FINANCIAL DECISION-MAKING AND PORTFOLIO CHOICE UNDER BEHAVIORAL PREFERENCES: IMPLICATIONS FOR THE EQUITY HOME BIAS PUZZLE

Alessandro Magi*

April 28, 2005

Abstract

The aim of this paper is to provide a plausible explanation of aggregate portfolio behavior, within a framework where economic agents have behavioral preferences (*prospect-type* utility). The idea is that representative agent derives utility not only from consumption (as in "standard" models) but also from financial (stock) wealth fluctuations. Moreover, the investor frames the stock market risk narrowly and has loss averse preferences. This agent makes sub-optimal choices and therefore it is possible to explain, for example, the equity home bias puzzle. Only economic agents able to process information deriving from stock markets correctly, exploit the diversification opportunities provided by international financial markets. For the italian case, this outcome is also confirmed by empirical analyses at the household level. At the best of our knowledge, the present paper is the first one to obtain the outcome described above under *narrow framing* preferences.

* Department of Statistics, University of Bologna and Department of Economics, University of Rome "La Sapienza". E-mail: magi@rimini.unibo.it. Address: University of Bologna (at Rimini), Faculty of Statistics, Piazza Teatini 10, 47900 Rimini, Italy.
I am grateful to Luigi Ventura, Attilio Gardini, Giorgio Calcagnini and Sergio Bruno for helpful comments. I especially thank Paolo Foschi for your help with MatLab codes in the numerical solution of the model.

1
Introduction

In the asset pricing literature there exist since '70s the so called equity home bias puzzle. What is it? Standard portfolio theory (mean/variance models) states that it would be optimal for investors to hold a large fraction of their equity portfolio invested in foreign stocks. In fact, empirical evidence shows that the most important components of household equity portfolios are domestic stocks.[1] Standard theory argues that portfolios with less foreign stocks are dominated (in terms of risk/return trade-off) by portfolios with more foreign stocks. Moreover, there is another reason for holding foreign over-weighted portfolios. Domestic equity returns are weakly correlated with foreign equity returns and hence, given the basics of portfolio diversification theory, it would be more convenient for economic agents to hold a larger fraction of foreign assets.

But available empirical evidence is in contrast with what the theory predicts. Most countries hold just a small share of foreign stocks in their equity portfolios. In particular, French-Poterba (1991) and Tesar-Werner (1995) estimated the percentage of aggregate stock market wealth invested in domestic equities in the beginning of the 1990s to have been well above 90% for US and Japan,[2] and around 80% for UK and Germany.[3]

Cooper-Kaplanis (1986) argue that the equity home bias there is also in small countries. They estimated, for Netherlands and Switzerland, a share of domestic assets equal, respectively, to 56.5% and 65% of the total stock wealth; in a more recent paper, Cooper-Kaplanis (1994), the same authors estimated that domestic equity investment, as a fraction of the total equity portfolio, ranges from 65% in France to near 100% in Sweden. And the large home bias found in small countries is a particularly puzzling fact, because small countries, whose equities comprise a small fraction of the global mean-variance efficient portfolio, presumably have the most to gain from international diversification. During the '90s the foreign equity participation by US investors has increased: Tesar-Werner (1998) show that in 1996 only around 10% of total US equity holdings was invested abroad. But this level, if compared with what theoretical models predict, is too low.

In the literature, many and different explanations have been provided about this puzzle. Lewis (1999) offers an extensive survey of potential explanations, ranging from the possibility for domestic stocks to better hedge

[1] See the seminal contributions by Levy-Sarnat (1970), Solnik (1974) and French-Poterba (1991); for recent exhaustive review articles see Lewis (1999) and Obstfeld-Rogoff (2000).

[2] To be precise, 94% for USA and 98% for Japan (French-Poterba, 1991).

