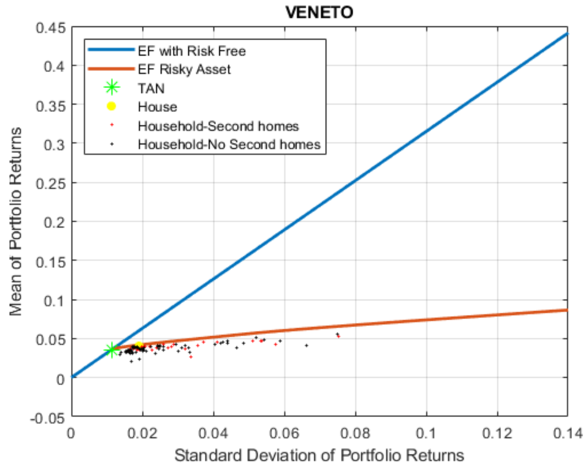
In this paragraph, we limit to report the Veneto case as an example.

Therefore, Figure 2.6 Graph A shows the efficient frontier with four risky assets freely tradeable in the market (house + risky financial assets), while Graph B shows how household portfolios change when we hedge the housing risk.

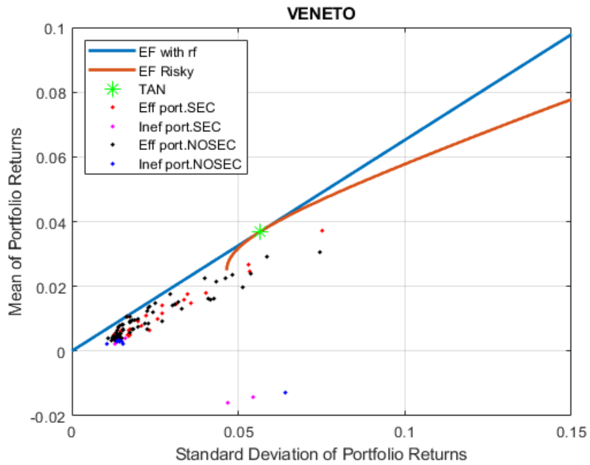
Figure 2.6

Efficient Frontiers with Housing and with the Hedge Term

Graph A



Graph B



Source: own elaboration on Eikon dataset and SHIW 2016.
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3. “SEC” states for second home owners, while “NOSEC” for main residence owners.

2.2.3 Second homes as an investment good

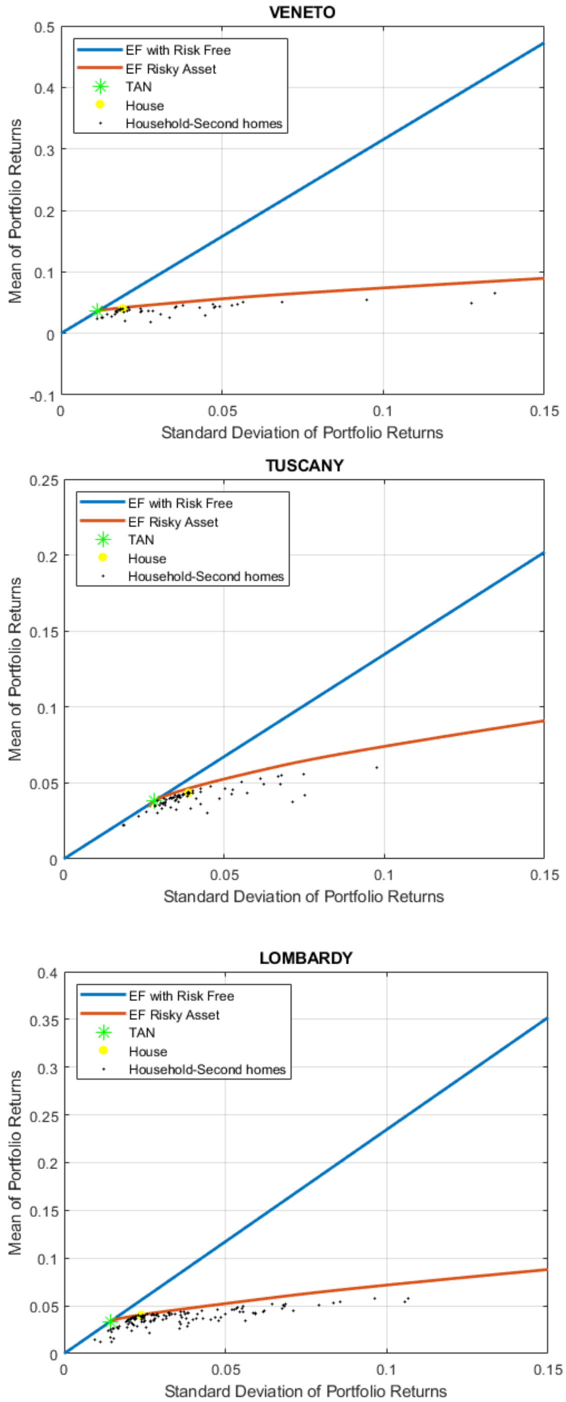
Our work so far takes into account housing wealth including both main residence and other dwellings. However, there is a limit in this specification, since some households may well consider the main residence not an investment good, because they would never sell it or liquidate it by other means (equity release). They would consider it a purely consumption g ood because households have to live somewhere. For this reason, in this section we rebuild the analysis considering housing wealth composed by second homes only.

As already said, in SHIW 2012 there are 522 households owning both second homes and at least one risky financial asset.

Figure 2.7 shows the case in which we treat second homes as an unconstrained investment asset. Again, we report Veneto, Tuscany and Lombardy as examples, referring to the Appendix (A6) for the remaining sixteen regions.

Figure 2.7

Efficient Frontiers with Housing



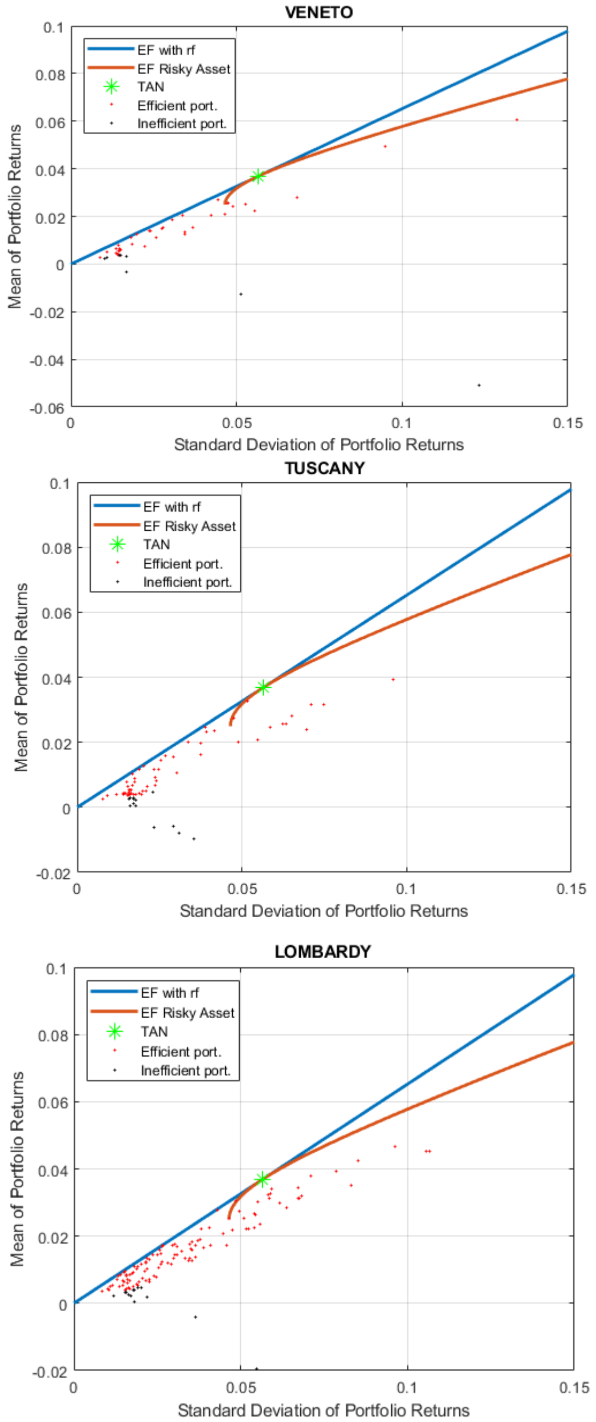
Source: own elaboration on Eikon dataset and SHIW 2012.

Still, the issue already explained in section 2.2.2 remains, since second home is an illiquid asset, even if we treat it as an investment good.

Therefore, households need to hedge the risk of owning it. Figure 2.8 shows how household portfolios change once we consider the hedge term (following equation 2.8).

Figure 2.8

Household Portfolios Net of the Hedge Term



Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Ch. 3.

To easily compare the two analysis, we report in Figure 2.8 the cases of Veneto, Tuscany and Lombardy. All the other sixteen regions can be found in the Appendix (A7).

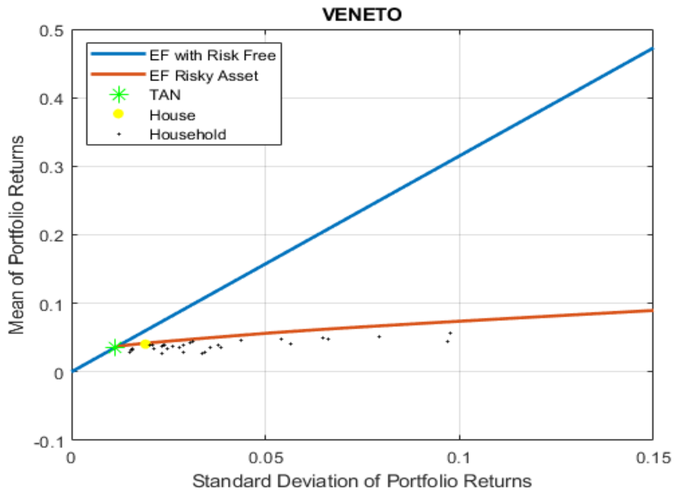
As in section 2.2.2, we conduct this analysis using SHIW 2016 too. However, as already said, there are only 399 second homes owners. Therefore, we report here only the case of Veneto, and we devote Appendix A8 and A9 to all the other regions and cases.

Graph A in Figure 2.9 shows the efficient frontier with housing as unconstrained, together with all household portfolios. Graph B, instead, shows how household portfolios change when they hedge housing risks.

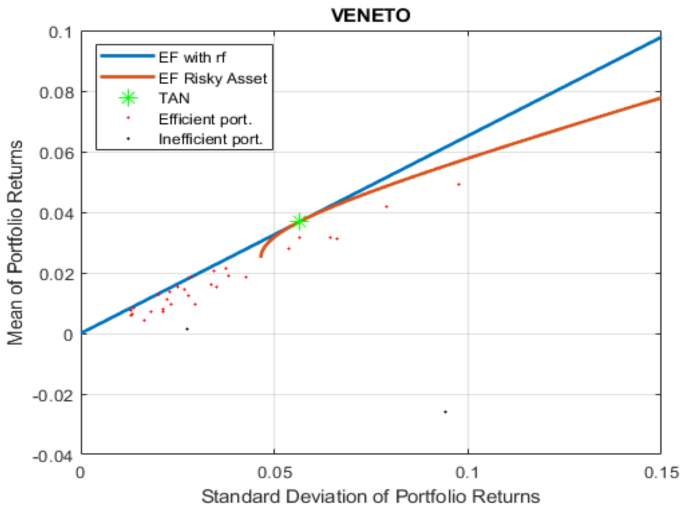
Figure 2.9

Efficient Frontiers with Housing and with the Hedge Term

Graph A



Graph B



Source: own elaboration on Eikon dataset and SHIW 2016.
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3.

Graphical comparisons are extremely useful, but do not consider that the efficiency frontier is estimated (and the same is true also for the mean-variance performance of any given portfolio). To assess whether a portfolio is indeed efficient we need to use a formal statistical test. In the next chapter we present the Gouriéroux and Jouneau efficiency test and test results.

3. Efficiency test

Our work so far can be summarized in two main points:

1. Italian households do not invest so much in financial assets, but a great number of them are homeowners, therefore they tie a huge portion of their wealth into housing. Moreover, a non-negligible portion of homeowners owns second homes too.

2. Since housing is an asset, it should be considered when assessing the efficiency of household portfolios. In particular, since there are high transaction costs and housing is an illiquid asset, we should take into account the correlation between housing and financial assets, to obtain a mean-variance analysis that accounts for the risky housing position (as shown in equation 2.8).

To understand whether and when households hold efficient portfolios, we now present a test which accounts for constrained assets, and then we apply it to our empirical analysis.

3.1 Gouriéroux and Jouneau efficiency test

Jobson and Korkie (1982), (1989) and Gibbons, Ross, and Shanken (GRS) (1989) have proposed a test of the significance of the difference between the investor portfolio and a corresponding efficient portfolio. Specifically, they base their test on the difference between the slopes of arrays from the origin through the two portfolios in the expected return standard deviation space. If the investor portfolio is efficient, the two slopes will be the same; if it is not the case, the slope of the efficient portfolio will be significantly greater. The issue of this test is the fact that it is valid for the standard case in which assets are unconstrained.

To this respect, Gouriéroux and Jouneau (1999) have extended the efficiency test for the conditional or constrained case, i.e., for the case where a subset of asset holdings is potentially constrained (housing in our case). The test is structured in the following way:
the Sharpe ratio of the unconstrained risky financial assets portfolios is:

$$S_1 = \boldsymbol{\mu}^{\boldsymbol{T}} \boldsymbol{\Sigma}^{-\mathbf{1}} \boldsymbol{\mu} \,. \tag{3.1}$$

The Sharpe ratio for constrained portfolio made of the n financial assets is:

$$S_1(Z) = \frac{[\boldsymbol{\mu}^{\boldsymbol{T}} \boldsymbol{v}_{\mathbf{1}}]^2}{\boldsymbol{v}_{\mathbf{1}}^{\boldsymbol{T}} \boldsymbol{\Sigma} \boldsymbol{v}_{\mathbf{1}}} \tag{3.2}$$

where $\boldsymbol{v_1} = \boldsymbol{x_0} + h_0\boldsymbol{\Sigma^{-1}\Gamma_{bP}}$ is the risky financial portfolio after eliminating the hedge term (as we already seen in equation 2.8).

On the assumption that all the asset returns are normally distributed, Gouriéroux and Jouneau's Wald statistic is:

$$\xi_1 = T\frac{\hat{S}_1 - \hat{S}_1(Z)}{1+\hat{S}_1(Z)\frac{\boldsymbol{Z^T\Omega Z}}{\boldsymbol{v_1^T\Sigma v_1}}} \tag{3.3}$$

and it is distributed as a $X^2(n_1 - 1)$ under the null hypothesis that the risky financial assets portfolio net of the hedge term is efficient i.e. lies on the financial efficient frontier. [19]

Gourieroux and Jouneau also show that their test is asymptotically equivalent to the GRS test when $\boldsymbol{v_1} = \boldsymbol{Z}$**.** Specifically, the test becomes:

$$\xi_e = T\frac{\hat{S} - \hat{S}(Z)}{1+\hat{S}(Z)} \tag{3.4}$$

where: $S = \boldsymbol{m^T\Omega^{-1}m}$ and $S(Z) = \frac{[\boldsymbol{m^TZ}]^2}{\boldsymbol{Z^T\Omega Z}}$

and it is distributed as a $X^2(n - 1)$ under the null that the portfolio lies on the efficient frontier.[20]

Both tests are based on (the square of) the Sharpe ratio, which is the ratio of the mean excess return to the standard deviation. The peculiarity of this test is that the Sharpe ratio can be used to test for efficiency in the "unconstrained" asset mean-variance space, after the hedge term is subtracted from the observed portfolios.

It is worth stressing, however, that as the test statistic is based on the square of the Sharpe ratio, Sharpe ratios of the same magnitude, but opposite sign are treated in the same way. For this reason, in our work we will treat as inefficient those portfolios that have a negative excess return.

3.2 Estimation and Test Results

In this section we compute the test statistic both for the case in which housing is an unconstrained asset (ξ_e) and for the case in which we treat it as constrained (ξ_1), and then we

---

[19] n_1 is a subset of assets, i.e. the number of financial assets (3 in our case) minus the number of constrained assets (1 in our case).

[20] n is the entire set of unconstrained assets, thus equal to 4 in our case since we treat housing as a liquid asset.

calculate for how many household portfolios the test fails to reject the null hypothesis of mean-variance efficiency at 10% and 5% significance levels.

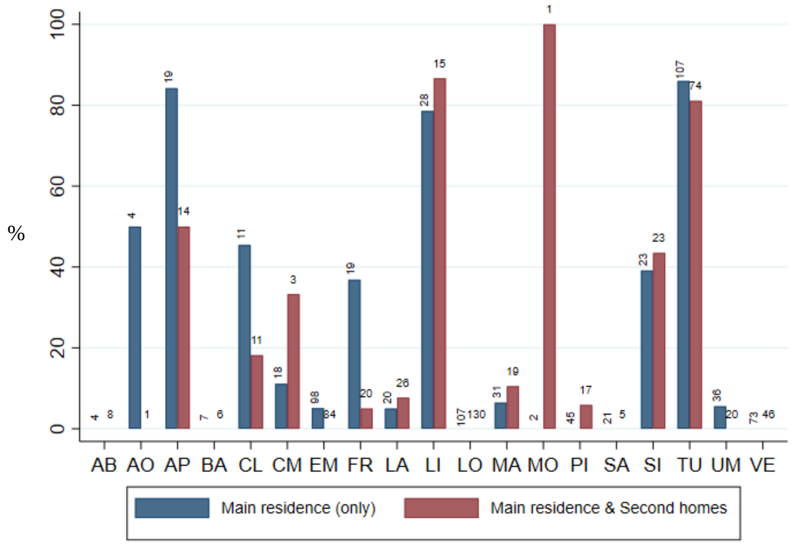
We do this procedure for both definitions of housing introduced in section 2.2.2 and 2.2.3.

We analyze here the portfolio efficiency for SHIW 2012 households. Results for SHIW 2016, instead, can be found in Appendix A11.

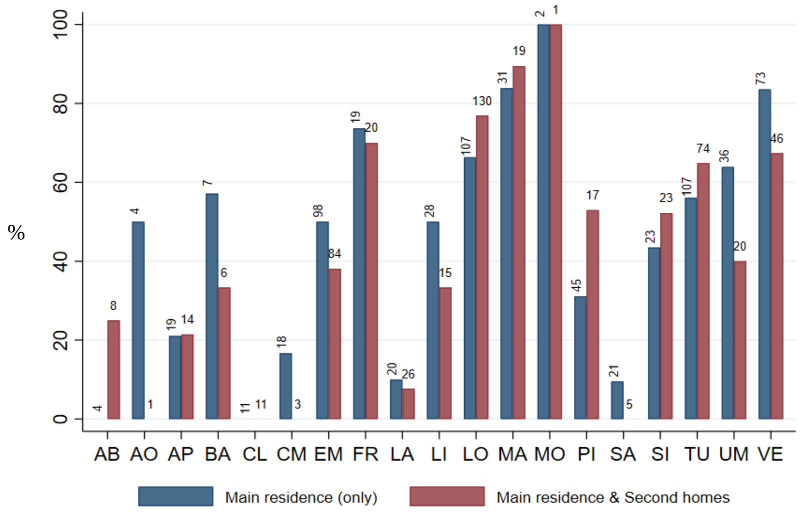
Figure 3.1

Efficiency test results – Broader definition of Housing

Graph A – Housing as an unconstrained asset



Graph B – Housing as a constrained asset



Source: own elaboration on Eikon dataset and SHIW 2012.

Notes: Efficiency is set at 10% significance level. Numbers over the bars denote the total number of households who own only the main residence or both main residence and second homes for each region. Blue bars indicate the percentage of efficient portfolios of households who own only their main residence, while maroon bars indicate households the percentage of efficient portfolios of households who own both their main residence and second homes. The results in absolute terms behind Graph A and B can be found in the Appendix (A10.a)

Starting from the broader definition of housing wealth, i.e. the sum of main residence and second homes, Figure 3.1 shows a comparison between the case in which we treat housing as an unconstrained asset and the case in which housing is the constrained asset.

Graph A shows the percentage of efficient portfolios when housing is an unconstrained asset, while Graph B shows the case in which households hedge housing risk.

Each graph divides households in two groups: blue bars indicate households who own only their main residence, while maroon bars indicate households who own both their main residence and second homes. As in chapter 2, in our analysis we consider only homeowners who hold at least one risky asset (1196 households).

As we can see from Graph A and Graph B, efficient portfolios increase once we hedge housing risk. At regional level, almost each region reports an increase in efficiency. In particular, Veneto, Lombardy and Emilia Romagna seem to be the regions which better exploit hedging opportunities. However, there are some regions such as Tuscany, Apulia, Liguria and Calabria that lose efficiency when housing is treated as constrained.

When we check which households are efficient in the unconstrained case and inefficient in the constrained case in these regions, we notice that all of them have housing portfolio weights close to unity.

The overall number of efficient portfolios net of the hedge term (at a conservative 10% level), however, is 647 out of 1196, which corresponds to 54%. There are, instead, only 265 efficient portfolios (22%) when housing is considered a standard liquid asset.

These results suggest that hedging opportunities are crucial when assessing the efficiency of a portfolio.

They are even more evident once we restrict our definition of housing wealth, considering only second homes, as in Figure 3.2.

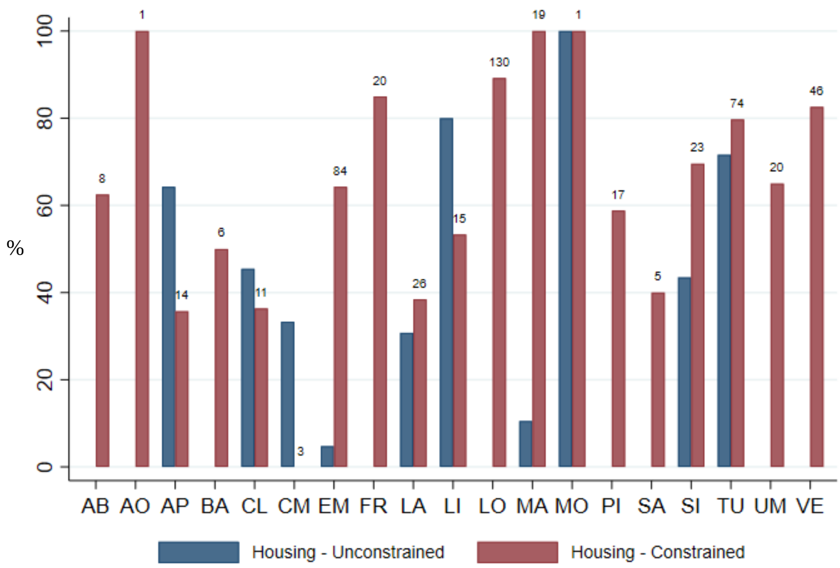
Indeed, overall, there are 381 out of 523 efficient portfolios (corresponding to 72.8%) when households hedge their housing position, while only 20% portfolios are efficient when housing is a liquid asset.

Aggregating all these results by macro areas, we find that they are in line with Pelizzon and Weber's (2008) (Table 3.1 and Table 3.2).

Indeed, we can see that NE and NW report the highest proportion of efficient portfolios conditional on housing. This means that apparently NE and NW households are the best at hedging housing risk. Financial portfolios with housing as an unconstrained asset are, instead, most often efficient in the Centre and in the South (plus Islands).

Figure 3.2

Efficiency test results – Narrower definition of Housing



Source: own elaboration on Eikon dataset and SHIW 2012.
Notes: Efficiency is set at 10% significance level. Numbers over the bars denote the total number of households who own second homes for each region. Blu bars represent the percentage of efficient portfolios when housing is an unconstrained asset, while maroon bars represent the case in which housing is treated as constrained. The results in absolute terms behind the figure can be found in the Appendix (A10.b).

Table 3.1 Efficiency test results per macro areas - Housing as unconstrained asset (ξ_e)

Efficiency test results – Broader definition of Housing						
	Housing as unconstrained asset (ξ_e)					
	Main residence Owners (only)			**Main residence & Second homes owners**		
	% of efficient portfolios			% of efficient portfolios		
Test size	**10%**	**5%**	*Tot*	**10%**	**5%**	*Tot*
# households per area						
North-West (347)	22.8	36.9	*184*	8.5	10.4	*163*
North-East (340)	6.8	18.4	*190*	0.6	3.3	*150*
Centre (333)	66.5	75.2	*194*	46.0	60.4	*139*
South and Islands (176)	35.2	40.9	*105*	29.5	53.5	*71*
Total (1196)	24.5	32.8	*673*	19.1	27.5	*523*

Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

Table 3.2 Efficiency test results per macro areas - Housing as constrained asset (ξ_1)

Efficiency test results – Broader definition of Housing						
	Housing as constrained asset (ξ_1)					
	Main residence Owners (only)			**Main residence & Second homes owners**		
	% of efficient portfolios			% of efficient portfolios		
Test size	**10%**	**5%**	*Tot*	**10%**	**5%**	*Tot*
# households per area						
North-West (347)	54.8	89.6	*184*	69.9	96.3	*163*
North-East (340)	65.3	92.6	*190*	51.3	88.6	*150*
Centre (333)	57.2	86.1	*194*	53.9	79.8	*139*
South and Islands (176)	23.8	60.0	*105*	28.1	78.8	*71*
Total (1196)	53.6	85.1	*673*	54.7	87.4	*523*

Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

Moreover, when housing is composed by second homes only, households in each macro region exploit hedging opportunities. This is, however, particularly evident for NW households since efficient portfolios increase from 7.3% to 82.8%.

Table 3.2 Efficiency test results – Narrower definition of Housing

Efficiency test results – Narrower definition of Housing				
	Housing as an unconstrained asset (ξ_e)		**Conditional on housing (ξ_1)**	
	% of efficient portfolios		% of efficient portfolios	
Test size	**10%**	**5%**	**10%**	**5%**
# households per region				
North-West (163)	7.3	9.8	82.8	98.0
North-East (150)	2.6	3.3	54.0	75.3
Centre (139)	45.3	58.9	72.6	92.0
South and Islands (171)	15.2	18.7	50.1	84.5
Total (523)	20.0	25.8	72.8	93.1

Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

Conclusion

In this thesis we addressed two issues on household portfolio decisions when housing is considered a risky asset.

The first issue is the relationship between homeownership and investment in risky assets. In particular, we focus on the effect of second homes on risky financial assets holdings.

To do this we use data on Italian households from SHIW 2012-2016. What we find is that households who own second homes invest more in financial assets compared to other households. Also, they have more diversified portfolios. However, when we focus on those second homes that are not rented, we find that they have an insignificant effect on the probability of risky financial assets ownership.

The second issue regards the efficiency of Italian household portfolios once housing wealth is taken into account. This approach differs from the standard mean-variance efficiency analysis which neglects the existence of illiquid wealth such as home equity. Pelizzon and Weber (2008) show that if there is correlation between financial assets returns and housing returns, household financial decisions are affected by the need to hedge some of the risks linked to their illiquid housing position. Therefore, we follow their paper introducing housing stock as an additional constraint to the optimization problem. This implies that the investors' optimal strategy is to choose the standard Markowitz portfolio according to their risk aversion and use the risky financial assets to hedge their position on the constrained asset (this last decision does not depend on their risk aversion).

We have used Gouriéroux and Jouneau (1999) efficiency test to formally assess whether Italian household portfolios are efficient once we account for housing wealth. Indeed, Gouriéroux and Jouneau have proposed an efficiency test for analyzing the performance of a portfolio of risky assets (in a mean-variance framework) when some constraints exist on a part of the portfolio.

We use Italian household portfolio data and time-series data on financial risky assets as well as regional house prices. We conduct the entire analysis for two different definitions of housing wealth: the first broader definition includes both main residence and second homes wealth, while the second narrower definition focuses on second homes wealth only. This choice derives from the fact that households may perceive their main residence as a pure consumption good since they have to live somewhere. Second homes, instead, are for sure durable investment goods, therefore households need to hedge their risks.

We perform the efficiency test for the two definitions of housing, analyzing portfolio efficiency only for homeowners that invest at least in one risky asset.

What we find is that when we consider housing as an unconstrained asset, we obtain few efficient portfolios. When, instead, we consider the illiquid nature of housing investment, many more portfolios become efficient, meaning that many households exploit hedging opportunities.

Bibliography

Arrondel and Savignac, 2015. “Risk management, housing and stockholding.*”* *Applied Economics*, 47, pp. 4208-4227.

Bank of Italy, 2018. “Measuring the financial literacy and inclusion among Italian adults: The experience of Banca d’Italia.” *Questioni di Economia e Finanza*, Occasional Papers 435.

Brunetti and Torricelli, 2017. “Second homes in Italy: every household’s dream or (un)profitable investments?” *Housing Studies*, 32, pp. 168-185

Bucciol and Miniaci, 2011. "Household Portfolios and Implicit Risk Preference," *The Review of Economics and Statistics,* MIT Press, 93, pp. 1235-1250.

Chetty, Sàndor and Szeidl, 2017. "The Effect of Housing on Portfolio Choice". *The Journal of Finance*, pp. 1171-1221.

Cocco, 2005. "Portfolio Choice in the Presence of Housing." *Review of Financial Studies*, 18, pp.535-567.

Flavin and Nakagawa, 2008. "A Model of Housing in the Presence of Adjustment Costs: A Structural Interpretation of Habit Persistence." *American Economic Review*, 98, pp. 474-95.

Flavin and Yamashita, 2002. "Owner-Occupied Housing and the Composition of the Household Portfolio". *The American Economic Review*, 92 pp.345-362.

Gibbons, Ross and Shanken, 1989. "A Test of Efficiency for a Given Portfolio." *Econometrica*, 57, pp. 1121-1152.

Gourieroux and Jouneau, 1999. "Econometrics of Efficient Fitted Portfolios." *Journal of Empirical Finance*, 6, pp.78-118.

Grossman , and Laroque, 1990. "Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods." *Econometrica*, 58, pp. 25-51.

Guiso and Jappelli, 2002. "Household Portfolios in Italy." In Household Portfolios, Guiso, Haliassos, and Jappelli, eds. Cambridge: MIT Press.

Guiso and Jappelli, 2018. "Investment in Financial Information and Portfolio Performance," *Einaudi Institute for Economics and Finance* (EIEF), Working Papers Series 1807.

Haliassos, 2002. “Calibration and Computation of Household Portfolio Models.” In Household Portfolios, Guiso, Haliassos, and Jappelli, eds. Cambridge: MIT Press.

Jobson and Korkie, 1982. "Potential Performance and Tests of Portfolio Efficiency." *Journal of Financial Economics,* 10, pp. 433-466.

Jobson and Korkie, 1989. "A Performance Interpretation of Multivariate Tests of Assets Set Intersec tion, Spanning, and Mean Variance Analysis." *Journal of Financial and Quantitative Analysis*, 24, pp. 183-204.

Pelizzon and Weber, 2008. “Are Household Portfolios Efficient? An Analysis Conditional on Housing.” *The Journal of Financial and Quantitative Analysis*, vol. 43, pp. 401-431.

Roon, Eichholtz and Koedijk, 2002. "The Portfolio Implications of Home Ownership". *Centre for Economic Policy Research.* Discussion Papers 3501.

Sierminska and Doorley, 2018. “To Own or Not to Own? Household Portfolios, demographics and institutions in a cross-national perspective.” *Journal of Income Distribution*, 25, pp. 1-43.

Vissing-Jørgensen, 2004. “Perspectives on Behavioral Finance: Does "Irrationality" Disappear with Wealth? Evidence from Expectations and Actions”, ”, NBER Macroeconomics Annual 2003, vol. 18, pp. 139–208.

Appendix

A1. LPM regression for SHIW 2016

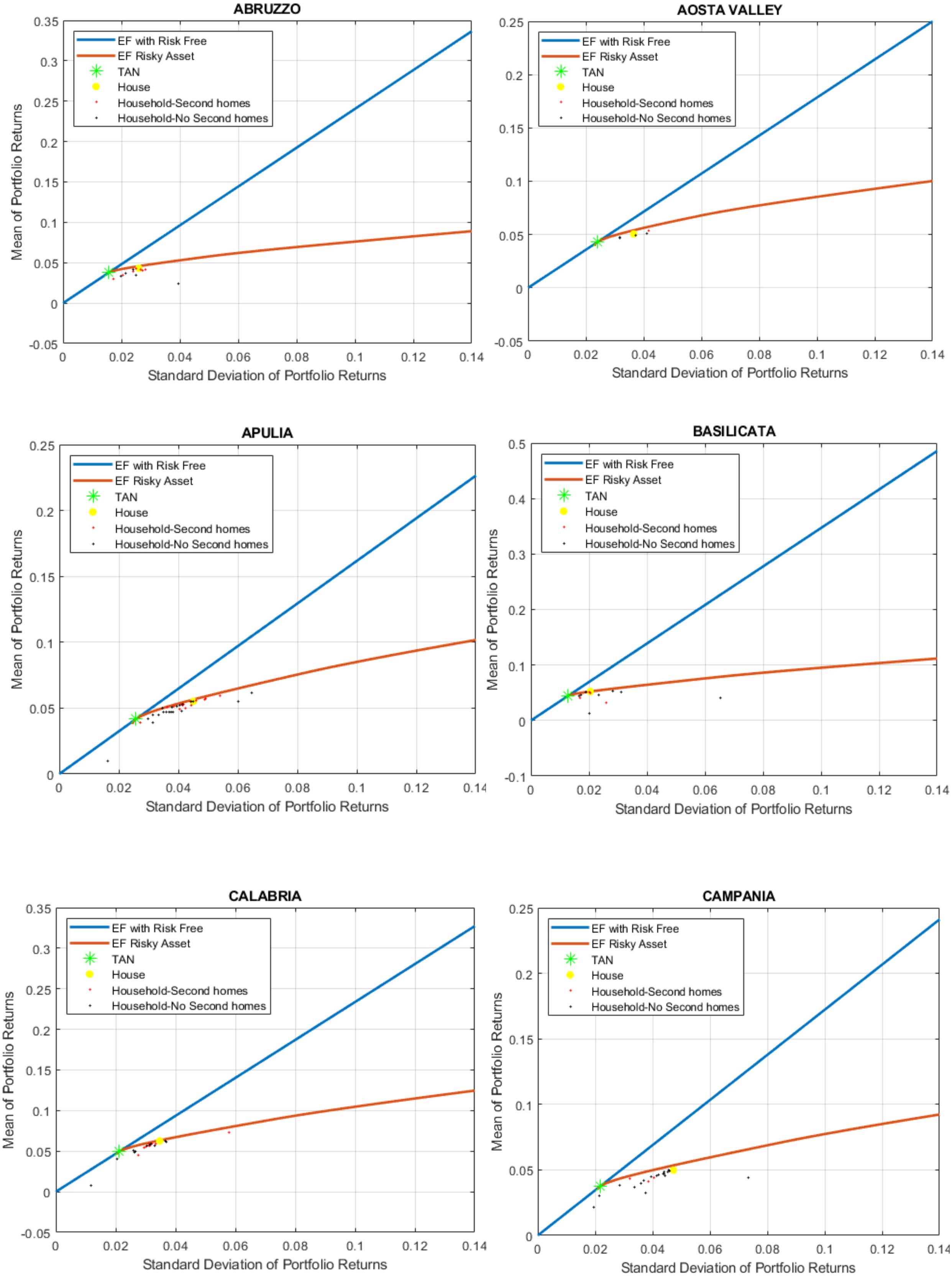
Table A1 LPM regression for Risky assets ownership

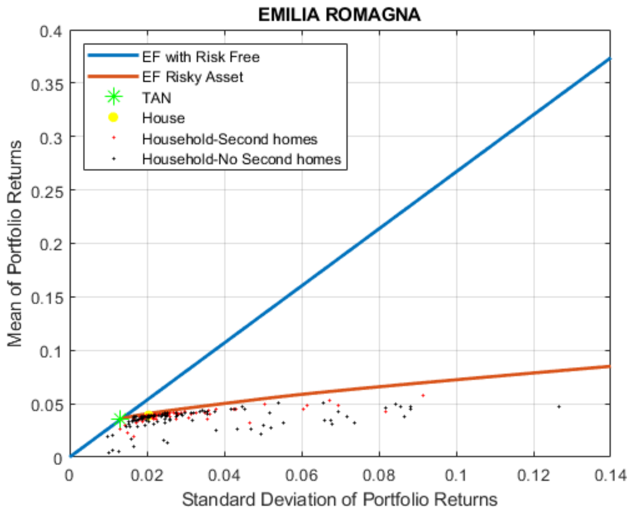
Risky assets ownership	(1)	(2)	(3)	(4)	(5)
Demographic and economic controls:					
Age	0.0702***	0.0703***	0.0632***	0.0632***	0.0648***
	(0.0187)	(0.0187)	(0.0187)	(0.0186)	(0.0187)
Age squared	-0.0100***	-0.0100***	-0.00937***	-0.00937***	-0.00937***
	(0.00238)	(0.00238)	(0.00237)	(0.00237)	(0.00239)
Education	0.0125***	0.0125***	0.0114***	0.0114***	0.0112***
	(0.00162)	(0.00162)	(0.00162)	(0.00162)	(0.00162)
Ln(Family size)	-0.0343**	-0.0341**	-0.0340**	-0.0335**	-0.0359**
	(0.0143)	(0.0143)	(0.0142)	(0.0142)	(0.0142)
Married	-0.000888	-0.000935	-0.00415	-0.00422	-0.00301
	(0.0141)	(0.0141)	(0.0141)	(0.0141)	(0.0141)
Area of residence					
North East	0.0652***	0.0652***	0.0699***	0.0701***	0.0694***
	(0.0169)	(0.0169)	(0.0168)	(0.0168)	(0.0168)
Center	-0.0375**	-0.0374**	-0.0273*	-0.0272*	-0.0274*
	(0.0163)	(0.0163)	(0.0163)	(0.0163)	(0.0163)
South and Islands	-0.140***	-0.140***	-0.134***	-0.133***	-0.134***
	(0.0145)	(0.0145)	(0.0145)	(0.0145)	(0.0145)
Ln(Income)	0.150***	0.149***	0.146***	0.146***	0.147***
	(0.00990)	(0.00990)	(0.00985)	(0.00983)	(0.00984)
Net real wealth quintiles:					
25-50%	0.111***	0.125***	0.0708**	0.0713**	0.0703**
	(0.0139)	(0.0277)	(0.0279)	(0.0278)	(0.0278)
50-75%	0.170***	0.186***	0.122***	0.123***	0.123***
	(0.0151)	(0.0304)	(0.0307)	(0.0306)	(0.0306)
75-90%	0.184***	0.200***	0.112***	0.111***	0.111***
	(0.0187)	(0.0325)	(0.0336)	(0.0335)	(0.0335)
90%	0.251***	0.267***	0.129***	0.128***	0.126***
	(0.0231)	(0.0353)	(0.0386)	(0.0385)	(0.0386)
Pensioner					0.0249
					(0.0163)
Real Estate controls:					
Main residence		-0.0163	0.0332	0.0327	0.0340
		(0.0272)	(0.0272)	(0.0271)	(0.0272)
Second homes			0.139***	0.152***	0.152***
			(0.0189)	(0.0203)	(0.0203)
Other buildings			0.0533**	0.0505*	0.0486*
			(0.0259)	(0.0274)	(0.0275)
Land			0.0355*	0.0383*	0.0390*
			(0.0215)	(0.0215)	(0.0215)
Unprofitable dwellings				-0.0617*	-0.0622*
				(0.0372)	(0.0371)
Unprofitable buildings				0.0194	0.0216
				(0.0698)	(0.0695)
Constant	-1.429***	-1.428***	-1.378***	-1.379***	-1.385***
	(0.0942)	(0.0942)	(0.0940)	(0.0939)	(0.0941)
Observations	6,703	6,703	6,703	6,703	6,703
R^2	0.195	0.195	0.195	0.195	0.195

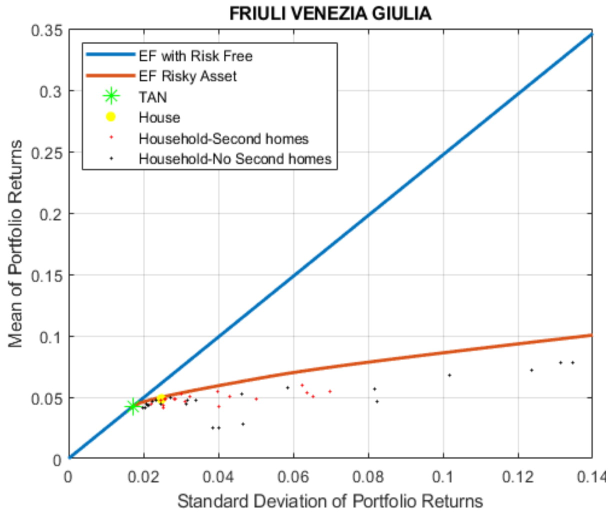
Source: own elaboration on SHIW 2016.
LPM estimated by OLS. Robust standard errors in parentheses.
Significant at 10 per cent.; **Significant at 5 per cent; ***Significant at 1 per cent.

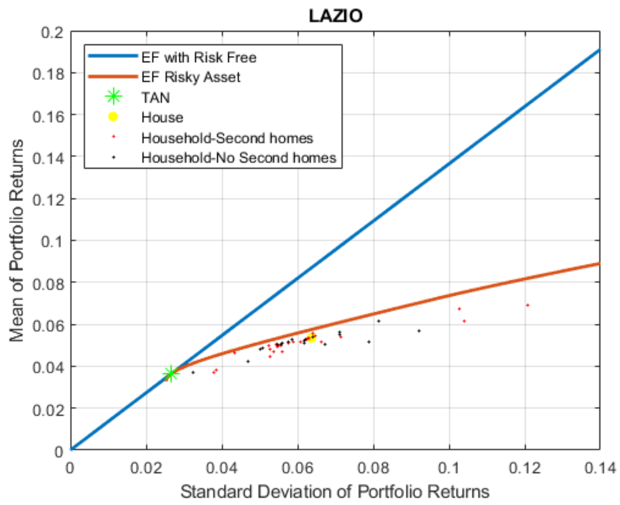
A2. Efficient frontier with housing as an unconstrained asset (2012)