[3] We note that this phenomenon in financial asset holdings, as documented by Golub (1990) and Tesar-Werner (1995), is also present in the bond market.

home risks than foreign stocks, the presence of non-tradable consumption goods, diversification costs exceeding the gains, the effects of uncertainty about the economic environment and the role of measurement errors in the data. But Lewis concludes that "*overall, equity home bias in portfolio levels remains a puzzle*". In other words, economists agree about the fact that, at the moment, no explanation is conclusive and fully satisfactory.

On the other hand, if we have a look at the microeconomic data, we can see that the situation is unchanged. In recent years, in different countries, many surveys that collect data at the household level have been available. Consider the italian case: from the analysis of the data of the Bank of Italy (*Survey on Household Income and Wealth*, henceforth SHIW), among others things, it emerges a clear fact. The foreign financial investments are very low and they represent only a small fraction of investors' risky financial portfolio (in 2002 about the 2% of total risky financial assets).[4] But we want to highlight that those who invest abroad are graduates, mostly. See Tables 1, 2 and 3. It is clear that graduates also invest the major part of their stock wealth in domestic assets, but however they are a category that holds a portfolio with a not negligible share of foreign assets. And, more important, we can see that, as the education level raises, both the investment in foreign assets and the foreign market participation increase (for the percentages of stock market participation see Tables 4, 5 and 6).

Composition (%) – "Risky" Portfolio

	<Secondary school	Secondary school	High school	Degree
Domestic equities	8,10	14,36	19,61	19,22
Domestic funds	22,28	29,67	21,64	30,13
Managed assets	18,30	12,77	25,81	15,51
Bonds	10,13	10,09	5,90	16,58
T-bills	40,51	32,31	25,36	16,58
Foreign equities	0,22	0,32	0,49	0,58
Bonds+Foreign funds	0,44	0,48	1,14	1,28
Other foreign assets	0,03	0,00	0,06	0,14
Total foreign assets	0,68	0,80	1,68	1,99
Total risky portfolio	**100,00**	**100,00**	**100,00**	**100,00**

Table 1 – 1998 Data – Education - (Our elaboration)

[4] Our elaboration based on SHIW data. We are assuming that a portfolio with all financial assets, with the exclusion of monetary assets, is a good proxy for the "virtual" household risky financial portfolio.

Composition (%) – "Risky" Portfolio

	<Secondary school	Secondary school	High school	Degree
Domestic equities	16,20	14,58	24,18	20,40
Domestic funds	24,20	30,02	24,86	31,54
Managed assets	8,27	10,27	14,57	14,19
Bonds	4,43	6,32	10,51	10,57
T-bills	46,59	37,70	24,07	18,76
Foreign equities	0,24	0,22	0,90	0,83
Bonds+Foreign funds	0,05	0,55	0,74	1,06
Other foreign assets	0,03	0,35	0,18	2,65
Total foreign assets	0,32	1,12	1,82	4,54
Total risky portfolio	**100,00**	**100,00**	**100,00**	**100,00**

Table 2 – 2000 Data – Education - (Our elaboration)

Composition (%) – "Risky" Portfolio

	<Secondary school	Secondary school	High school	Degree
Domestic equities	8,14	14,85	23,27	16,50
Domestic funds	16,81	20,71	21,92	15,57
Managed assets	12,13	15,78	7,47	17,91
Bonds	25,26	24,43	24,59	24,40
T-bills	37,24	23,29	21,00	21,42
Foreign equities	0,42	0,32	0,42	1,29
Bonds+Foreign funds	0,00	0,62	1,09	2,65
Other foreign assets	0,00	0,00	0,24	0,26
Total foreign assets	0,42	0,94	1,75	4,20
Total risky portfolio	**100,00**	**100,00**	**100,00**	**100,00**

Table 3 - 2002 Data – Education - (Our elaboration)

Participation (%) for category

	<Secondary school	Secondary school	High school	Degree	
Foreign equities	0,09	0,17	0,78	1,73	
Bonds+Foreign funds	0,06	0,17	0,65	1,86	
Other foreign assets	0,07	0,00	0,07	0,17	
Foreign fin assets	0,16	0,28	1,21	3,20	
Fract. of Households (%)	34,71	26,73	29,87	8,70	**100,00**