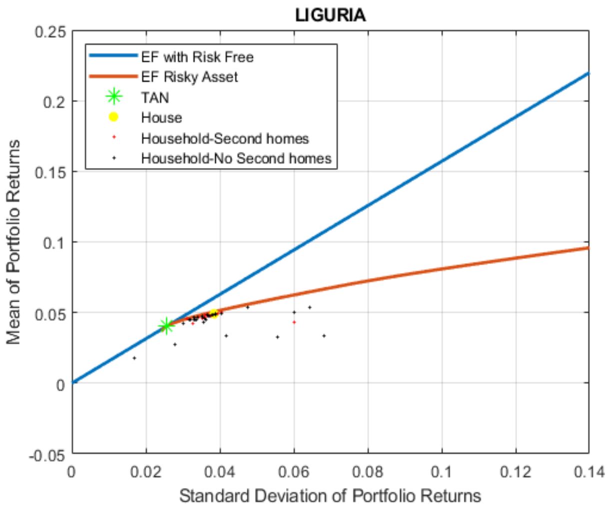
Efficient Frontiers with Housing

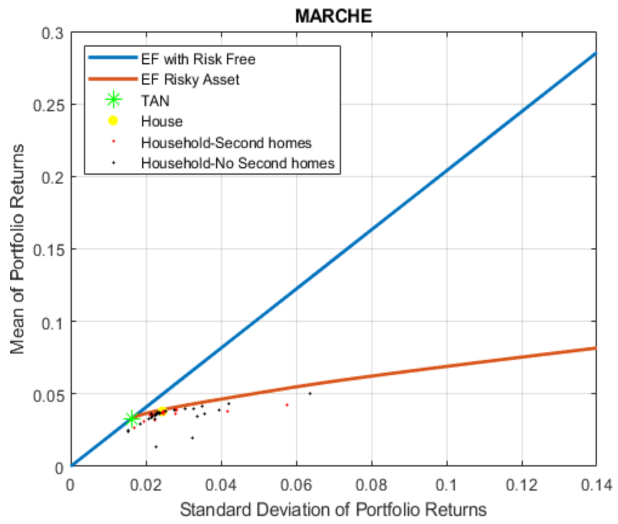


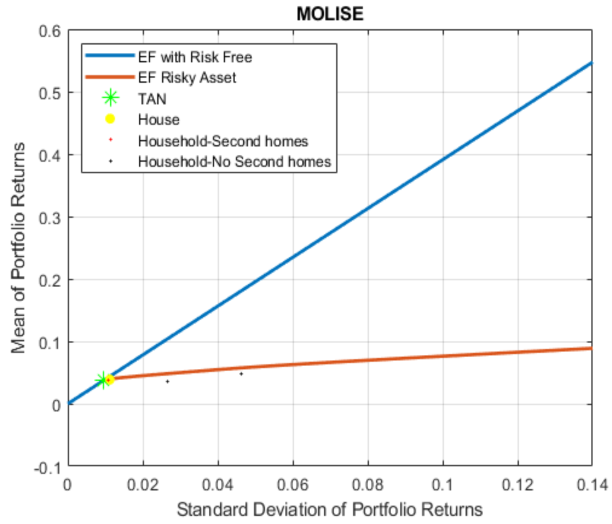

EMILIA ROMAGNA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

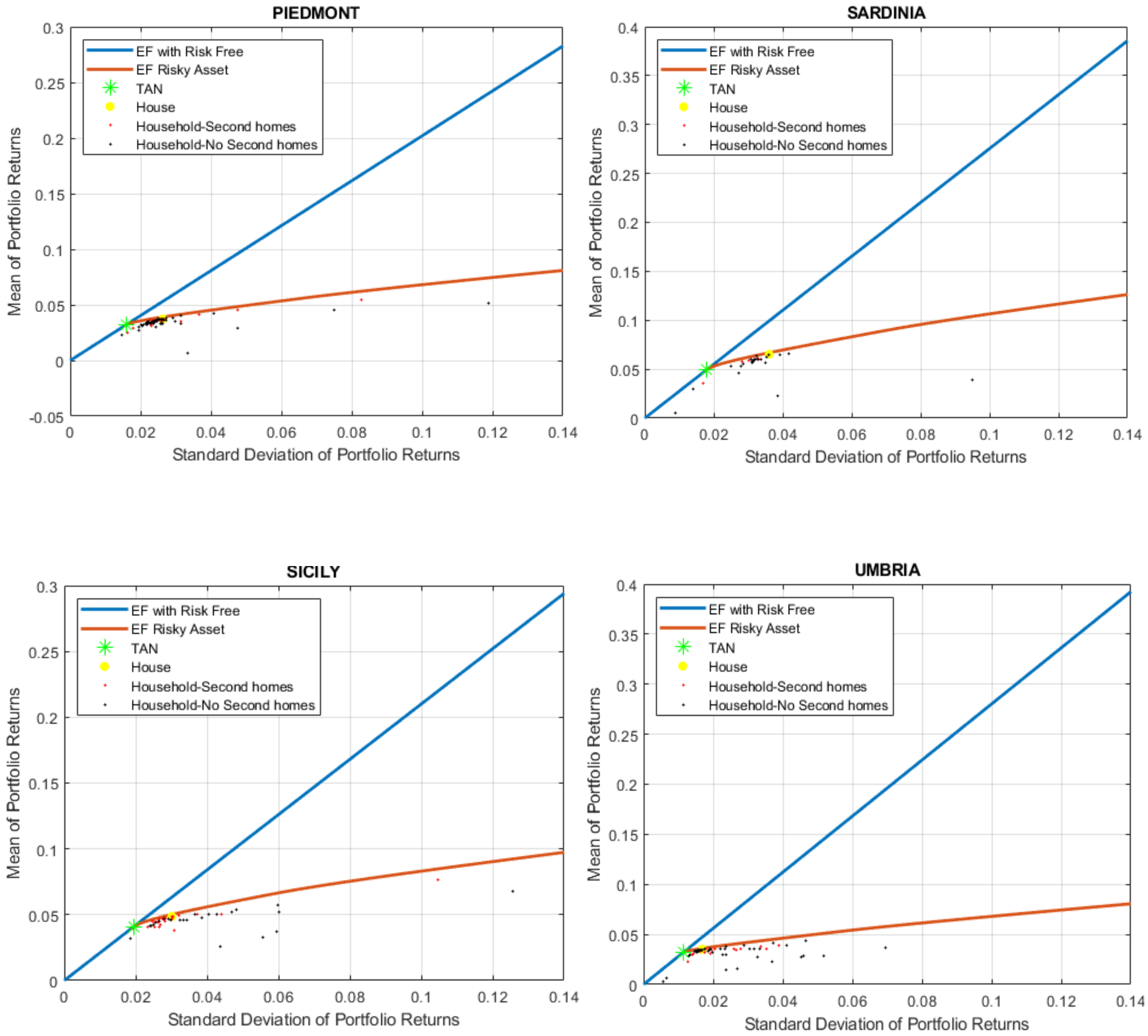

FRIULI VENEZIA GIULIA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


MARCHE
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

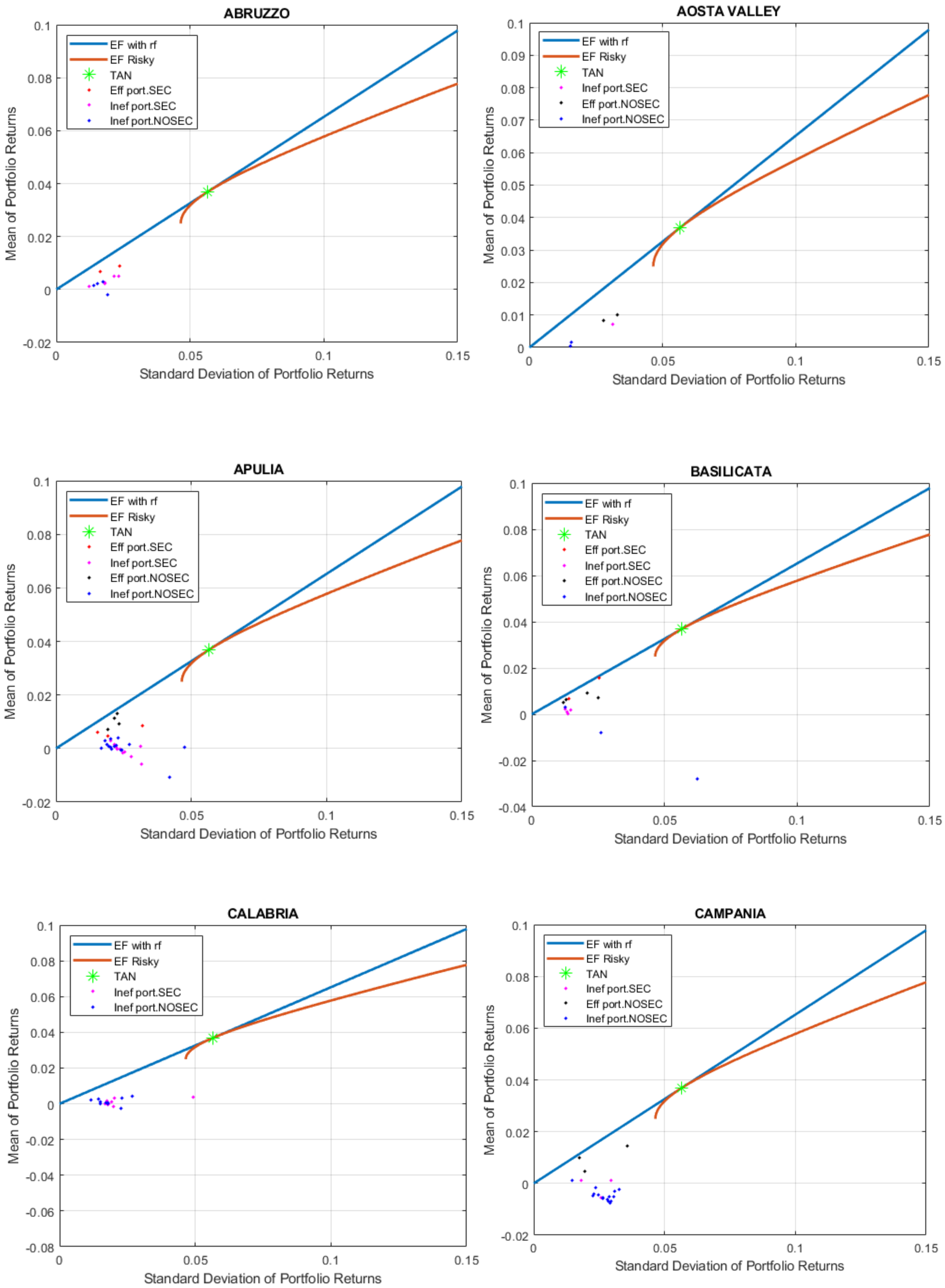

MOLISE
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

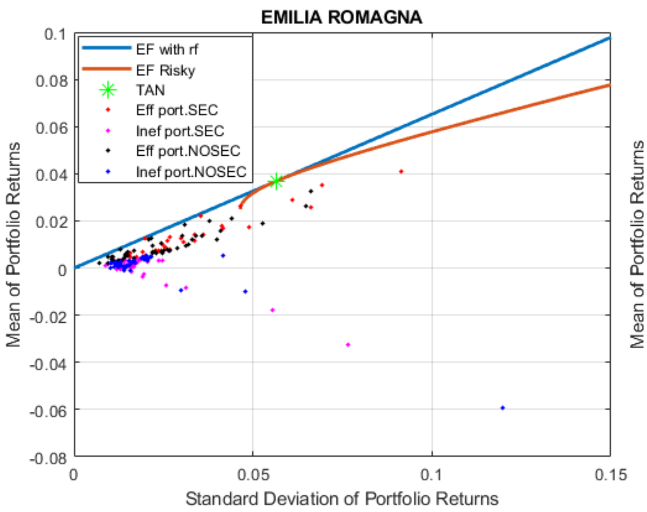


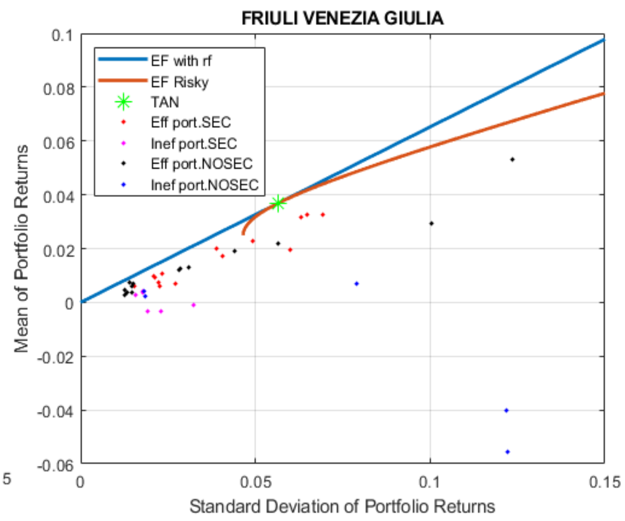
Source: own elaboration on Eikon dataset and SHIW 2012.

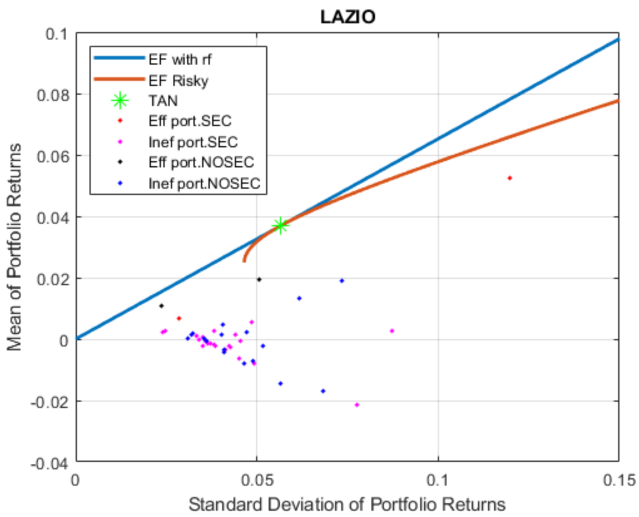
A3. Household portfolios net of the hedge term (SHIW 2012)

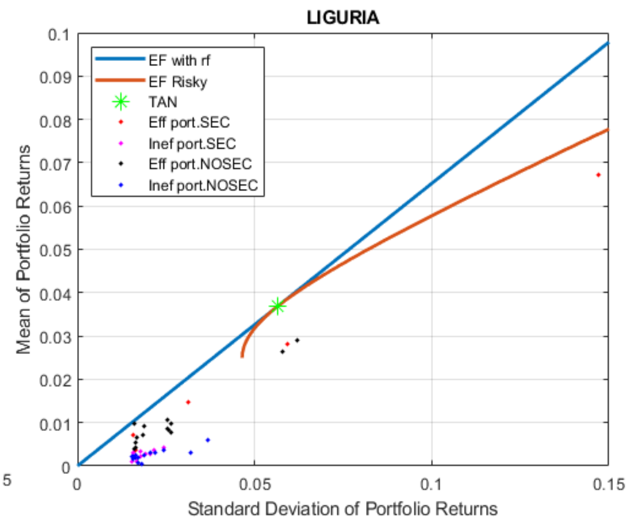
Household Portfolios Net of the Hedge Term

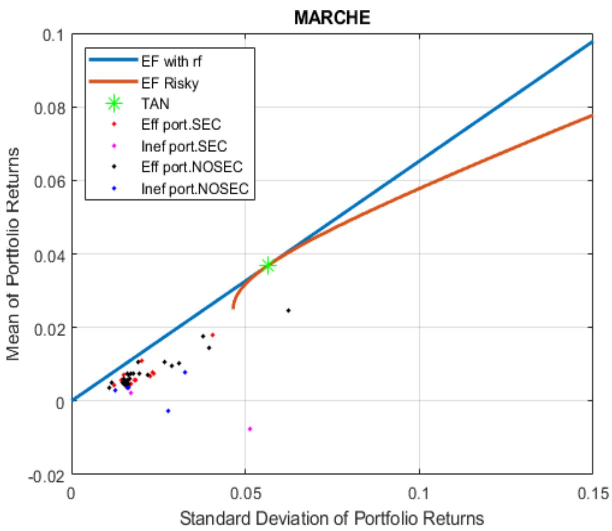


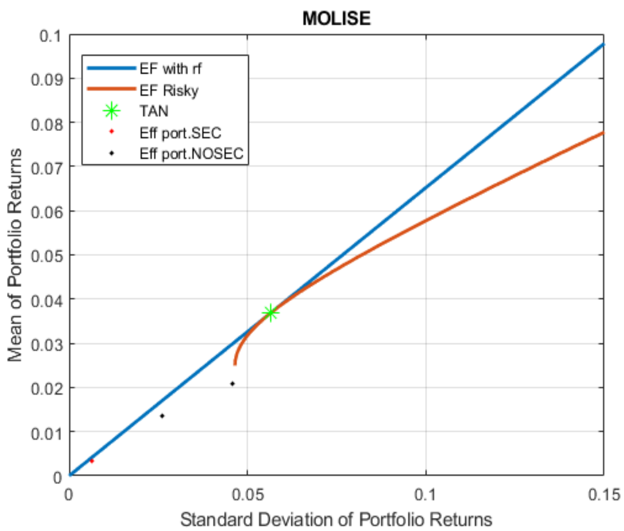

EMILIA ROMAGNA
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

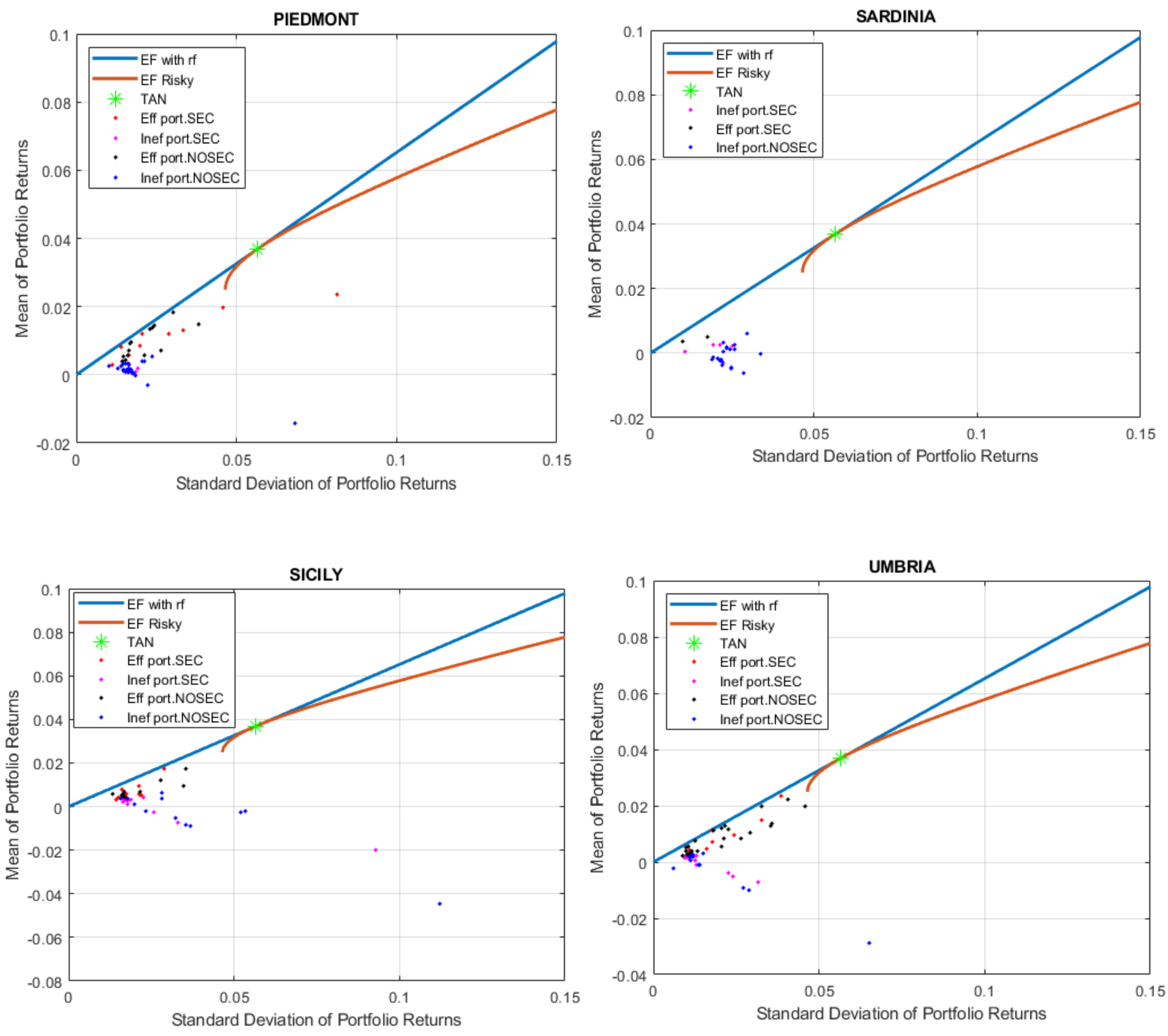

FRIULI VENEZIA GIULIA
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


MARCHE
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

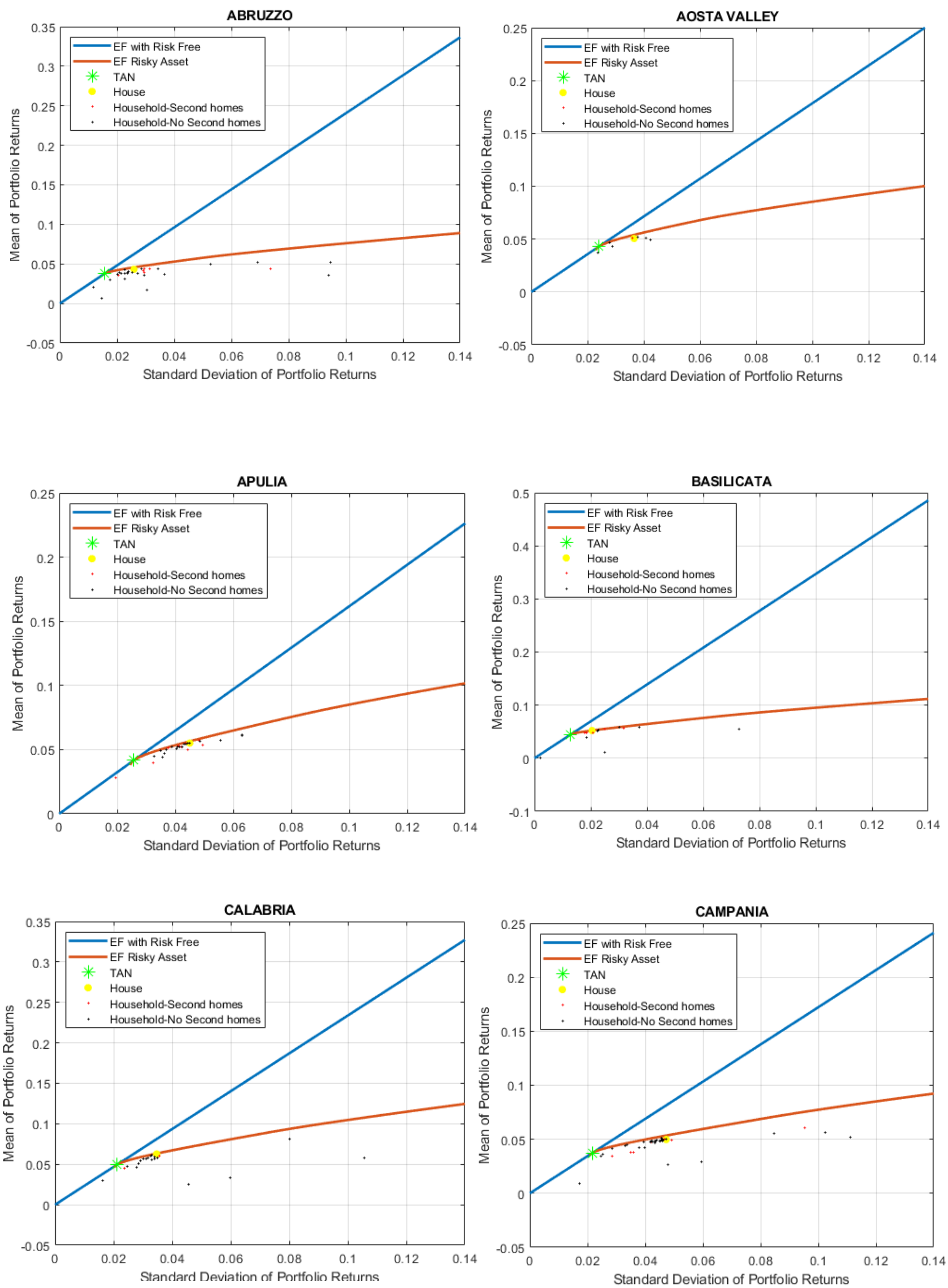

MOLISE
EF with rf
EF Risky
TAN
Eff port.SEC
Eff port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

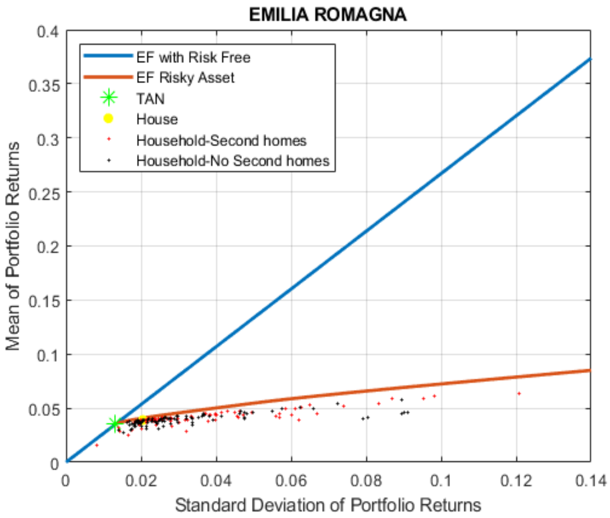


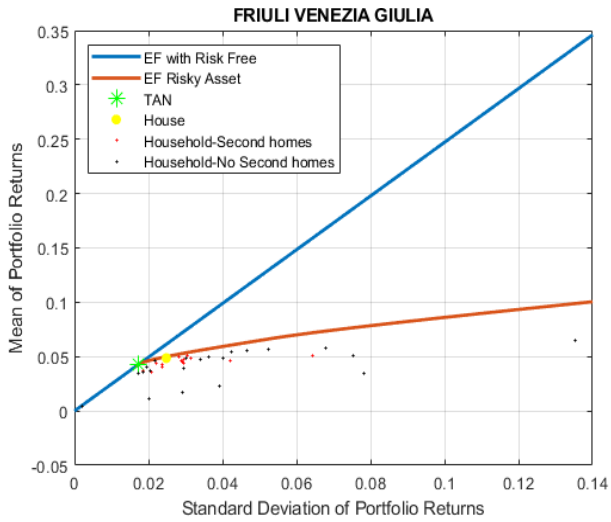
Source: own elaboration on Eikon, OMI and SHIW 2012 dataset.
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3. "SEC" states for second home owners, while "NOSEC" for main residence owners only.

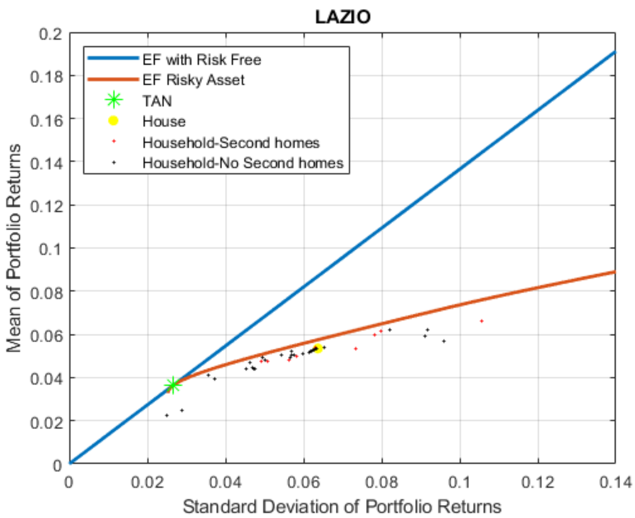
A4. Efficient frontier with second home as an unconstrained asset (SHIW 2016)

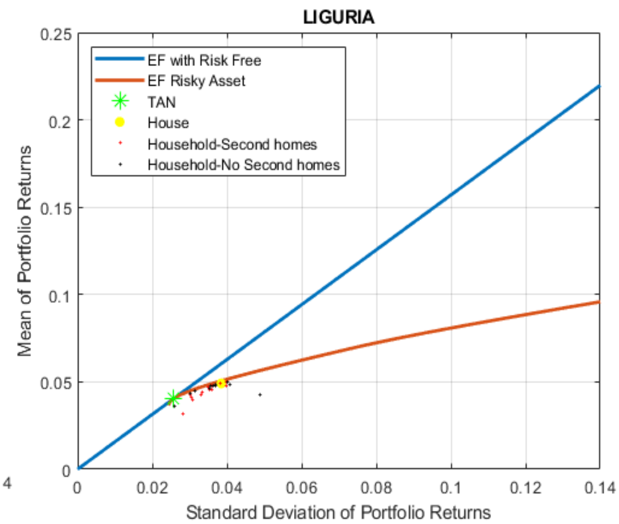
Efficient Frontiers with housing

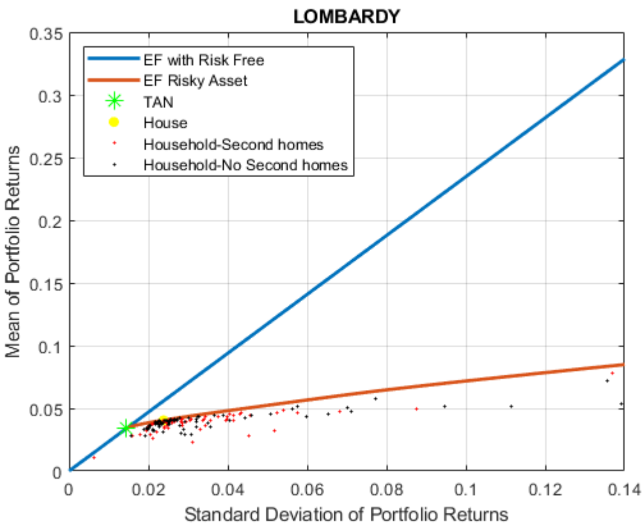


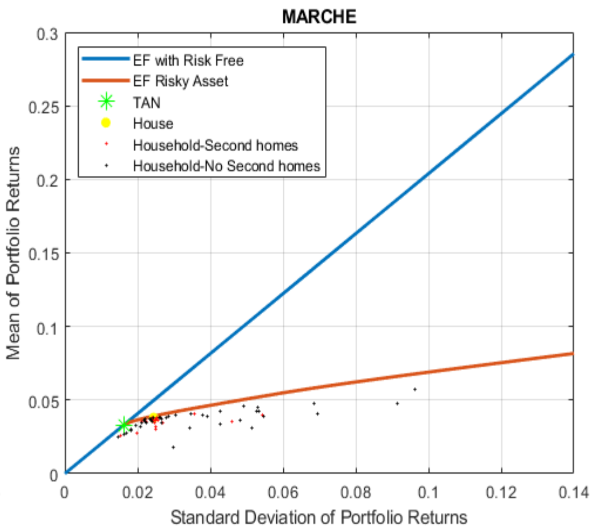

EMILIA ROMAGNA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

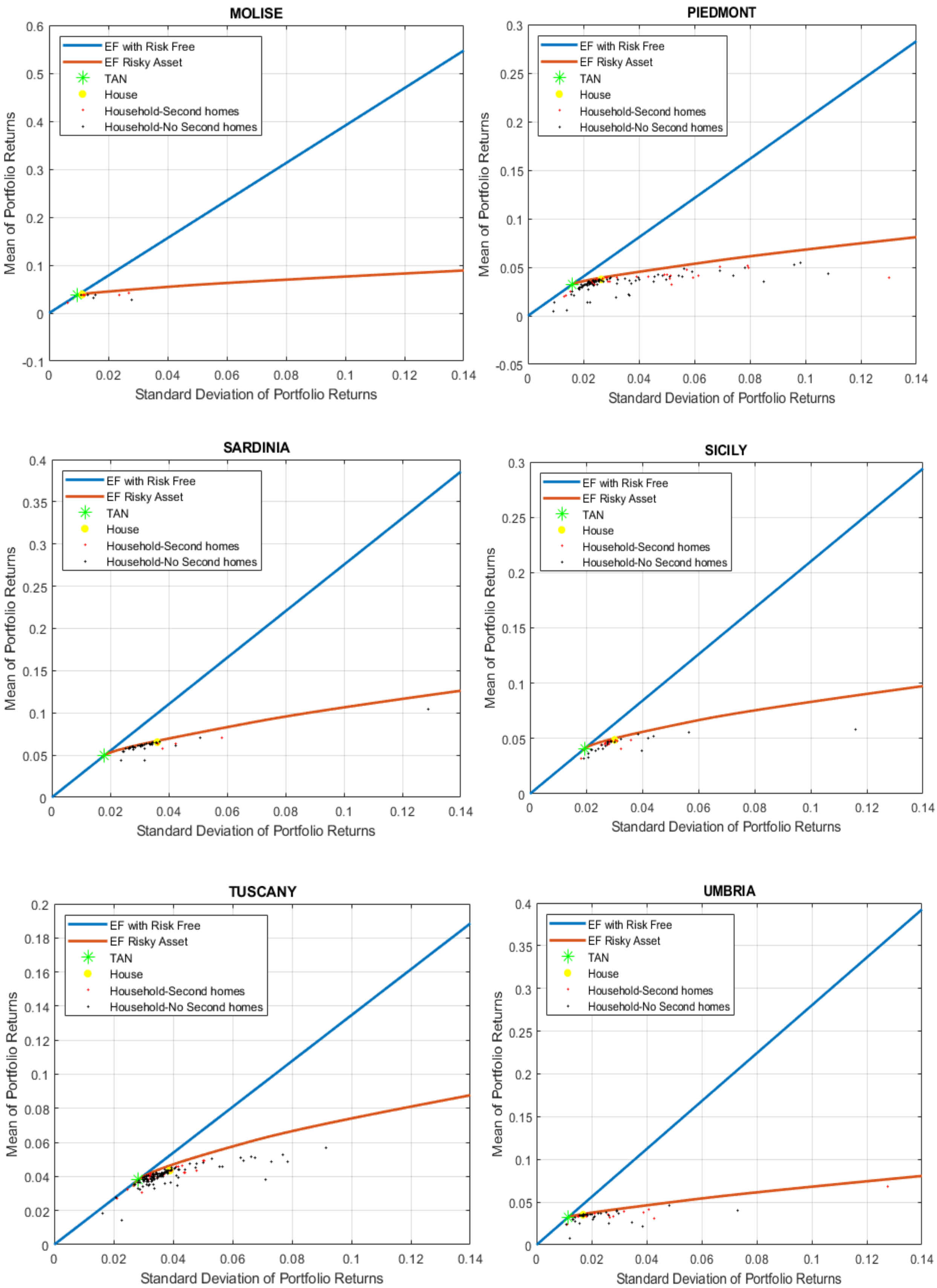

FRIULI VENEZIA GIULIA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LOMBARDY
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

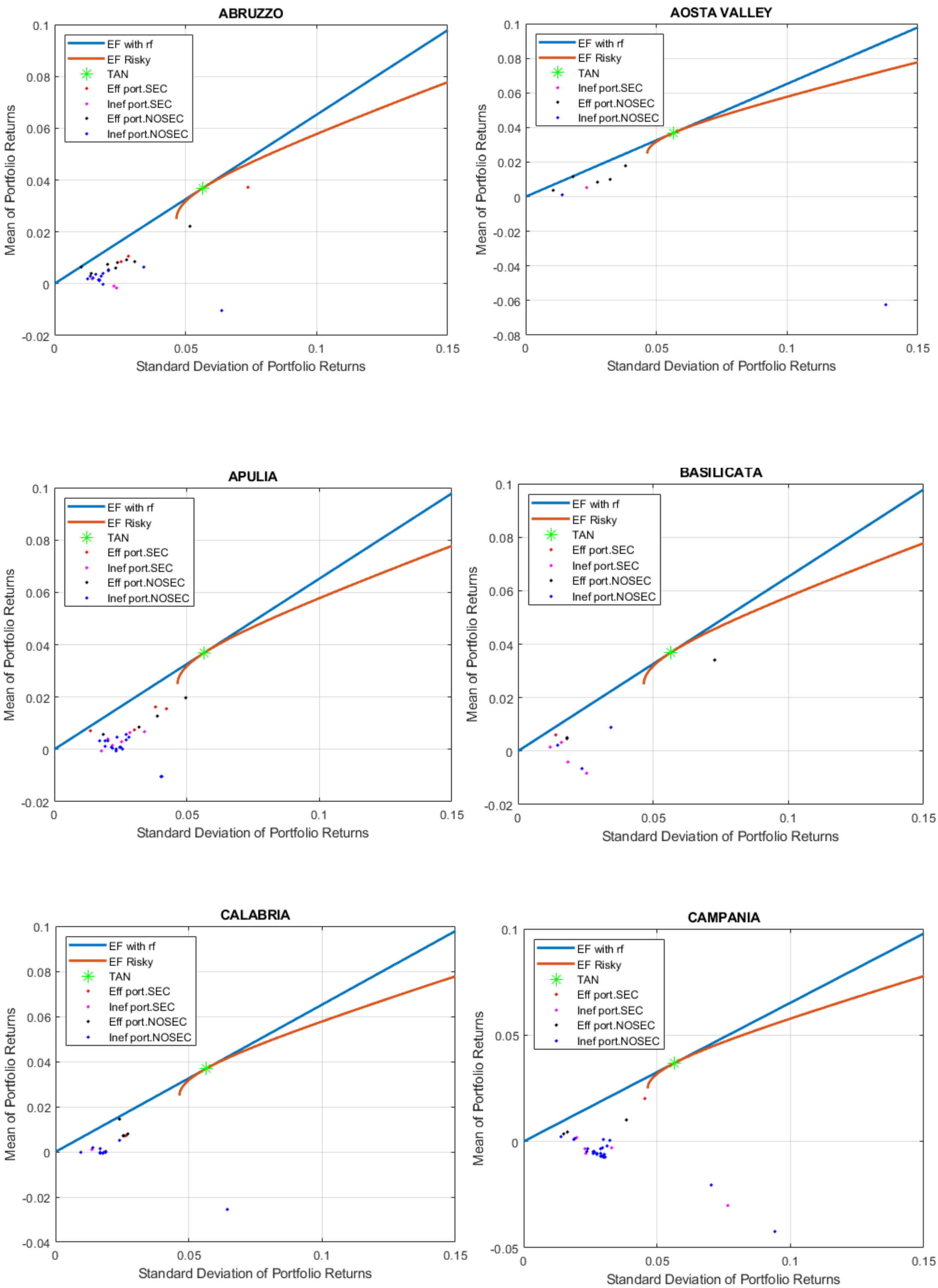

MARCHE
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Household-No Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

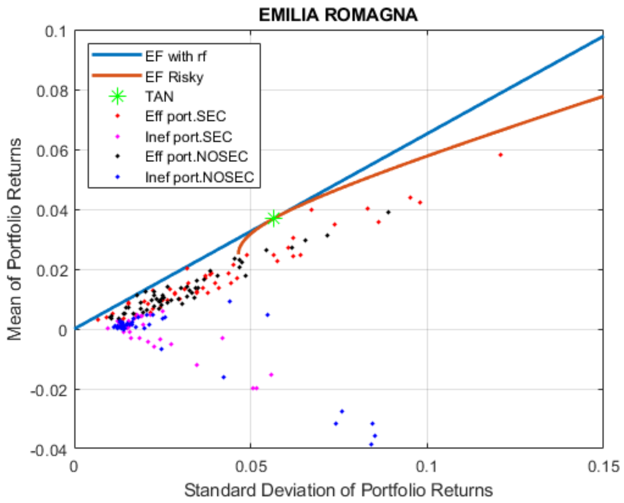


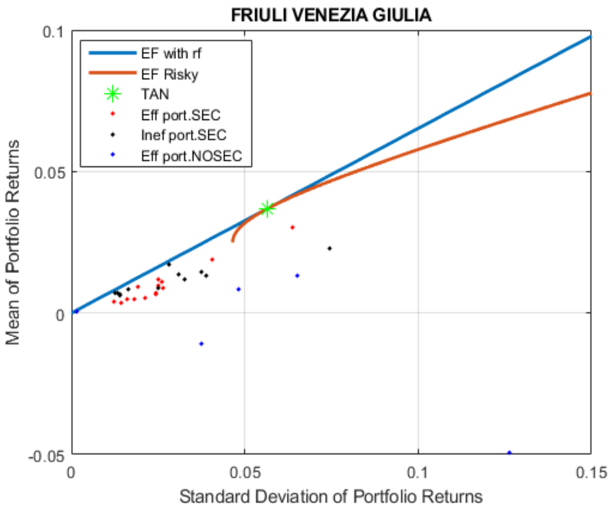
Source: own elaboration on Eikon, OMI and SHIW 2016 dataset.

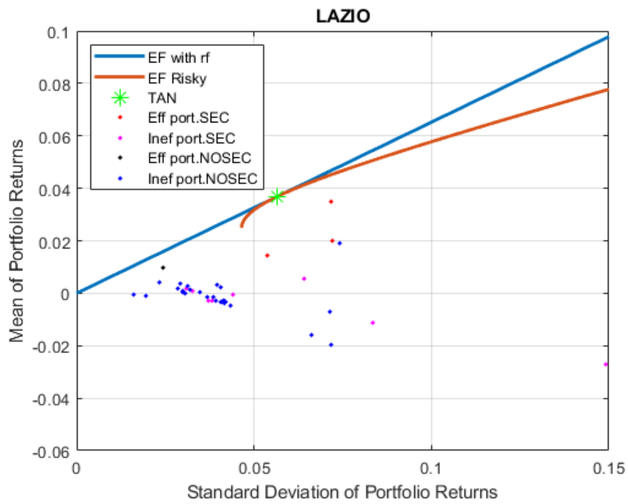
A5. Household portfolios net of the hedge term (2016)

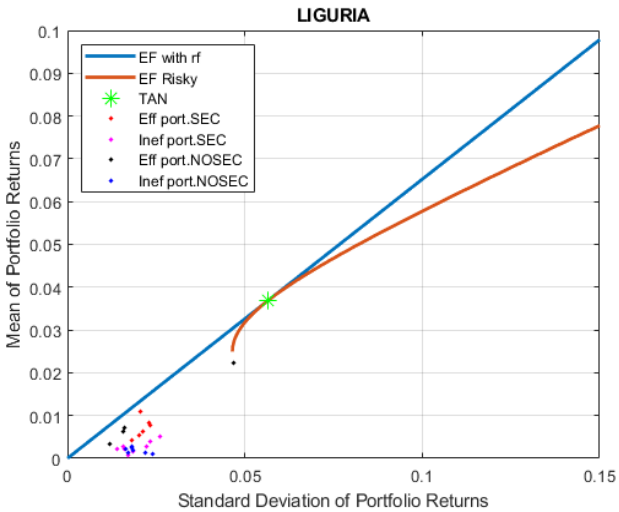
Household Portfolios Net of the Hedge Term

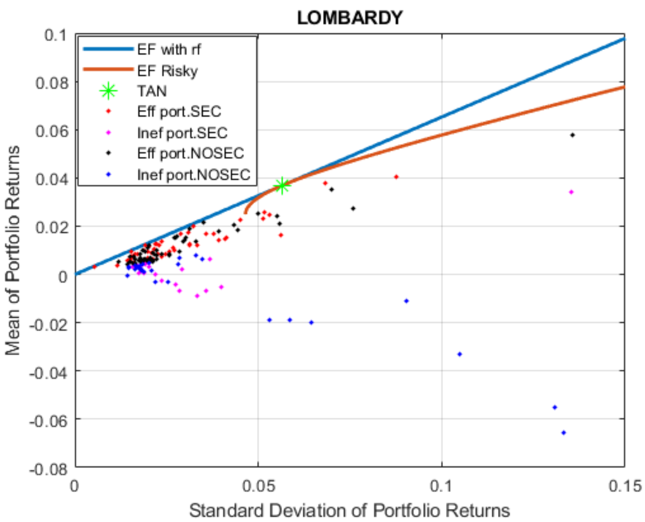


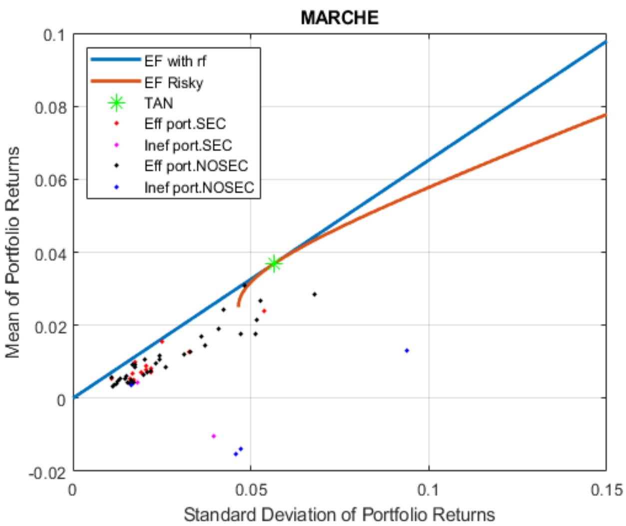

EMILIA ROMAGNA
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

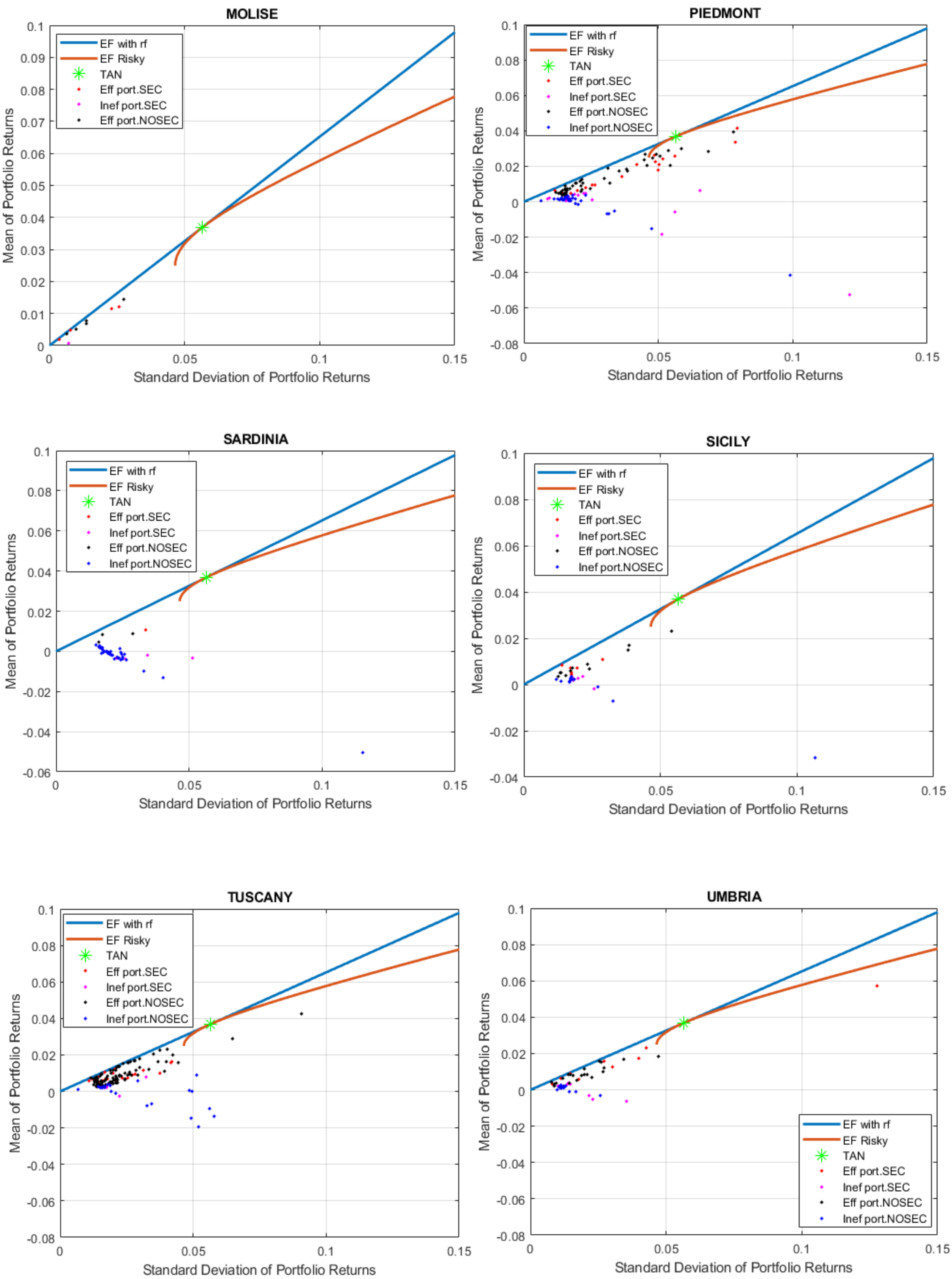

FRIULI VENEZIA GIULIA
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LOMBARDY
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