Table 4 – 1998 Data – Education - (Our elaboration)

Participation (%) for category

	<Secondary school	Secondary school	High school	Degree	
Foreign equities	0,07	0,16	0,78	3,45	
Bonds+Foreign funds	0,04	0,51	0,70	2,59	
Other foreign assets	0,03	0,13	0,26	0,40	
Foreign fin assets	0,11	0,80	1,56	4,64	
Fract. of Households (%)	33,37	27,64	29,82	9,17	**100,00**

Table 5 – 2000 Data – Education - (Our elaboration)

Participation (%) for category

	<Secondary school	Secondary school	High school	Degree	
Foreign equities	0,05	0,37	0,49	1,38	
Bonds+Foreign funds	0,00	0,41	1,13	2,78	
Other foreign assets	0,00	0,00	0,18	0,04	
Foreign fin assets	0,05	0,76	1,66	3,75	
Fract. of Households (%)	32,25	28,41	30,32	9,02	**100,00**

Table 6 – 2002 Data – Education - (Our elaboration)

But the very interesting thing is the fact that the empirical evidence described above consistently provides a strong support to the basic theoretical arguments of some recent portfolio models developed in a Behavioral Finance context. As we will see better in the present paper, this is especially true for portfolio models which adopt the so-called "BH preferences". Exploiting this line of research, we will argue that in particular people with poor capabilities of processing information do not diversify their financial investments at all. And it is reasonable to suppose that, among people with poor capabilities of processing information, we find in particular people with a low level of education, while those with a higher level of education (an undergraduate degree or more) have higher capabilities. But for understanding in detail what we are discussing, it is necessary to proceed "step by step".

What do we mean with the term Behavioral Finance? It is a recent and growing line of research which attempts to explain some financial economics topics using models with non-fully rational economic agents. Starting by some experimental investigations related to the psychology of investors, behavioral models introduce, through different approaches, the concept of bounded rationality, which implies a number of interesting implications. Here, without providing a complete review of these contributions, we briefly present those useful to the goals of our work.[5]

In section 2 we briefly see one of such contribution, particularly relevant for our purposes: the so-called BHS model. This model represents the conceptual basis of what we will see in the next sections and it will be very useful for getting used to some typical mechanisms of behavioral finance models. In the third section we discuss the conceptual basics of these models, finding the origins of such basics in the applied psychology literature. Section 4 presents in brief the so-called BH model, which is, under different aspects, an evolution of BHS model. In section 5, adopting the preferences introduced in the BH approach, we build and solve a simple international portfolio choice model in order to investigate and explain the equity home bias puzzle. The most important outcomes and implications of the model are presented and discussed in section 6. Finally, section 7 concludes the paper.

2
Utility functions and financial wealth fluctuations

In attempting to build a model for matching empirical evidence, Barberis-Huang-Santos (2001)[6] propose a new approach, avoiding to go on further with the refinement of standard consumption-based capital asset pricing models (C-CAPM models), with or without the habit formation hypothesis.[7] They propose a new source of utility for the representative

---

[5] For a complete survey of behavioral finance contributions see Barberis-Thaler (2003); for a review specifically focused on aggregate stock market behavior see Stracca (2002a).
[6] Henceforth BHS.
[7] For a survey about these topics see Campbell (2003), Kocherlakota (1996) and Campbell-Cochrane (1999).

agent, besides the usual one, consumption. The basic idea is the following: economic agents derive direct utility not only from consumption but also from fluctuations in the value of their financial wealth. And such fluctuations heavily affect investors' risk aversion, independently from their correlation with consumption growth. This idea has its origins in the seminal contribution by Kahneman-Tversky (1979), which introduced the so-called *prospect theory*, based on prospect-type utility: economic agent derives utility not from consumption/wealth levels but from their changes, evaluated with respect to a reference level. Therefore, utility function is defined on gains and losses. In its most simple version, it is as follows:

$$U(x) = \begin{cases} x & \text{if} \quad x \geq 0 \\ \lambda x & \phantom{\text{if}} \quad x < 0 \end{cases} \qquad \lambda > 1$$