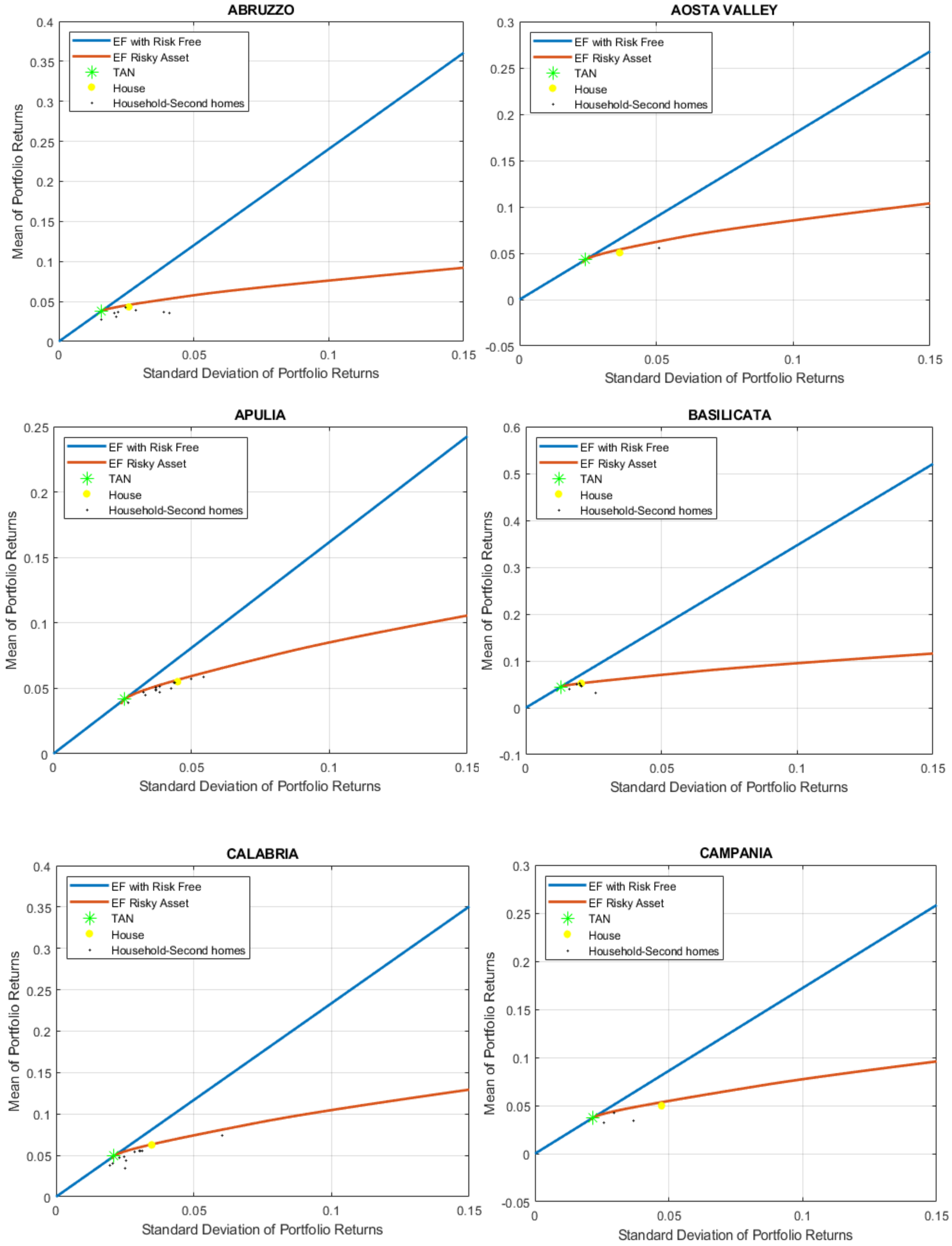

MARCHE
EF with rf
EF Risky
TAN
Eff port.SEC
Inef port.SEC
Eff port.NOSEC
Inef port.NOSEC
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

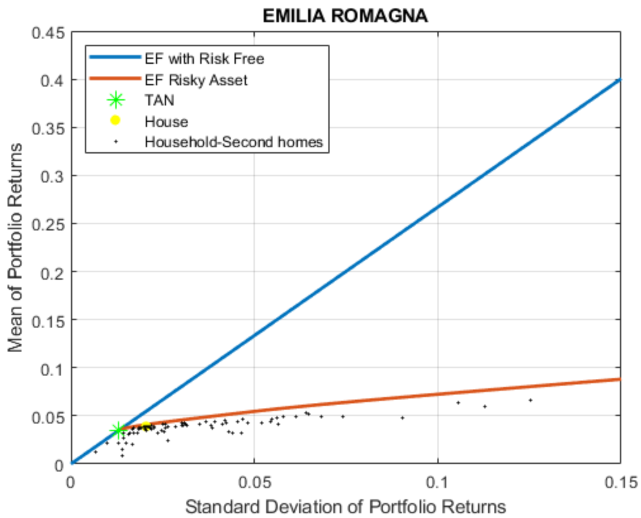


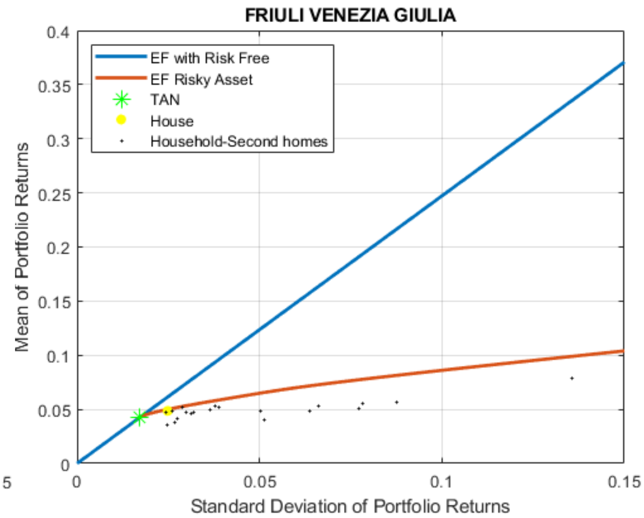
Source: own elaboration on Eikon, OMI and SHIW 2016 dataset.
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3. “SEC” states for second home owners, while “NOSEC” for main residence owners only.

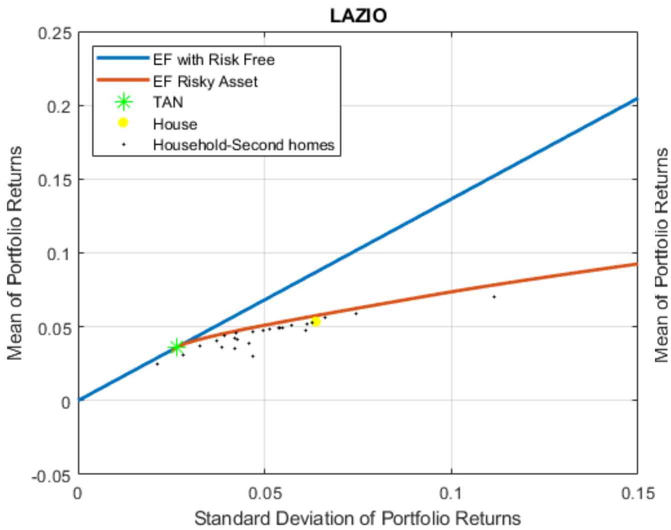
A6. Efficient frontier with housing as an unconstrained asset and housing wealth composed by second homes only. (SHIW 2012)

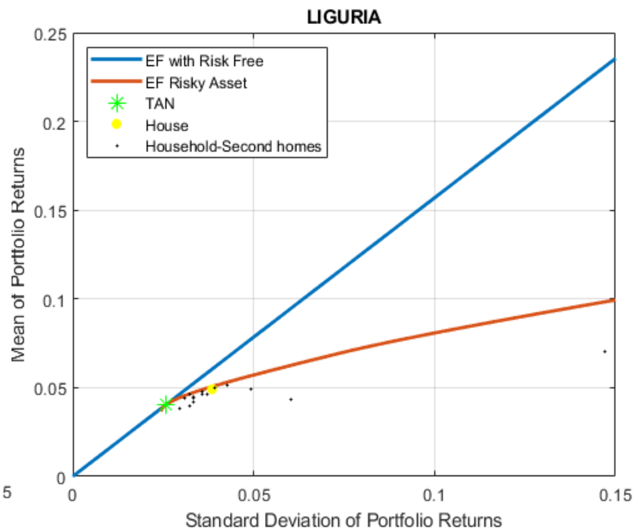
Efficient Frontiers with Housing

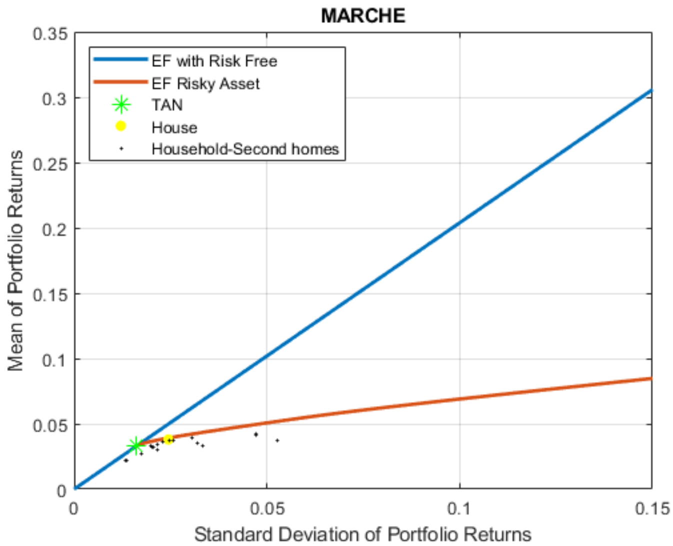


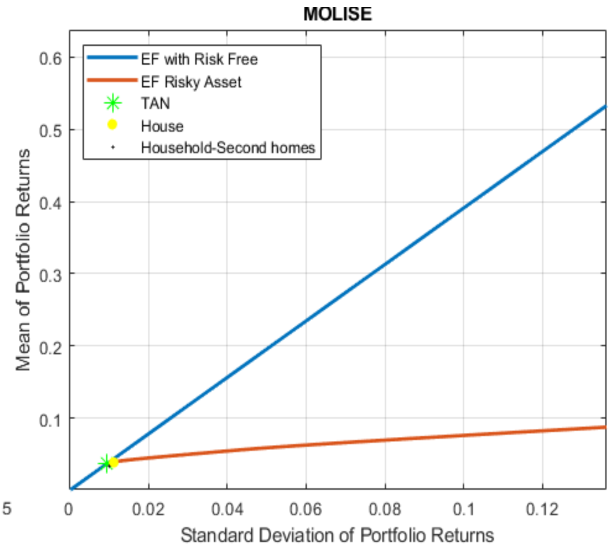

EMILIA ROMAGNA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15

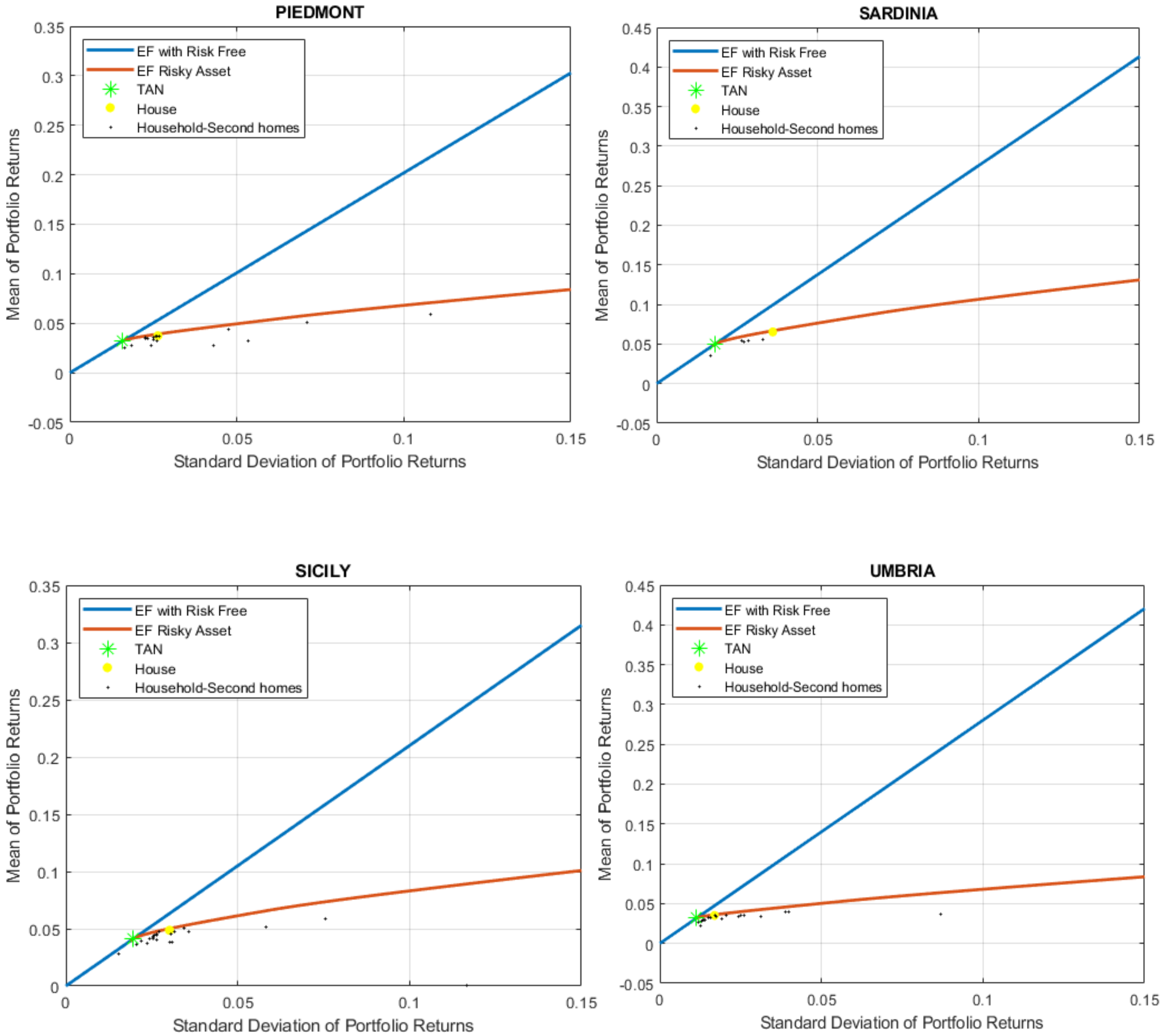

FRIULI VENEZIA GIULIA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15


LAZIO
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns
0.25
0.2
0.15
0.1
0.05
0
-0.05
0
0.05
0.1
0.15


LIGURIA
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15


MARCHE
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15


MOLISE
EF with Risk Free
EF Risky Asset
TAN
House
Household-Second homes
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns
0.6
0.5
0.4
0.3
0.2
0.1
0
0.02
0.04
0.06
0.08
0.1
0.12

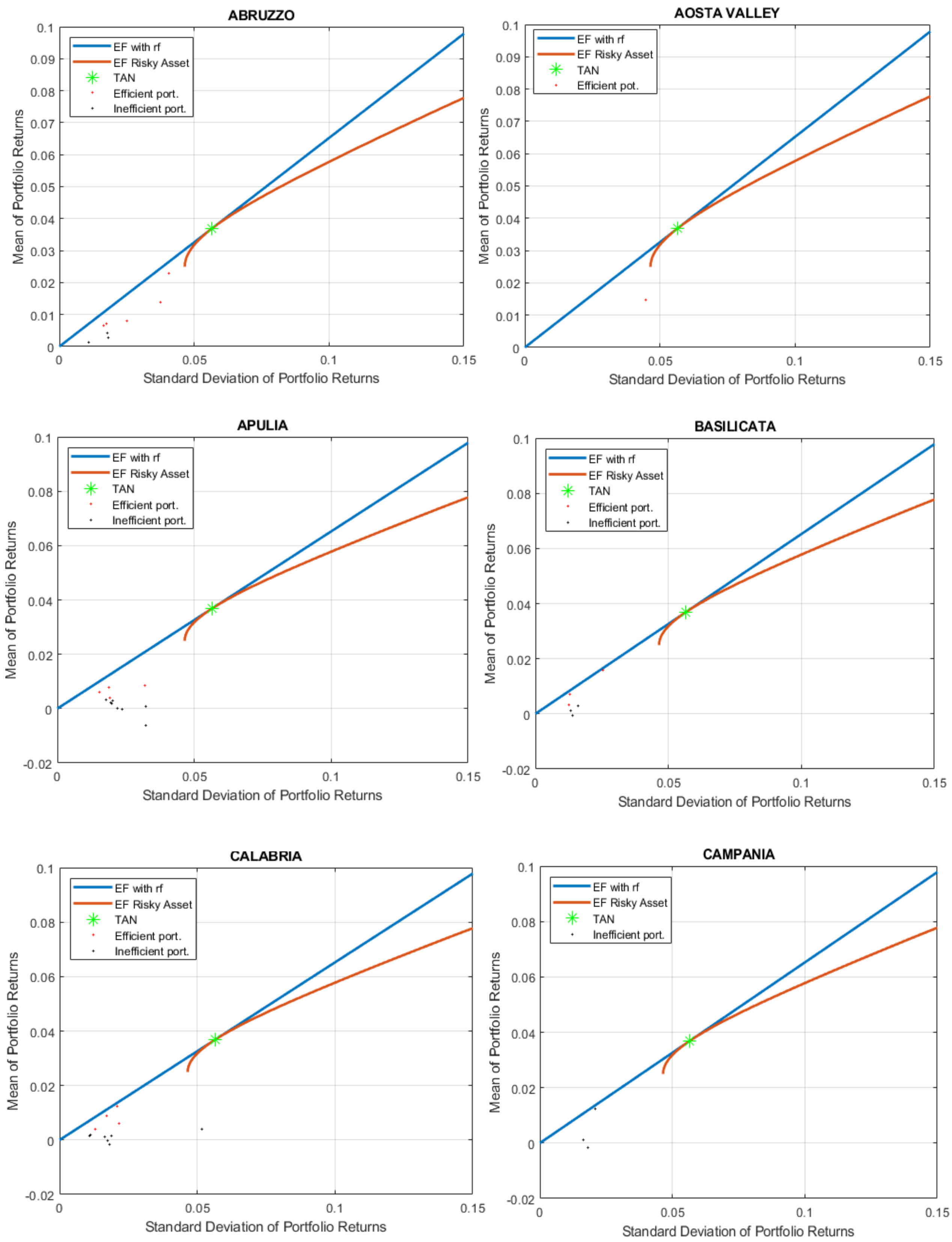


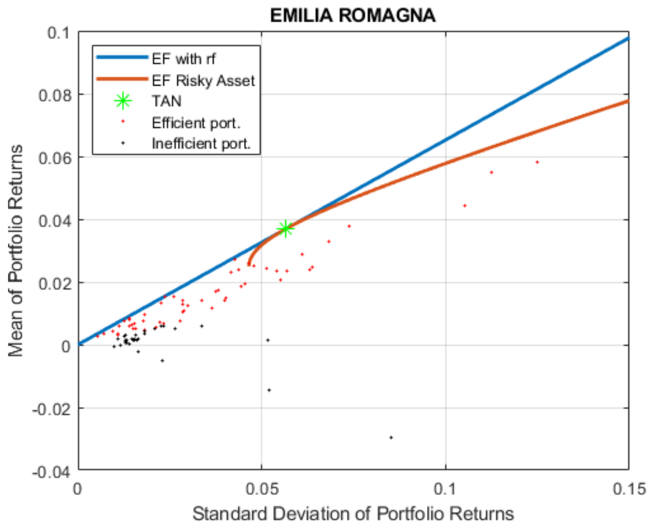
Source: own elaboration on Eikon, OMI and SHIW 2012 dataset.

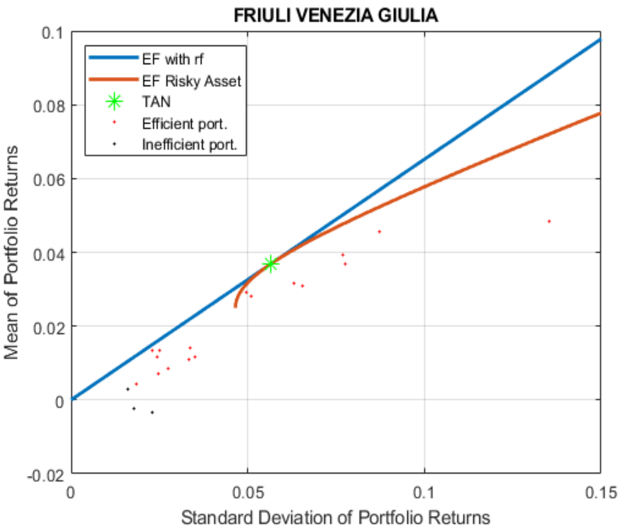
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3.