Note that this functional form also captures the so-called *loss aversion*, i.e. the fact that the agent is more sensitive to reductions in his wealth rather than increases of the same magnitude. We can easily verify that

$$\frac{dU(x)}{dx} = 1 \text{ if } x \geq 0 \qquad \frac{dU(x)}{dx} = \lambda > 1 \text{ if } x < 0.$$

Obviously, this approach is in contrast with standard asset pricing models, which assume that in making their portfolio choices, economic agents only care of their future utility deriving from consumption levels. But now, in the economic literature there are many contributions that, by means of theoretical arguments and experimental works, show that standard explanations of individual attitudes towards risk are widely questionable and often wrong (see Rabin, 1998, 2002). As stressed by Rabin (2002), "….*Our attitudes towards risk are driven instead primarily by attitudes towards change in wealth levels*." In the BHS approach the motivating idea is that after a big loss in the stock market, consumer/investor may experience a sense of regret over his decision to invest in stocks. As a consequence, "*he may interpret this loss as a sign that he is a second-rate investor, thus dealing his ego a painful blow; and he may feel humiliation in front of friends and family when word leaks out*" (BHS, 2001).

The BHS model is set in a Lucas (1978) framework: we are in a pure exchange economy, with no labor income. Here we present a very short version of this model, in order to see only its fundamental features.[8] As often done in the literature, we assume the presence of two financial assets: a risky asset (stock) with gross rate of return $R_{S,t+1} = 1 + r_{S,t+1}$ between t e t+1 and a

[8] For the detailed analysis of the model see BHS (2001).

risk-free asset with safe return R_f.[9] The big "novelty" of the model emerges in defining representative agent's preferences; he maximizes the following multiperiod utility function,

$$U_0 = E_0 \left\{ \sum_{t=0}^{\infty} \left[\beta^t \frac{C_t^{1-\gamma}}{1-\gamma} + b_t \beta^{t+1} v(G_{S,t+1}) \right] \right\} \tag{1}$$

subject to the budget constraint

$$W_{t+1} = (W_t - C_t)(\theta_{S,t} R_{S,t+1} + (1-\theta_{S,t}) R_f) \tag{2}$$

with

$$G_{S,t+1} = \theta_{S,t}(W_t - C_t)(R_{S,t+1} - R_f) \tag{3}$$

and

$$v(G) = \begin{cases} G & \text{per} \quad G \geq 0 \\ \lambda G & \phantom{\text{per}} \quad G < 0 \end{cases} \qquad \lambda > 1 \tag{4}$$

where $\theta_{S,t}$ is the fraction of post-consumption wealth invested in the risky asset and $(1-\theta_{S,t})$ is the fraction invested in the risk-free asset.[10]

Which novelty does emerge from the utility function? The first term is the usual one we find in standard asset pricing models. The new element is in the second term, $v(G_{t+1})$, which represents utility deriving from individual stock wealth changes: in other words, utility deriving from fluctuations in individual's risky financial wealth.[11] In particular, G_{t+1} is the gain or loss obtained by the agent on his equity investments between t and t+1. The utility (disutility) deriving to the investor from this gain (loss) is measured by the function $v(\cdot)$. As we can note by (3), the *reference level* for measuring the gain/loss is given by the initial value of financial asset parameterized with the risk-free asset. The idea is that investor will be satisfied if $R_{S,t+1} > R_f$ and unsatisfied vice versa (BHS, 2001).

Now, let's analyze the particular form of the function $v(G_{t+1})$. In Figure 1 we have a simple graphical representation of it. We note that its form makes clear the fundamental feature of representative agent's preferences, i.e. the higher sensitivity to stock wealth setbacks rather than to increases of the same magnitude: as previously said, it is the so-called loss aversion. It is important to stress that in the "complete" version of the BHS model, loss aversion

---

[9] We can avoid putting time index to the risk-free return because for assumption it is known with certainty every period.