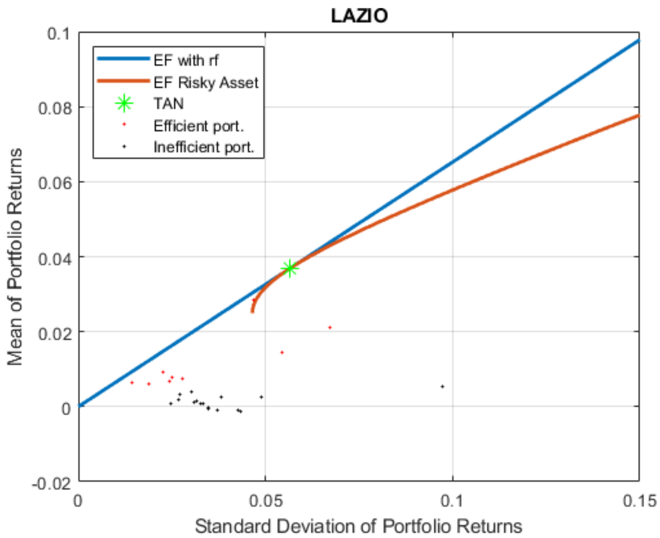
A7. Household portfolios net of the hedge term when housing includes second homes only. (SHIW 2012)

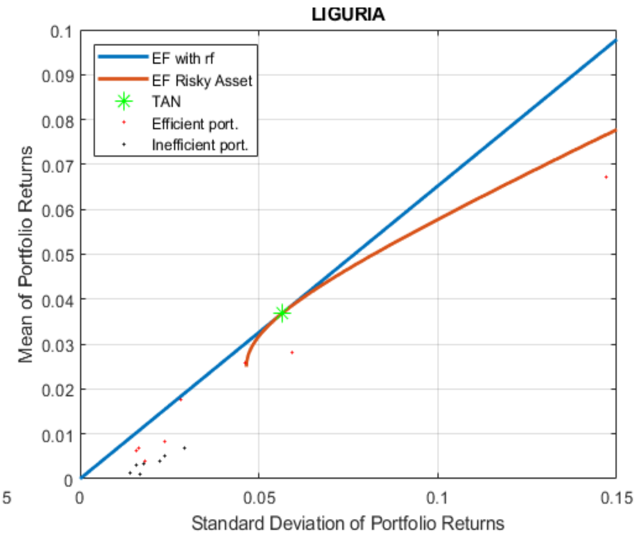
Household Portfolios Net of the Hedge Term

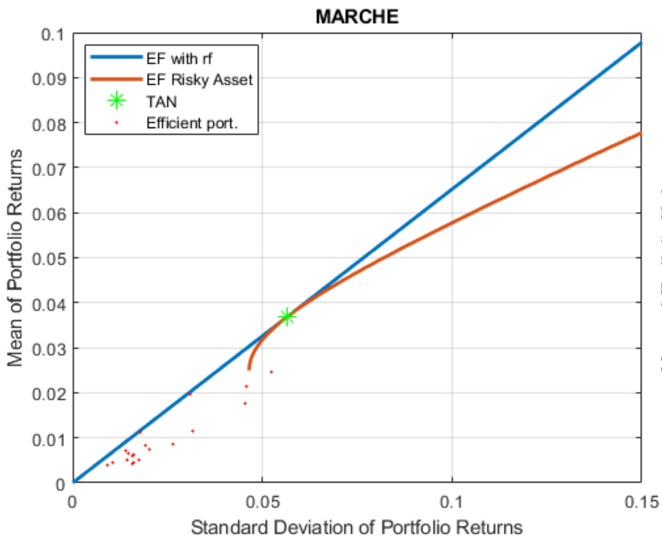


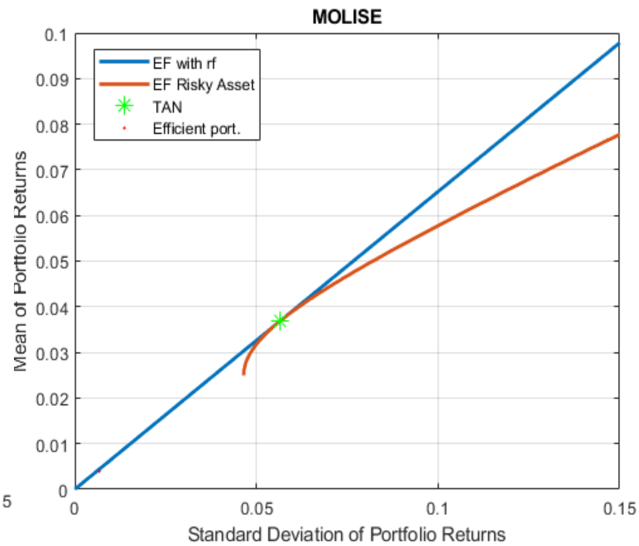

EMILIA ROMAGNA
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

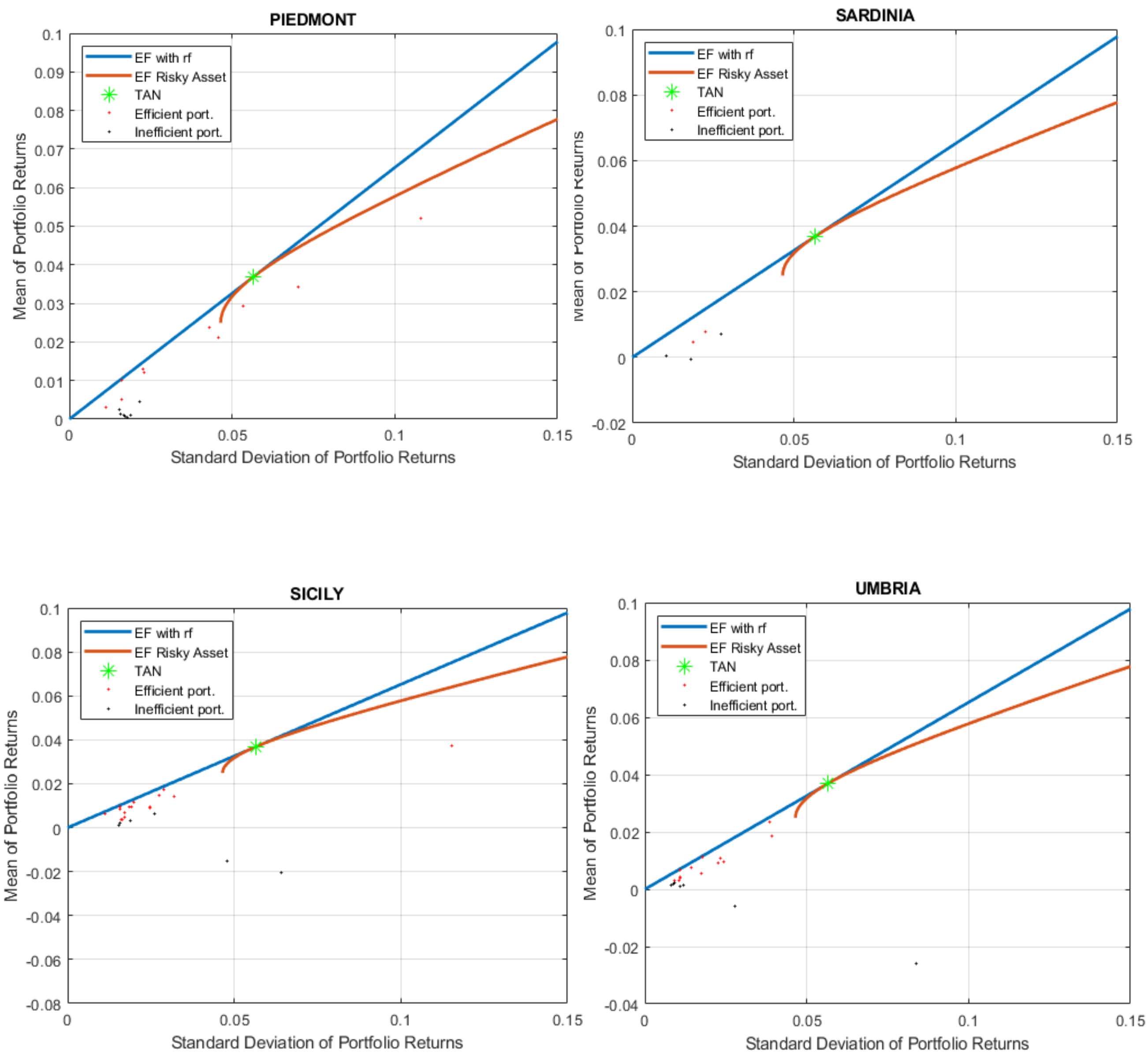

FRIULI VENEZIA GIULIA
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


MARCHE
EF with rf
EF Risky Asset
TAN
Efficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


MOLISE
EF with rf
EF Risky Asset
TAN
Efficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

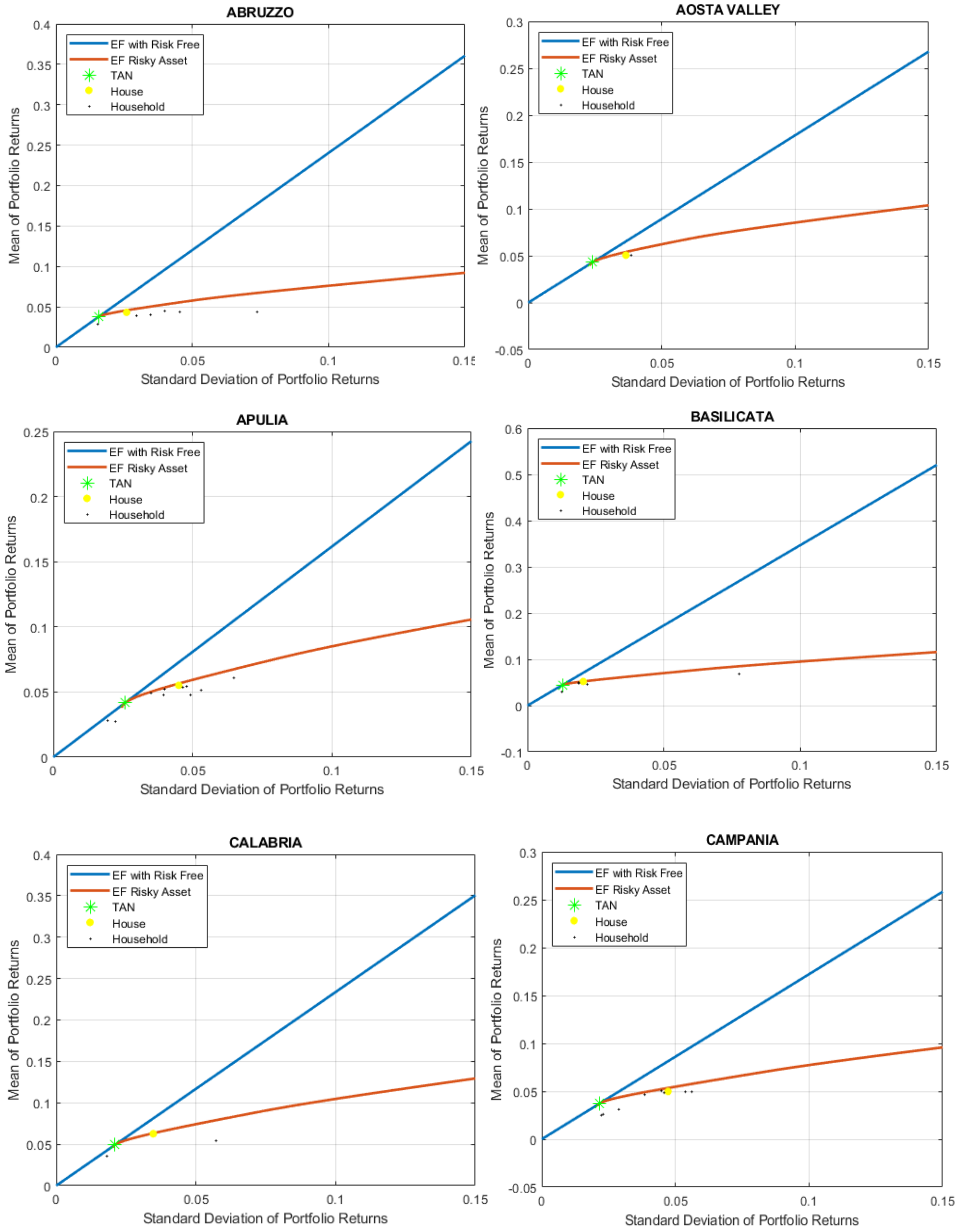


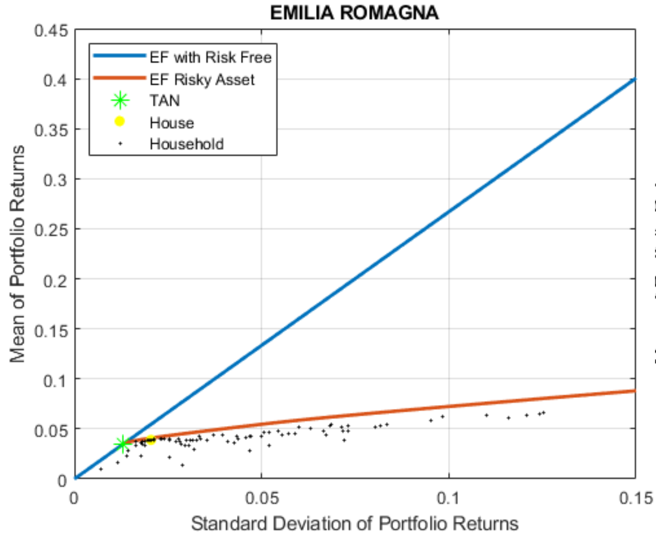
Source: own elaboration on Eikon, OMI and SHIW 2012 dataset.

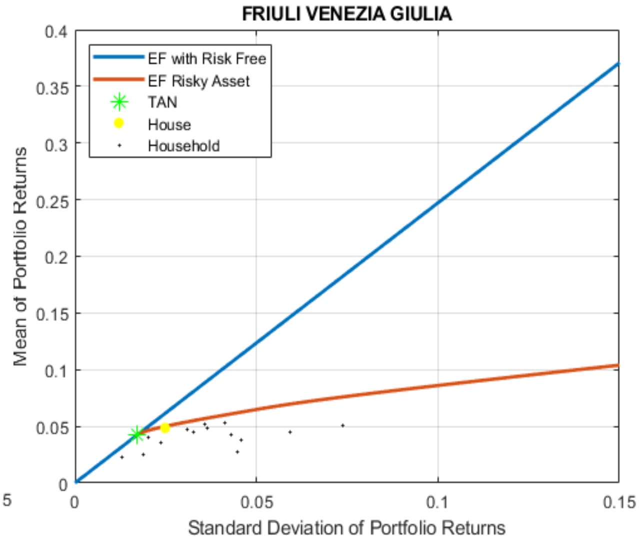
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3.

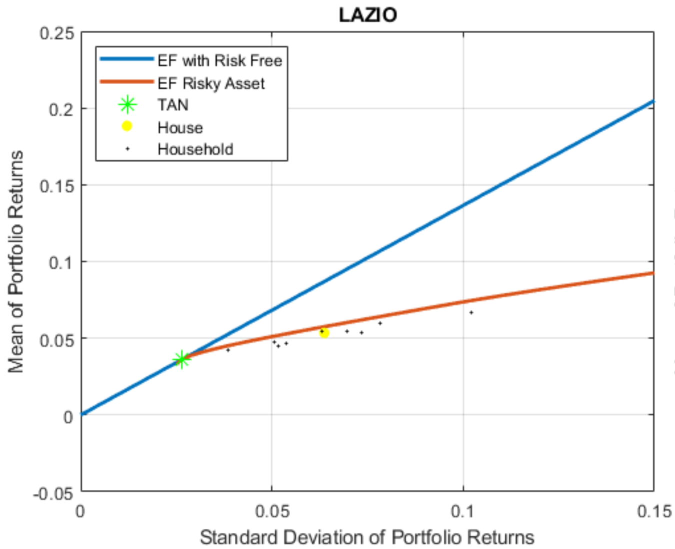
A8. Efficient frontier with housing as an unconstrained asset and housing wealth composed by second homes only. (SHIW 2016)

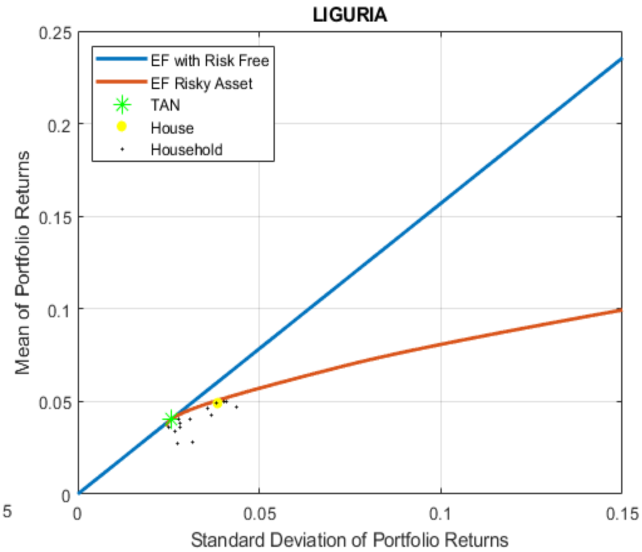
Efficient Frontiers with Housing

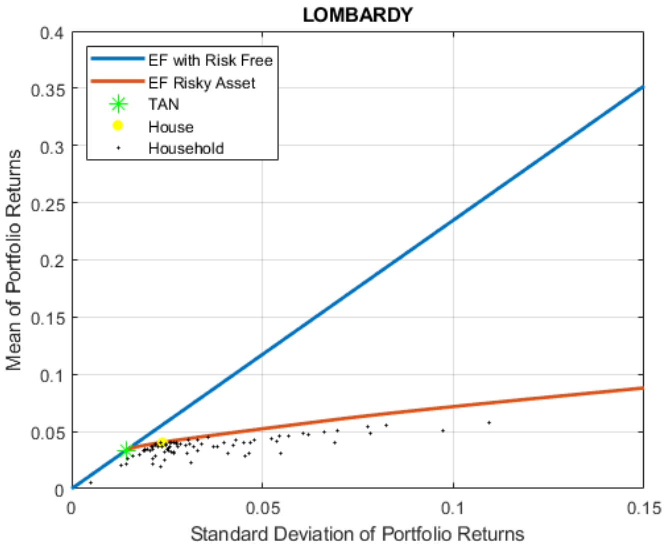


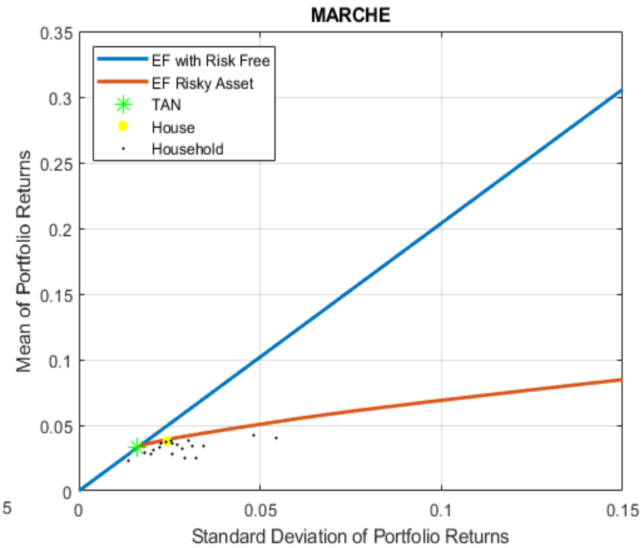

EMILIA ROMAGNA
EF with Risk Free
EF Risky Asset
TAN
House
Household
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

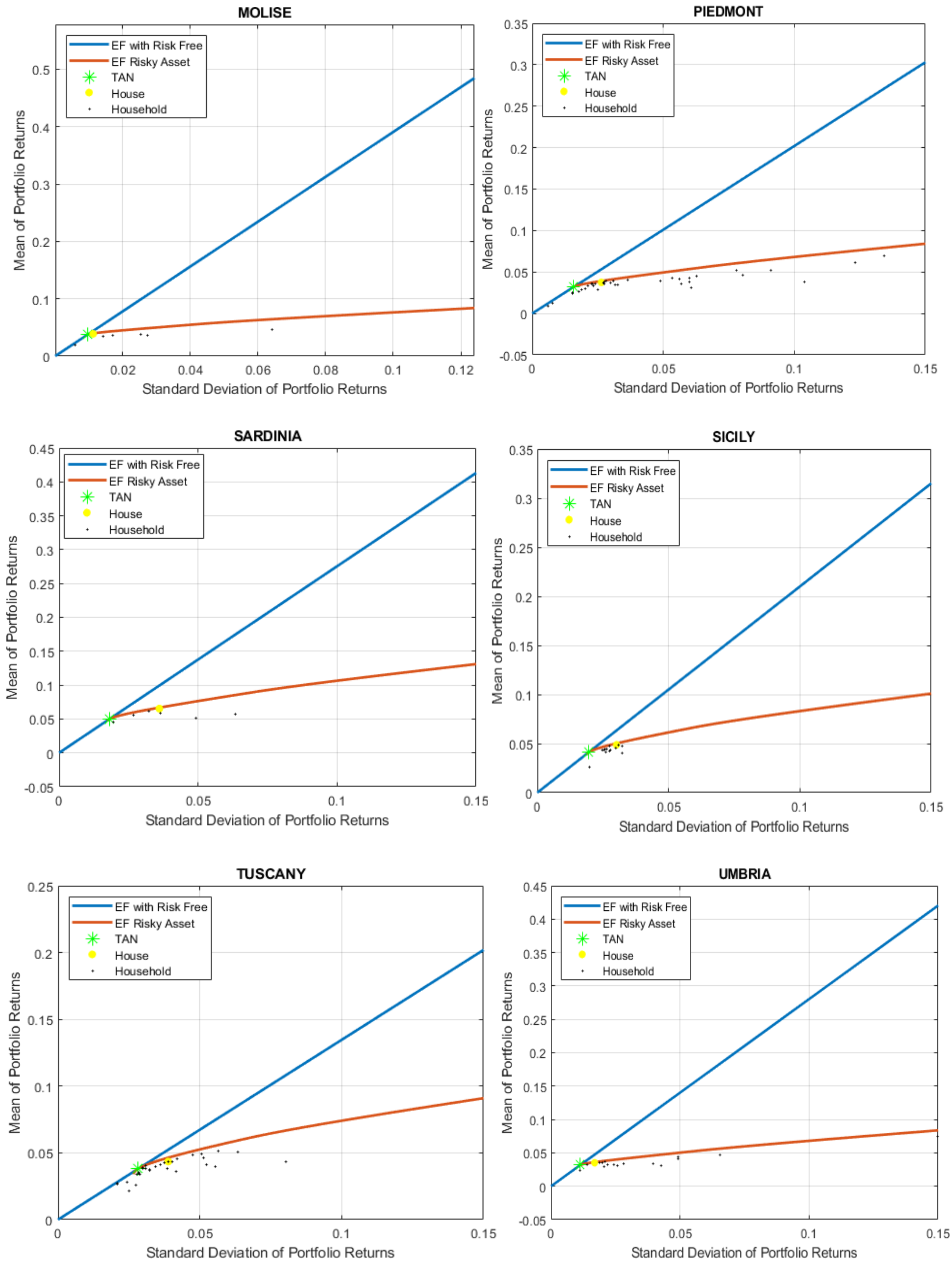

FRIULI VENEZIA GIULIA
EF with Risk Free
EF Risky Asset
TAN
House
Household
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with Risk Free
EF Risky Asset
TAN
House
Household
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with Risk Free
EF Risky Asset
TAN
House
Household
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LOMBARDY
EF with Risk Free
EF Risky Asset
TAN
House
Household
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


MARCHE
EF with Risk Free
EF Risky Asset
TAN
House
Household
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

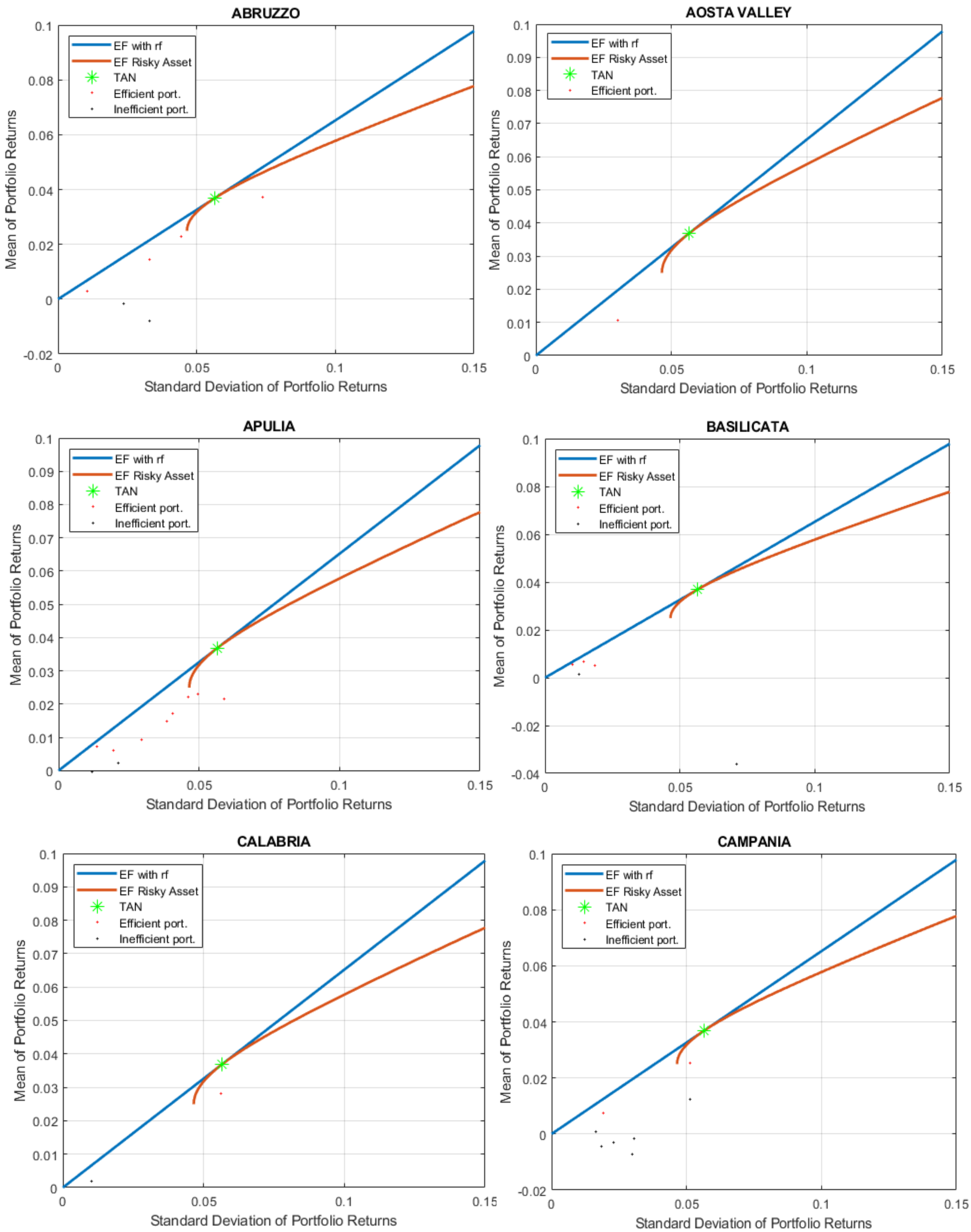


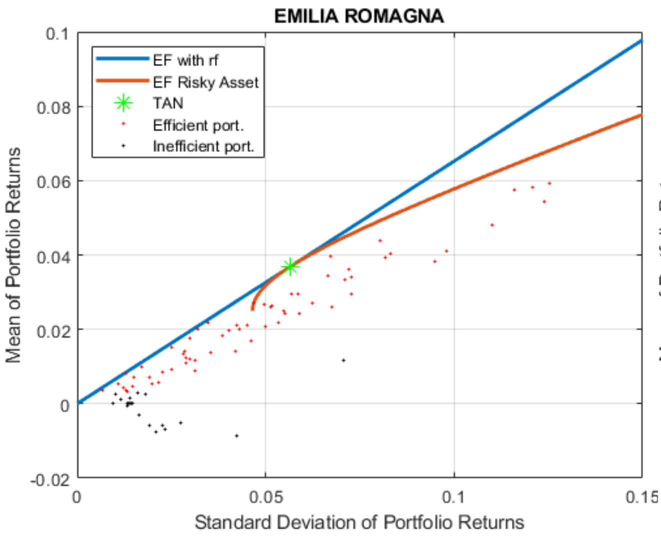
Source: own elaboration on Eikon, OMI and SHIW 2016 dataset.

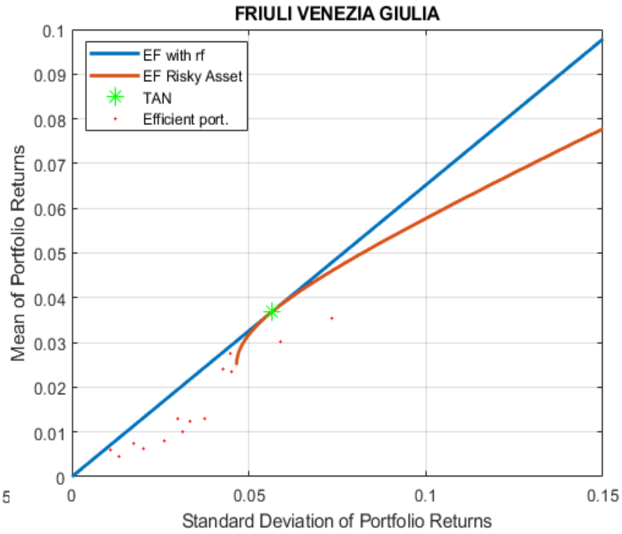
Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3.

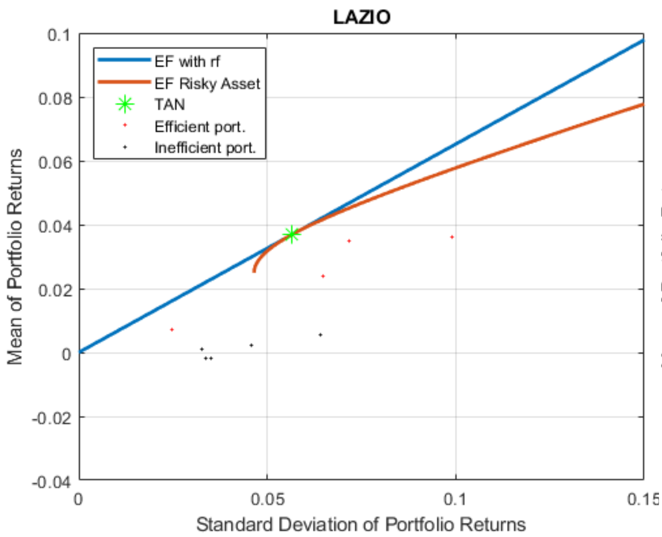
A9. Household portfolios net of the hedge term when housing includes second homes only. (SHIW 2016)

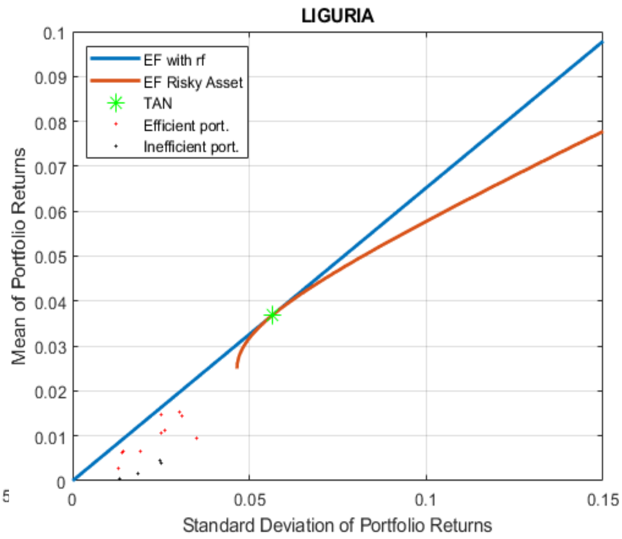
Household Portfolios Net of the Hedge Term

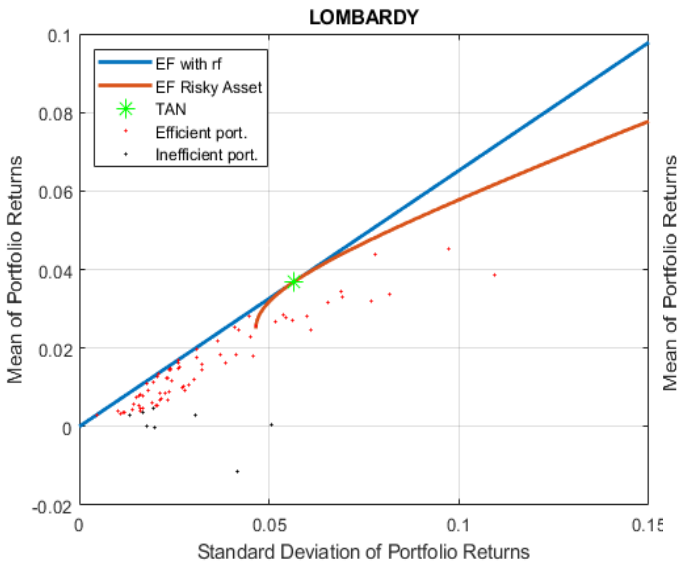


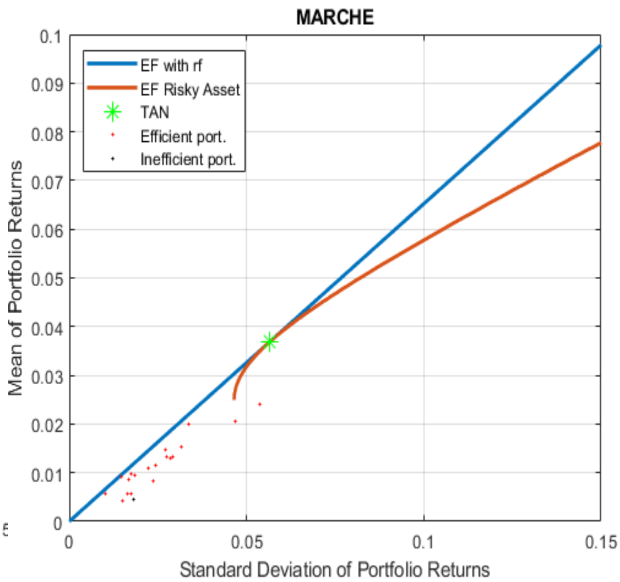

EMILIA ROMAGNA
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns

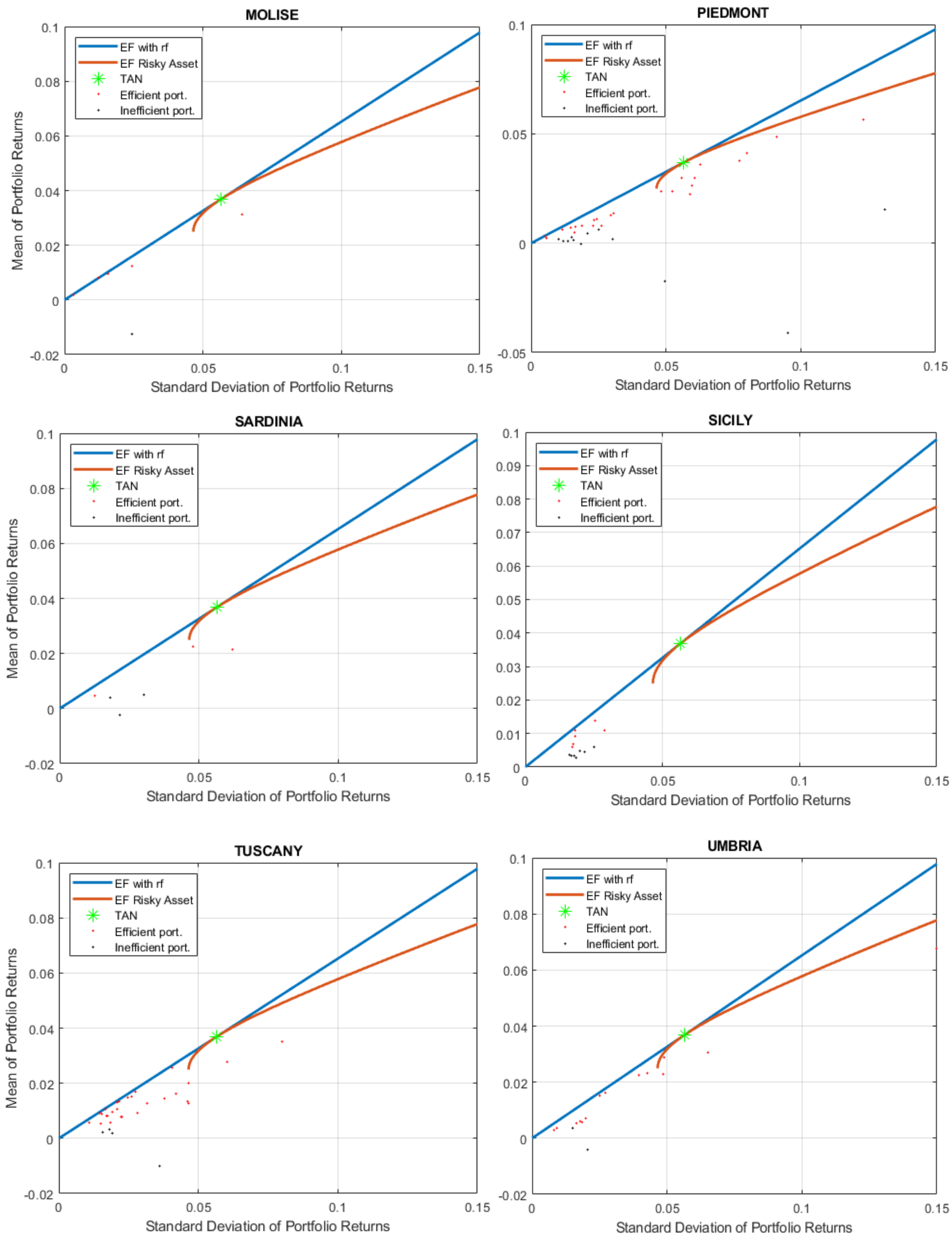

FRIULI VENEZIA GIULIA
EF with rf
EF Risky Asset
TAN
Efficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LAZIO
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LIGURIA
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


LOMBARDY
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns


MARCHE
EF with rf
EF Risky Asset
TAN
Efficient port.
Inefficient port.
Mean of Portfolio Returns
Standard Deviation of Portfolio Returns



Source: own elaboration on Eikon, OMI and SHIW 2016 dataset.

Note: Efficiency is set at 10% significance level following test results for portfolio efficiency reported in Chapter 3.

A10. Efficiency test results – SHIW 2012

a) Tables behind Figure 3.1

Table A10.a Efficiency test results when housing is an unconstrained asset (ξ_e)

Efficiency test results – Housing as unconstrained asset (ξ_e)						
	Main residence Owners (only)			**Main residence & Second homes owners**		
	# of efficient portfolios			# of efficient portfolios		
Test size	**10%**	**5%**	*Tot*	**10%**	**5%**	*Tot*
# households per region						
ABRUZZO (12)	0	0	*4*	0	0	*8*
AOSTA VALLEY (5)	2	3	*4*	0	0	*1*
APULIA (33)	16	17	*19*	7	13	*14*
BASILICATA (13)	0	0	*7*	0	0	*6*
CALABRIA (22)	5	7	*11*	2	8	*11*
CAMPANIA (21)	2	2	*18*	1	1	*3*
EMILIA ROM. (182)	5	6	*98*	0	3	*84*
FRIULI VEN. G. (39)	7	7	*19*	1	2	*20*
LAZIO (46)	1	4	*20*	2	5	*26*
LIGURIA (43)	22	23	*28*	13	13	*15*
LOMBARDY (237)	0	3	*107*	0	0	*130*
MARCHE (50)	2	21	*31*	2	10	*19*
MOLISE (3)	0	0	*2*	1	1	*1*
PIEDMONT (62)	0	12	*45*	1	4	*17*
SARDINIA (26)	0	1	*21*	0	0	*5*
SICILY (46)	9	10	*23*	10	15	*23*
TUSCANY (181)	92	100	*107*	60	69	*74*
UMBRIA (56)	2	5	*36*	0	0	*20*
VENETO (119)	0	0	*73*	0	0	*46*
Total (1196)	165	221	*673*	100	144	*523*

Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

Table A10.b Efficiency test results when housing is a constrained asset (ξ_1)

Efficiency test results – Conditional on housing (ξ_1)						
	Main residence Owners (only)			**Main residence & Second homes owners**		
	# of efficient portfolios			# of efficient portfolios		
Test size	**10%**	**5%**	*Tot*	**10%**	**5%**	*Tot*
# households per region						
ABRUZZO (12)	0	3	*4*	2	8	*8*
AOSTA VALLEY (5)	2	4	*4*	0	1	*1*
APULIA (33)	4	15	*19*	3	8	*14*
BASILICATA (13)	4	5	*7*	2	6	*6*
CALABRIA (22)	0	8	*11*	0	8	*11*
CAMPANIA (21)	3	4	*18*	0	2	*3*
EMILIA ROM. (182)	49	90	*98*	32	74	*84*
FRIULI VEN. G. (39)	14	17	*19*	14	17	*20*
LAZIO (46)	2	11	*20*	2	11	*26*
LIGURIA (43)	14	28	*28*	5	15	*15*
LOMBARDY (237)	71	93	*107*	100	124	*130*
MARCHE (50)	26	30	*31*	17	18	*19*
MOLISE (3)	2	2	*2*	1	1	*1*
PIEDMONT (62)	14	42	*45*	9	17	*17*
SARDINIA (26)	2	10	*21*	0	4	*5*
SICILY (46)	10	16	*23*	12	19	*23*
TUSCANY (181)	60	96	*107*	48	66	*74*
UMBRIA (56)	23	30	*36*	8	16	*20*
VENETO (119)	61	69	*73*	31	42	*46*
Total (1196)	361	573	*673*	286	457	*523*

Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

b) Table behind Figure 3.2

Efficiency test results				
	Housing as an unconstrained asset (ξ_e)		**Conditional on housing (ξ_1)**	
	# of efficient portfolios		# of efficient portfolios	
Test size	**10%**	**5%**	**10%**	**5%**
# households per region				
ABRUZZO (8)	0	0	5	8
AOSTA VALLEY (1)	0	0	1	1
APULIA (14)	9	11	5	11
BASILICATA (6)	0	0	3	5
CALABRIA (11)	5	7	4	9
CAMPANIA (3)	1	1	0	2
EMILIA ROM. (84)	4	4	54	78
FRIULI VEN. G. (20)	0	1	17	18
LAZIO (26)	8	12	10	21
LIGURIA (15)	12	12	8	15
LOMBARDY (130)	0	1	116	127
MARCHE (19)	2	11	19	19
MOLISE (1)	1	1	1	1
PIEDMONT (17)	0	3	10	17
SARDINIA (5)	0	0	2	4
SICILY (23)	10	12	16	20
TUSCANY (74)	53	57	59	70
UMBRIA (20)	0	2	13	18
VENETO (46)	0	0	38	43
Total (523)	105	135	381	487

Source: own elaboration on Eikon, OMI and SHIW 2012 datasets.

A11. Efficiency test results – SHIW 2016

Table A11.1 Efficiency test results when housing is an unconstrained asset (ξ_e)

Efficiency test results – Housing as unconstrained asset (ξ_e)						
	Main residence owners			**Main residence & Second homes owners**		
	# of efficient portfolios			# of efficient portfolios		
Test size	**10%**	**5%**	*Tot*	**10%**	**5%**	*Tot*
# households per region						
ABRUZZO (28)	0	2	*22*	0	0	*6*
AOSTA VALLEY (8)	3	4	*7*	1	1	*1*
APULIA (31)	16	18	*21*	7	8	*10*
BASILICATA (11)	0	0	*6*	0	0	*5*
CALABRIA (17)	2	9	*15*	1	1	*2*
CAMPANIA (37)	5	5	*29*	0	0	*8*
EMILIA ROM. (184)	2	3	*100*	2	2	*84*
FRIULI VEN. G. (32)	3	4	*18*	2	2	*14*
LAZIO (43)	4	11	*32*	0	2	*11*
LIGURIA (25)	10	10	*11*	13	14	*14*
LOMBARDY (170)	0	0	*88*	0	1	*82*
MARCHE (59)	9	15	*39*	2	7	*20*
MOLISE (11)	1	1	*5*	3	4	*6*
PIEDMONT (115)	3	25	*78*	1	7	*37*
SARDINIA (49)	2	9	*43*	0	0	*6*
SICILY (38)	10	15	*24*	6	11	*14*
TUSCANY (15)	99	105	*119*	28	31	*31*
UMBRIA (51)	2	5	*35*	0	2	*16*
VENETO (109)	0	0	*77*	0	0	*32*
Total (1168)	171	241	*769*	66	93	*399*

Source: own elaboration on Eikon, OMI and SHIW 2016 datasets.

Table A11.2 Efficiency test results when housing is a constrained asset (ξ_1)

Efficiency test results – Conditional on housing (ξ_1)						
	Main residence owners			**Main residence & Second homes owners**		
	# of efficient portfolios			# of efficient portfolios		
Test size	**10%**	**5%**	*Tot*	**10%**	**5%**	*Tot*
# households per region						
ABRUZZO (28)	9	20	*22*	3	4	*6*
AOSTA VALLEY (8)	5	6	*7*	0	1	*1*
APULIA (31)	4	18	*21*	4	9	*10*
BASILICATA (11)	3	5	*6*	1	3	*5*
CALABRIA (17)	4	8	*15*	1	2	*2*
CAMPANIA (37)	3	8	*29*	1	2	*8*
EMILIA ROM. (184)	56	92	*100*	53	71	*84*
FRIULI VEN. G. (32)	12	15	*18*	14	14	*14*
LAZIO (43)	1	13	*32*	3	6	*11*
LIGURIA (25)	4	11	*11*	6	14	*14*
LOMBARDY (170)	56	77	*88*	58	76	*82*
MARCHE (59)	35	37	*39*	18	19	*20*
MOLISE (11)	5	5	*5*	5	6	*6*
PIEDMONT (115)	46	71	*78*	17	32	*37*
SARDINIA (49)	3	13	*43*	1	1	*6*
SICILY (38)	12	21	*24*	6	13	*14*
TUSCANY (15)	93	111	*119*	24	30	*31*
UMBRIA (51)	21	31	*35*	9	13	*16*
VENETO (109)	66	76	*77*	28	30	*32*
Total (1168)	438	638	*769*	252	346	*399*

Source: own elaboration on Eikon, OMI and SHIW 2016 datasets.

Table A11.3 Efficiency test results

Efficiency test results				
	Housing as an unconstrained asset (ξ_e)		**Conditional on housing (ξ_1)**	
	# of efficient portfolios		# of efficient portfolios	
Test size	**10%**	**5%**	**10%**	**5%**
# households per region				
ABRUZZO (6)	0	1	4	4
AOSTA VALLEY (1)	0	1	1	1
APULIA (10)	4	5	8	9
BASILICATA (5)	0	0	3	4
CALABRIA (2)	1	1	1	2
CAMPANIA (8)	0	0	2	4
EMILIA ROM. (84)	1	1	64	76
FRIULI VEN. G. (14)	1	1	14	14
LAZIO (11)	1	2	4	8
LIGURIA (14)	10	11	10	14
LOMBARDY (81)	0	0	73	78
MARCHE (20)	1	5	19	20
MOLISE (6)	1	1	5	5
PIEDMONT (37)	1	7	25	34
SARDINIA (6)	1	1	3	5
SICILY (14)	6	8	6	14
TUSCANY (31)	22	25	27	30
UMBRIA (16)	1	1	14	15
VENETO (32)	0	0	30	31
Total (399)	51	71	313	368

Source: own elaboration on Eikon, OMI and SHIW 2016 datasets.