[10] It can be either a bond or a T-Bill, but for example "cash on hand" as well.

[11] Only risky asset fluctuations are taken into account because the time t+1 risk-free return is known with certainty at time t: so, there is no element of risk in the changes of the latter asset.

depends on prior outcomes performed on the stock markets. This implies a more complicated formulation for $v(\bullet)$ and, consequently, for the entire model. Hence, we want to emphasize that in BHS model the matter related to the dynamic aspects of loss aversion has a very important role. But here, given our purposes, we will not investigate in deep such very interesting matter.[12]

A very important question is the frequency by which the investor evaluates his financial situation. In other words: when does the investor check his stock market performances? BHS (2001), following the results obtained by Benartzi-Thaler (1995), consider the year as standard time evaluation period. It is true that the time horizon of equity investments usually is longer, 3-5 years, but it is reasonable to suppose that at least once a year the individual seriously checks his financial market performances. This point of view is confirmed by some elements: we file taxes once a year, receive our most comprehensive mutual fund reports once a year and institutional investors scrutinize their money managers' performances most carefully on an annual basis (BHS, 2001).

Utility function with loss aversion

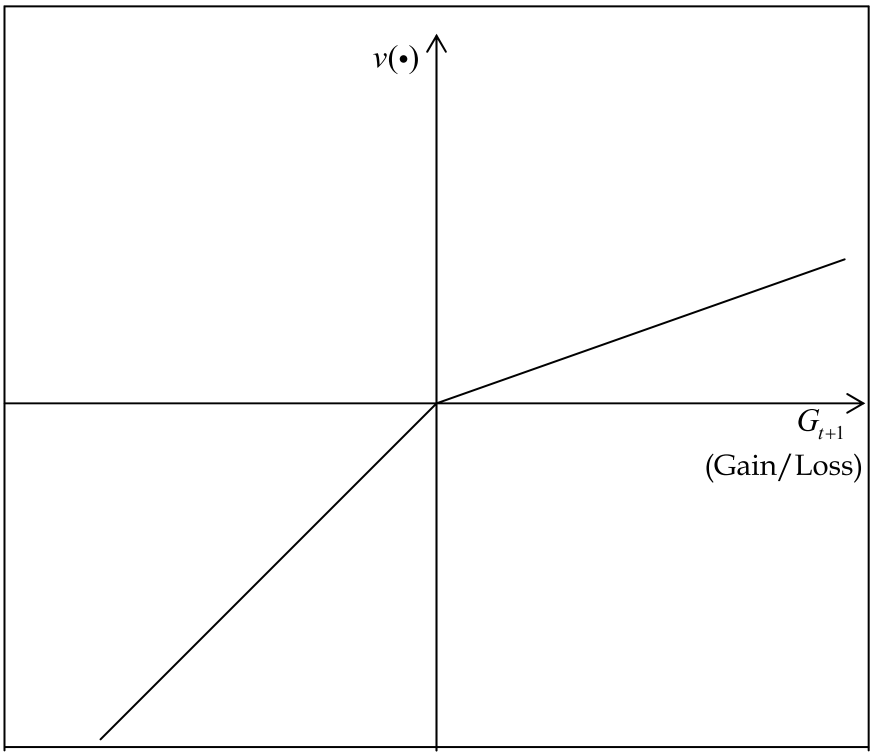


Figure 1

[12] On this topic see BHS (2001) and especially the seminal paper by Thaler-Johnson (1990).