B. MATLAB codes for mean-variance analysis and efficiency tests.

In the following pages we report MATLAB codes implemented to conduct our empirical analysis described in chapter 2 and 3. For brevity, we show only the case in which housing wealth includes both main residence and second homes. We point out, however, that they work with a minor change also for the restrictive definition of housing wealth i.e. when it is composed by second homes only.

```
%% EFFICIENT FRONTIERS - FINANCIAL ASSETS
clear;
clc;
load 'fasset.mat'

fassets(1,:) = [];

rA=table2array(fassets(:,:));
rA=rA(6:end-2,:);
AM=mean(rA(:,3:5));
AV=cov(rA(:,3:5));


p= Portfolio('AssetMean',AM, 'AssetCovar',AV);
p = setDefaultConstraints(p);
p.LowerBound=[-1; -1; -1];
figure
plotFrontier(p, 100);
weights = estimateMaxSharpeRatio(p);
[risk, ret] = estimatePortMoments(p, weights);
hold on
plot(risk,ret,'*g');

p1= Portfolio('AssetMean',AM, 'AssetCovar',AV,'RiskFreeRate',0
p1 = setDefaultConstraints(p1);
p1=setBudget(p1,0,10);
p1.LowerBound=[-1; -1; -1];
xlim([0 0.25])
f=estimateFrontier(p1,100);
[risk, ret] = estimatePortMoments(p1, f);
plot(risk,ret,'--k')

btp = Portfolio('AssetMean',AM(1,1), 'AssetCovar',AV(1,1));
btp = setDefaultConstraints(btp);
weights1 = estimateMaxSharpeRatio(btp);
[risk, ret] = estimatePortMoments(btp, weights1);
scatter (risk,ret,'filled','m')

corp = Portfolio('AssetMean',AM(1,2), 'AssetCovar',AV(2,2));
corp = setDefaultConstraints(corp);
weights = estimateMaxSharpeRatio(corp);
[risk, ret] = estimatePortMoments(corp, weights);
scatter (risk,ret,'filled','r')

stock = Portfolio('AssetMean',AM(1,3), 'AssetCovar',AV(3,3));
stock = setDefaultConstraints(stock);
weights = estimateMaxSharpeRatio(stock);
```

```
[risk, ret] = estimatePortMoments(stock, weights);
scatter (risk,ret,'filled','c')
title ('Efficent frontier-financial assets')
legend('EF risky ass.', 'TAN','EF with rf', 'L-T GOV BOND', 'CORP
BOND','STOCK','location','best')
hold off

% PLOT Household portfolios (financial assets only)

load ammontari.mat

hasset=table2array(ammontari(:,[2 3 4 5 7 8 9 31]));
G=any(hasset(:,2:4),2);
hasset=hasset(G,:);
hasset(:,2)=hasset(:,2)
hasset(:,3)=hasset(:,3)-hasset(:,6)+hasset(:,7)./2;
hasset(:,4)=hasset(:,4)+hasset(:,7)./2;
hasset=hasset(:,[1 2 3 4 8]);


for i=1:size(hasset,1)
    for e=1:size(hasset,2)-1
        W(i,e)=hasset(i,e)./sum(hasset(i,1:end-1));
    end
end

sechouse=W(any(hasset(:,5),2),2:4);
nosechouse=W(not(any(hasset(:,5),2)),2:4);
household=W(:,2:4);



figure
household=household';
[risk, ret] = estimatePortMoments(p, household(:,:));
plot(risk,ret,'*k','MarkerSize',1);
hold on

p= Portfolio('AssetMean',AM, 'AssetCovar',AV);
p = setDefaultConstraints(p);
p.LowerBound=[-1; -1; -1];

plotFrontier(p, 100);
weights1 = estimateMaxSharpeRatio(p);
[risk, ret] = estimatePortMoments(p, weights1);

plot(risk,ret,'*g','MarkerSize',10);

p1= Portfolio('AssetMean',AM, 'AssetCovar',AV,'RiskFreeRate',0);
p1 = setDefaultConstraints(p1);
p1.LowerBound=[-1; -1; -1];
p1=setBudget(p1,0,10);
xlim([0 0.25])
f=estimateFrontier(p1,100);
[risk, ret] = estimatePortMoments(p1, f);
plot(risk,ret,'--k')

btp = Portfolio('AssetMean',AM(1,1), 'AssetCovar',AV(1,1));
btp = setDefaultConstraints(btp);
weights = estimateMaxSharpeRatio(btp);
[risk, ret] = estimatePortMoments(btp, weights);
scatter (risk,ret,'filled','m')
```

```
corp = Portfolio('AssetMean',AM(1,2), 'AssetCovar',AV(2,2));
corp = setDefaultConstraints(corp);
weight = estimateMaxSharpeRatio(corp);
[risk, ret] = estimatePortMoments(corp, weights);
scatter (risk,ret,'filled','r')

stock = Portfolio('AssetMean',AM(1,3), 'AssetCovar',AV(3,3));
stock = setDefaultConstraints(stock);
weights = estimateMaxSharpeRatio(stock);
[risk, ret] = estimatePortMoments(stock, weights);
scatter (risk,ret,'filled','c')

legend('Households','EF risky ass.', 'TAN','EF with rf', 'L-T GOV BOND',
'CORP BOND','STOCK','location','best')

xlim ([0,0.25]);

hold off



%% EFFICIENT FRONTIER- HOUSE AS AN ASSET (2012)

clear
clc
load ammontari.mat
f={'ABRUZZO','BASILICATA','CALABRIA','CAMPANIA','EMILIA ROMAGNA','FRIULI
VENEZIA
GIULIA','LAZIO','LIGURIA','LOMBARDY','MARCHE','MOLISE','PIEDMONT','APULIA',
'SARDINIA','SICILY','TUSCANY','UMBRIA','AOSTA VALLEY','VENETO'};

for k=1:19
  clear W S G hasset risk ret

hasset=table2array(ammontari);
hasset=hasset(:,2:end);
j=any(hasset(:,10+k),2);
hasset=hasset(j,:);
G=any(hasset(:,2:4),2);
hasset=hasset(G,:);
l=any(hasset(:,5),2);
hasset=hasset(l,:);
hasset(:,2)=hasset(:,2)-hasset(:,6);
hasset(:,3)=hasset(:,3)-hasset(:,7)+hasset(:,8)./2;
hasset(:,4)=hasset(:,4)+hasset(:,8)./2;
hasset=hasset(:,[1 2 3 4 5 30]);

nfam(:,k)=size(hasset,1);
if size(hasset,1)==0
else

for i=1:size(hasset,1)
    for e=1:size(hasset,2)-1
        W(i,e)=hasset(i,e)./sum(hasset(i,1:end-1));
    end
end

sechouse=W(any(hasset(:,6),2),2:5);
nosechouse=W(not(any(hasset(:,6),2)),2:5);
```

```
d=xlsread('f_assets.xlsx','LO');
rA=d(6:19,:);

rOMI=xlsread('OMI.xlsx','exNc5');
rA=[rA ,rOMI(:,k+1)];


AM=mean(rA(:,3:6));
AV=cov(rA(:,3:6));


p= Portfolio('AssetMean',AM, 'AssetCovar',AV,'RiskFreeRate',0);
p = setDefaultConstraints(p);
p.LowerBudget=0;
p.UpperBudget=15;
p.LowerBound=[-1; -1; -1; 0]

p1= Portfolio('AssetMean',AM, 'AssetCovar',AV);
p1 = setDefaultConstraints(p1);
p1.LowerBound=[-1; -1; -1; 0];
figure
plotFrontier(p, 200);
hold on
plotFrontier(p1, 200);
weights = estimateMaxSharpeRatio(p1);
[risk, ret] = estimatePortMoments(p1, weights);
plot(risk,ret,'*g','MarkerSize',10)

pesiTAN(:,k)=weights

house = Portfolio('AssetMean',AM(1,4), 'AssetCovar',AV(4,4));
house = setDefaultConstraints(house);
weights = estimateMaxSharpeRatio(house);
[risk, ret] = estimatePortMoments(house, weights);
scatter(risk,ret,'filled','y')

% Households' portfolios
title([ f(:,k)]);
xlim([0 0.14]); %3 persone fuori dal 0.15
if size(sechouse,1)~=0
sechouse=sechouse';
[risk, ret] = estimatePortMoments(p, sechouse(:,:));
plot(risk,ret,'*r','MarkerSize',1);
else
end
if size(nosechouse,1)~=0
nosechouse=nosechouse';
[risk, ret] = estimatePortMoments(p, nosechouse(:,:));
plot(risk,ret,'*k','MarkerSize',1);
legend({'EF with Risk Free','EF Risky Asset','TAN','House','Household-
Second homes','Household-No Second homes'},'Location','northwest')
hold off
else
end

end

end
nfam(:,20)=sum(nfam);
```

```
%% EFFICIENT FRONTIER NET OF HEDGE TERM
%anno 2012
clear all
clc
f={'ABRUZZO','BASILICATA','CALABRIA','CAMPANIA','EMILIA ROMAGNA','FRIULI
VENEZIA
GIULIA','LAZIO','LIGURIA','LOMBARDY','MARCHE','MOLISE','PIEDMONT','APULIA',
'SARDINIA','SICILY','TUSCANY','UMBRIA','AOSTA VALLEY','VENETO'};

load v1.mat
load test.mat
for k=1:19
    v1s=v1S(v1S==k,2:end);
    v1ns=v1NS(v1NS==k,2:end);
    ineffR=ineffS(ineffS(:,1)==k,:);
    ineffRN=ineffNS(ineffNS(:,1)==k,:);

pS1=Portfolio('AssetMean',AM(1,1:3),'AssetCovar',SIGMA,'RiskFreeRate',0);
pS1 = setDefaultConstraints(pS1);
pS1.LowerBudget=0;
pS1.UpperBudget=15;
pS1.LowerBound=[-1;-1;-1];

pS=Portfolio('AssetMean',AM(1,1:3),'AssetCovar',SIGMA);
pS = setDefaultConstraints(pS);
pS.UpperBudget=1;
pS.LowerBound=[-1;-1;-1];

figure
plotFrontier(pS1, 200);
hold on
plotFrontier(pS, 200);
weights = estimateMaxSharpeRatio(pS);
[risk, ret] = estimatePortMoments(pS, weights);
plot(risk,ret,'*g','MarkerSize',10)

g=any(ineffR(:,3),2);
j=any(ineffRN(:,3),2);

title([ f(:,k)]);
xlim([0 0.15]);
v1ss=v1s';
if size(v1s(g,:),1)~=0

[risk, ret] = estimatePortMoments(pS1, v1ss(:,g));
plot(risk,ret,'*r','MarkerSize',2);
else
end

title([ f(:,k)]);
xlim([0 0.15]);
if size(v1s(~g,:),1)~=0
[risk, ret] = estimatePortMoments(pS1, v1ss(:,~g));
plot(risk,ret,'*m','MarkerSize',2);
else
end

title([f(:,k)]);
xlim([0 0.15]);
v1ss=v1ns';
if size(v1ns(j,:),1)~=0
```

```
[risk, ret] = estimatePortMoments(pS1, v1ss(:,j));
plot(risk,ret,'*k','MarkerSize',2);
else
end

title([ f(:,k)]);
xlim([0 0.15]);
if size(v1ns(~j,:),1)~=0
[risk, ret] = estimatePortMoments(pS1, v1ss(:,~j));
plot(risk,ret,'*b','MarkerSize',2);
legend({'EF with rf','EF Risky','TAN','Eff port.SEC','Inef port.SEC','Eff
port.NOSEC','Inef port.NOSEC'},'Location','northwest')
else
end
end

%% EFFICIENCY TEST-HOUSING AS AN ASSET
clear
clc
load ammontari.mat
f={'ABRUZZO','BASILICATA','CALABRIA','CAMPANIA','EMILIA ROMAGNA','FRIULI
VENEZIA
GIULIA','LAZIO','LIGURIA','LOMBARDY','MARCHE','MOLISE','PIEDMONT','APULIA',
'SARDINIA','SICILY','TUSCANY','UMBRIA','AOSTA VALLEY','VENETO'};
N=0;
M=0;
for k=1:19
  clear W S G hasset
hasset=table2array(ammontari);
hasset=hasset(:,2:end);
j=any(hasset(:,10+k),2);
hasset=hasset(j,:);
G=any(hasset(:,2:4),2);
hasset=hasset(G,:);
l=any(hasset(:,5),2);
hasset=hasset(l,:);
hasset(:,2)=hasset(:,2)-hasset(:,6);
hasset(:,3)=hasset(:,3)-hasset(:,7)+hasset(:,8)./2;
hasset(:,4)=hasset(:,4)+hasset(:,8)./2;
hasset=hasset(:,[1 2 3 4 5 30]);

nfam(:,k)=size(hasset,1);

if size(hasset,1)==0
else
for i=1:size(hasset,1)
    for e=1:size(hasset,2)-1
        W(i,e)=hasset(i,e)./sum(hasset(i,1:end-1));
    end
end

sechouse=W(any(hasset(:,6),2),2:5)';
nosechouse=W(not(any(hasset(:,6),2)),2:5)';

d=xlsread('f_assets.xlsx','LO');
rA=d(6:19,:);
rOMI=xlsread('OMI.xlsx','Exc_Rncap');
rA=[rA ,rOMI(:,k+1)+0.05];

AM=mean(rA(:,3:6));
AV=cov(rA(:,3:6));
```

```
if size(sechouse,2)==0 | size(sechouse,1)==0
else
for z=1:size(sechouse,2)
%GJ TEST
OMEGA=AV
x0=sechouse(1:3,z);
h0=sechouse(4,z);
v1=[(x0') h0]' ;
Z=v1;
v1S(z+N,1)=k;
v1S(z+N,2:5)=v1;

S1a=((AM*Z)^2)/(Z'*OMEGA*Z) ;

Sa=AM*inv(OMEGA)*AM'

T=14
csi=T*(Sa-S1a)/(1+S1a)

SecondH(z+N,1)=k;
SecondH(z+N,2)=csi;
SecondH(z+N,3)= csi<chi2inv(0.9,3);
SecondH(z+N,4)= csi<chi2inv(0.95,3);
SecondH(z+N,5)= csi<chi2inv(0.80,3);
end
end

if size(nosechouse,2)==0 | size(nosechouse,1)==0
else
for z=1:size(nosechouse,2)

OMEGA=AV
x0=nosechouse(1:3,z);
h0=nosechouse(4,z);
v1=[(x0') h0]' ;
Z=v1;
v1NS(z+M,1)=k;
v1NS(z+M,2:5)=v1;

S1a=((AM*Z)^2)/(Z'*OMEGA*Z) ;

Sa=AM*inv(OMEGA)*AM'

T=14
csi=T*(Sa-S1a)/(1+S1a)

NoSecondH(z+M,1)=k;
NoSecondH(z+M,2)=csi;
NoSecondH(z+M,3)= csi<chi2inv(0.9,3);
NoSecondH(z+M,4)= csi<chi2inv(0.95,3);
NoSecondH(z+M,5)= csi<chi2inv(0.80,3);
end
end

N=N+size(sechouse,2);
M=M+size(nosechouse,2);
end
end

v1s=v1S'
pS1=Portfolio('AssetMean',AM,'AssetCovar',AV,'RiskFreeRate',0);
```

```
pS1 = setDefaultConstraints(pS1);
pS1.LowerBudget=0;
pS1.UpperBudget=15;
pS1.LowerBound=[-1;-1;-1];
[risk, ret] = estimatePortMoments(pS1, v1s(2:5,:));
ineffS=SecondH;
ineffS(ret<0,3:5)=0;

v1Ns=v1NS'
[risk, ret] = estimatePortMoments(pS1, v1Ns(2:5,:));
ineffNS=NoSecondH;
ineffNS(ret<0,3:5)=0;

for k=1:19
  h=SecondH(:,1)==k;
  nP(:,1)=nnz(SecondH(h,3));
  nP(:,2)=nnz(SecondH(h,4));
  nP(:,3)=nnz(SecondH(h,5));
  NumPosSec(k,:)=nP
end

for k=1:19
  c=ineffS(:,1)==k;
  nIP(:,1)=nnz(ineffS(c,3));
  nIP(:,2)=nnz(ineffS(c,4));
  nIP(:,3)=nnz(ineffS(c,5));
  NumPosInefS(k,:)=nIP
end

for k=1:19
  h=NoSecondH(:,1)==k;
  nP(:,1)=nnz(NoSecondH(h,3));
  nP(:,2)=nnz(NoSecondH(h,4));
  nP(:,3)=nnz(NoSecondH(h,5));
  NumPosNoSec(k,:)=nP
end

for k=1:19
  c=ineffNS(:,1)==k;
  nIP(:,1)=nnz(ineffNS(c,3));
  nIP(:,2)=nnz(ineffNS(c,4));
  nIP(:,3)=nnz(ineffNS(c,5));
  NumPosInefNS(k,:)=nIP
end

TotSecEff(:,1)=sum(NumPosSec(:,1))
TotSecEff(:,2)=sum(NumPosSec(:,2))
TotSecEff(:,3)=sum(NumPosSec(:,3))

TotNoSecEff(:,1)=sum(NumPosNoSec(:,1))
TotNoSecEff(:,2)=sum(NumPosNoSec(:,2))
TotNoSecEff(:,3)=sum(NumPosNoSec(:,3))

TotIneffS(:,1)=sum(NumPosInefS(:,1))
TotIneffS(:,2)=sum(NumPosInefS(:,2))
TotIneffS(:,3)=sum(NumPosInefS(:,3))

TotIneffNS(:,1)=sum(NumPosInefNS(:,1))
TotIneffNS(:,2)=sum(NumPosInefNS(:,2))
TotIneffNS(:,3)=sum(NumPosInefNS(:,3))
```

```
% EFFICIENCY TEST CONDITIONAL ON HOUSING-REGIONAL LEVEL
%Effciency test: 90% 95% 80%
clear all
clc
load ammontari.mat
f={'Abruzzo','Basilicata','Calabria','Campania','Emilia Romagna','Friuli
Venezia
Giulia','Lazio','Liguria','Lombardia','Marche','Molise','Piemonte','Puglia'
,'Sardegna','Sicilia','Toscana','Umbria','Val Aosta','Veneto'};
N=0;
M=0;
for k=1:19
  clear W S G hasset
hasset=table2array(ammontari);
hasset=hasset(:,2:end);
j=any(hasset(:,10+k),2);
hasset=hasset(j,:);
G=any(hasset(:,2:4),2);
hasset=hasset(G,:);
l=any(hasset(:,5),2);
hasset=hasset(l,:);
hasset(:,2)=hasset(:,2)-hasset(:,6);
hasset(:,3)=hasset(:,3)-hasset(:,7)+hasset(:,8)./2;
hasset(:,4)=hasset(:,4)+hasset(:,8)./2;
hasset=hasset(:,[1 2 3 4 5 30]);

nfam(:,k)=size(hasset,1);

if size(hasset,1)==0
else
for i=1:size(hasset,1)
    for e=1:size(hasset,2)-1
        W(i,e)=hasset(i,e)./sum(hasset(i,1:end-1));
    end
end

sechouse=W(any(hasset(:,6),2),2:5)';
nosechouse=W(not(any(hasset(:,6),2)),2:5)';

d=xlsread('f_assets.xlsx','LO');
rA=d(6:19,:);
rOMI=xlsread('OMI.xlsx','Exc_Rncap');
rA=[rA ,rOMI(:,k+1)+0.05];

AM=mean(rA(:,3:6));
AV=cov(rA(:,3:6));
if size(sechouse,2)==0 | size(sechouse,1)==0
else
for z=1:size(sechouse,2)
%GJ TEST
SIGMA=AV(1:3,1:3);
LAMBDAbP=AV(1:3,4);
x0=sechouse(1:3,z);
h0=sechouse(4,z);
v1= x0 + h0*inv(SIGMA)*LAMBDAbP ;
Z=[(x0') h0]' ;
v1S(z+N,1)=k;
v1S(z+N,2:4)=v1;

S1a=((AM(1,1:3)*v1)^2)/(v1'*SIGMA*v1) ;

Sa=AM(1,1:3)*inv(SIGMA)*AM(1,1:3)'
```

```
T=14
csi=T*(Sa-S1a)/(1+S1a*((Z'*AV*Z)/(v1'*SIGMA*v1)))

SecondH(z+N,1)=k;
SecondH(z+N,2)=csi;
SecondH(z+N,3)= csi<chi2inv(0.9,2);
SecondH(z+N,4)= csi<chi2inv(0.95,2);
SecondH(z+N,5)= csi<chi2inv(0.80,2);
end
end

if size(nosechouse,2)==0 | size(nosechouse,1)==0
else
for z=1:size(nosechouse,2)

SIGMA=AV(1:3,1:3);
LAMBDAbP=AV(1:3,4);
x0=nosechouse(1:3,z);
h0=nosechouse(4,z);
v1= x0 + h0*inv(SIGMA)*LAMBDAbP
Z=[(x0') h0]'

v1NS(z+M,1)=k;
v1NS(z+M,2:4)=v1;

S1a=((AM(1,1:3)*v1)^2)/(v1'*SIGMA*v1) ;

Sa=AM(1,1:3)*inv(SIGMA)*AM(1,1:3)'

T=14
csi=T*(Sa-S1a)/(1+S1a*((Z'*AV*Z)/(v1'*SIGMA*v1)))

NoSecondH(z+M,1)=k;
NoSecondH(z+M,2)=csi;
NoSecondH(z+M,3)= csi<chi2inv(0.9,2);
NoSecondH(z+M,4)= csi<chi2inv(0.95,2);
NoSecondH(z+M,5)= csi<chi2inv(0.80,2);

end
end

N=N+size(sechouse,2);
M=M+size(nosechouse,2);
end
end

v1s=v1S'
pS1=Portfolio('AssetMean',AM(1,1:3),'AssetCovar',SIGMA,'RiskFreeRate',0);
pS1 = setDefaultConstraints(pS1);
pS1.LowerBudget=0;
pS1.UpperBudget=15;
pS1.LowerBound=[-1;-1;-1];
[risk, ret] = estimatePortMoments(pS1, v1s(2:4,:));
ineffS=SecondH;
ineffS(ret<0,3:5)=0;

v1Ns=v1NS'
[risk, ret] = estimatePortMoments(pS1, v1Ns(2:4,:));
ineffNS=NoSecondH;
ineffNS(ret<0,3:5)=0;
```

```
save v1.mat v1S v1NS SIGMA LAMBDAbP AM

for k=1:19
  h=SecondH(:,1)==k;
  nP(:,1)=nnz(SecondH(h,3));
  nP(:,2)=nnz(SecondH(h,4));
  nP(:,3)=nnz(SecondH(h,5));
  NumPosSec(k,:)=nP
end
for k=1:19
  c=ineffS(:,1)==k;
  nIP(:,1)=nnz(ineffS(c,3));
  nIP(:,2)=nnz(ineffS(c,4));
  nIP(:,3)=nnz(ineffS(c,5));
  NumPosInefS(k,:)=nIP
end

for k=1:19
  h=NoSecondH(:,1)==k;
  nP(:,1)=nnz(NoSecondH(h,3));
  nP(:,2)=nnz(NoSecondH(h,4));
  nP(:,3)=nnz(NoSecondH(h,5));
  NumPosNoSec(k,:)=nP
end
for k=1:19
  c=ineffNS(:,1)==k;
  nIP(:,1)=nnz(ineffNS(c,3));
  nIP(:,2)=nnz(ineffNS(c,4));
  nIP(:,3)=nnz(ineffNS(c,5));
  NumPosInefNS(k,:)=nIP
end

TotSecEff(:,1)=sum(NumPosSec(:,1))
TotSecEff(:,2)=sum(NumPosSec(:,2))
TotSecEff(:,3)=sum(NumPosSec(:,3))

TotNoSecEff(:,1)=sum(NumPosNoSec(:,1))
TotNoSecEff(:,2)=sum(NumPosNoSec(:,2))
TotNoSecEff(:,3)=sum(NumPosNoSec(:,3))

TotIneffS(:,1)=sum(NumPosInefS(:,1))
TotIneffS(:,2)=sum(NumPosInefS(:,2))
TotIneffS(:,3)=sum(NumPosInefS(:,3))

TotIneffNS(:,1)=sum(NumPosInefNS(:,1))
TotIneffNS(:,2)=sum(NumPosInefNS(:,2))
TotIneffNS(:,3)=sum(NumPosInefNS(:,3))
```