In the BHS model the parameter b_t plays a crucial role. It is an exogenous parameter, used in part for scaling the model, but it is also specified in order to include a preference parameter that is of crucial importance for BHS model's behavior. We have:

$$b_t = b_0 \overline{C}_t^{-\gamma} = \frac{b_0}{\overline{C}_t^{\gamma}}, \qquad b_0 \geq 0$$

where $\overline{C}_t$ is the aggregate per-capita consumption at time t and therefore is exogenous for the investor. The parameter b_t have to be scaled in an opportune manner, because it must ensure that some quantities, like the price-dividend ratio and the equity premium, would remain stationary as aggregate wealth increases over time. In order to reach this goal, aggregate per-capita consumption $\overline{C}_t$ plays a very important role. Instead, without such variable, the prospect theory term[13] of the objective function will come to dominate the consumption term as aggregate wealth grows.

Regardless the "ad hoc" requirements relative to the stationarity of crucial variables, in b_t is embedded the parameter b_0, which permits us to control for the importance of utility deriving from financial wealth changes relative to the utility deriving from consumption. If we set $b_0 = 0$ we have $b_t = 0$ and therefore we find the standard consumption-based asset pricing model again. Very important to note, in the next sections we will see that b_0 can also be interpreted as the *narrow framing* degree of a risky investment.

However, given our aims, here it is not necessary to describe further the technical aspects of BHS model. What we want to highlight is that with a framework of this kind, BHS are able (with some acceptable approximations) to account for several asset pricing puzzles, like the equity premium and risk-free rate puzzles and the volatility one as well. This good result basically depends on the fact that the care of the investor about his financial wealth fluctuations introduces, together with the loss aversion, a further element of risk which, in equilibrium, induces the investor to hold the risky assets in excess only if there is a high equity risk premium.

---

[13] $\beta^{t+1} v(G_{S,t+1})$.

3
The narrow framing of risks

BHS (2001) has had a great success, in the behavioral finance literature, in explaining aggregate stock market behavior. However, in very recent times, this approach has been updated and re-defined from a terminological point of view: we will refer to the so-called *loss aversion/narrow framing approach*, or *narrow framing approach* only.[14] Poorly speaking, with the expression "narrow framing" we mean evaluating risky financial investments in isolation (with respect to other risky alternatives). But we note that the idea of an utility function based not only on consumption is maintained as basic distinctive feature of the model.

The search for more refined models is also motivated by the fact that, a part from some negligible empirical inconsistencies (see BHS, 2001), BHS model suffers of three important theoretical problems. First, it is strongly intractable in partial equilibrium analyses: this is a big problem especially in portfolio choice frameworks.[15] Second, it is necessary to use the scaling factor represented by aggregate per-capita consumption, $\bar{C}_t^{-\gamma}$; otherwise, as aggregate wealth increases the *prospect theory* term dominates the consumption one in the utility function, causing problems for obtaining stationary equilibriums.[16] Third, although for us of marginal importance, it is not possible to calculate explicitly the economic agent's indirect value function and so it is not possible to verify if people's choices are consistent with their attitudes to independent monetary gambles.[17]

This problems have induced the authors engaged on this topic to modify the model, introducing some analytical novelties we will see in the next section. In fact, before of introducing the so-called "BH model",[18] we have to explain in some detail the meaning of a certain expression. The two peculiar features of the model proposed by Barberis-Huang (2004a) are the loss aversion and the narrow framing of risks. About the former we have already discussed; the latter has a prominent role, more important than the former, and therefore it need a detailed explanation.

In traditional models[19] the economic agent typically adopts the following behavior: he merges the new choices he faces with those already faced, then he controls if the new gamble improve or not the future

[14] See in particular Barberis-Huang (2004a, b) and Barberis-Huang-Thaler (2003).
[15] For example it becomes a problem to handle the stock market participation issue.
[16] For details on this point see BHS (2001).
[17] This is a very interesting question, but not so important for the present work. See Barberis-Huang (2004a, b) and especially Barberis-Huang-Thaler (2003).
[18] From now on we refer to this model calling it either "BH model" or "BH approach".
[19] We refer to models based on traditional Von Neumann-Morgenstern utility functions, defined on consumption and/or wealth.

distribution of wealth and/or consumption. But in recent years, experimental evidence on financial decision making under uncertainty (started with the seminal paper by Tversky-Kahneman, 1981) has shown that individuals often do not behave as in traditional models. In many cases, when people evaluate risk, they often engage in *narrow framing*: that is, they often evaluate risks in isolation, separately from other risks they are already facing. As remarked by BH (2004a), "*…..narrow framing means that the agent derives utility directly from the outcome of a specific gamble he is offered, and not just indirectly via its contribution to his total wealth. Equivalently, he derives utility from the gamble's outcome over and above what would be justified by a concern for his overall wealth risk*".

The classic demonstration of such behavior is due to the seminal paper of Tversky-Kahneman (1981). The two authors ask 150 subjects the following question: "Imagine that you face the following pair of concurrent decisions. First examine both decisions, then indicate the options you prefer":

CHOICE 1:

- A) a sure gain of $240;
- B) 25% chance to gain $1.000 and 75% chance to gain nothing;

CHOICE 2:

- C) a sure loss of $750;
- D) 75% chance to lose $1.000 and 25% chance to lose nothing;

Regard CHOICE 1, 84% of subjects chose A, with only 16% choosing B; regard CHOICE 2, 87% chose D, with only 13% choosing C. But what is surprising in this experiment is that if we verify what are the individuals' "combined" choices we can see that most of subjects (73%) chose the combination A&D, i.e.

25% chance to win $240,   75% chance to lose $760

while the least popular combination (3%) was B&C, i.e.

25% chance to win $250,   75% chance to lose $750.

But it is very easy to note that combination A&D is dominated by combination B&C.

How is possible to comment and explain such contradiction? It is evident that economic agents make a sub-optimal choice, opting for a dominated strategy: why? What happens is that instead of focusing on the *combined* outcome of decisions 1 and 2 (i.e. on the outcome that determines their final wealth), individuals are focusing on the outcome of each decision *separately*. Hence, such explanation is a descriptive choice theory which does not say how economic agents should behave for optimizing, but it explain for what reasons, in certain circumstances, they choose wrongly, getting a sub-optimal outcome.

There are different real world situations where we can find a similar behavior: in particular when some choices are preferred to others, also if the latter are better (on basis of theoretical grounds) than the former. For example, we can think about the so-called stock market non-participation and the equity home bias: in both cases favorable diversification opportunities are rejected.

In the first case[20], we deal with a phenomenon typical of the most important world economies: many households refuse to allocate even a small amount of their wealth to a stock market that is relatively uncorrelated with other major household risks.[21] They prefer to invest in other assets with lower returns. Moreover, given basic portfolio diversification theory, the uncorrelation above mentioned would mean that investing in stocks would be more convenient. In the second case, as just discussed in the introduction, competition is instead between domestic and foreign stocks.

But are there in the literature framing theories which lead individuals to evaluate risk alternatives narrowly? About this question, BH (2004a) refers to the theory proposed by Kahneman (2003) on the AER in his *Nobel Lecture*. Let's see in brief what he proposed.

The basic idea is very simple. When an agent evaluates a new gamble, the distribution of the gamble, considered separately, is much more accessible than the distribution of his overall wealth once the new gamble has been merged with his other risks. What means "accessible"? As Kahneman argues, such expression refers to the fact that many decisions are made taking into account the more easily interpretable features and information: in other words, the features and information more accessible. And this consideration is based on the idea that many choices are made intuitively rather than through effortful reasoning. We note that we are departing from the full rationality of economic agents, going to the concept of bounded rationality.

Consistently with the explanation of Kahneman (2003) and in support of it, we can remember the seminal contribution provided to social sciences by Simon (1982). In proposing arguments in favor of the hypothesis of bounded rationality of economic agents, Simon remarks that their cognitive resources are limited: this element forces individuals to simplify the space of the choice problem, that would result unmanageable for his excessive complexity.

[20] See Mankiw-Zeldes (1991) and Bertaut-Haliassos (1995).

[21] It is the case of "housing risk", or human capital (present value of expected future labor income). Some recent papers provide empirical evidence of the fact that such risks are just weakly correlated with stock market risk. See Bertaut-Haliassos (1995) but, especially, Heaton-Lucas (2000).

On these premises, it is natural thinking of financial markets as a field where we can apply the theoretical approach we are discussing. In fact, a few sectors of human activity are characterized by a so huge quantity of information as it occurs in stock markets (Slovic, 1972). Such information is highly accessible by everyone because it can be daily reached by means of newspapers, tv-news, internet, etc.[22] But the problem here is related to the correct and optimal elaboration of information. The coming of new technologies, making quickly available information about world stock market movements, has highly contributed to increase individual's difficulties in exploiting at the maximum the huge amount of information available to them. In fact, it is true that a larger amount of information means more accuracy in evaluating alternative choices, but it is also true that, as argued by Simon (1982), an amount of information in excess, given the bounded individual cognitive resources, makes the decision space unmanageable. And it is in attempting to simplify this space that economic agents make narrow framing and not "overall" evaluations: as a consequence, this behavior implies that individuals make the choice that is apparently the best one. The overall evaluation of the problem would lead to a better choice than that effectively made, but the lack of the "optimal" skills in processing information leads to the sub-optimal choice. The overall framing is involuntary declined in favor of the narrow one because of the lack of such optimal skills in processing information.[23]

The example seen above by Kahneman-Tversky (1981) fits very well to what we are proposing. In that example, analysing the outcome of each one of choices A, B, C and D, is highly accessible. Instead, much less accessible is the overall outcome once two choices, A&D, say, or B&C, are combined. In this case the distributions are less obvious than the distributions (A, B, C and D) given in the original question. Therefore, it seems evident that in decision-making processes, the single outcomes seen above (A, B, C, D) play a more important role than usually predicted by traditional utility functions defined only over wealth or consumption.

Hence, it seems very easy, in particular in light of the SHIW empirical evidence briefly discussed in the Introduction, to do the following consideration. What are the subjects able to process the huge amount of stock market information optimally? Maybe, people with a high degree of education, like graduates or more. And it is a fact that, in the italian case, empirical evidence available at the household level confirms such interpretation, showing that graduates exploit at least in part the diversification opportunities provided by stock markets, investing in foreign

[22] We refer to "ordinary" information. Information of "straordinary" nature is not easily accessible to anyone, but only to a few people, directly involved and strictly related to the business firm in object.

[23] Relative to the equity home bias issue, among recent papers that stress the role of information and its optimal elaboration, see in particular Van Nieuwerburgh-Veldkamp (2004).

equities relatively more than people with a lower education. Therefore, it would be very useful to build and solve a model able to explain consistently investors' behavior about their portfolio choices. In doing so, it seems that the preferences introduced by Barberis and Huang in their approach are a promising methodological instrument. We will see such approach in the next section.

4
The BH approach: narrow framing and recursive utility

BH (2004a) propose a new formulation of the utility function in order to overcome the problems of the BHS model. The crucial elements of the BH approach are the loss aversion and, especially, the narrow framing of risks. Now, we will see formally this approach, keeping in mind that the basic idea is the one of the BHS model, i.e. the possibility for the economic agent to derive utility not only from consumption levels but also from financial (stock) wealth fluctuations.

The analytical novelty introduced by BH (2004a) is the use of recursive utility (EZW utility: Epstein-Zin-Weil).[24] In its standard and commonly used version, we have the following formulation,

$$U_t = W\left(C_t, \mu(U_{t+1} | I_t)\right) \tag{5}$$

where $\mu(U_{t+1}|I_t)$ is the certainty equivalence of future utility U_{t+1}, given the time t information. The function $W(\cdot,\cdot)$ is an aggregator which combines future utility U_{t+1} with current consumption C_t in order to generate current utility U_t. Usually, in most applications we find in this kind of literature, the aggregator function assumes the CES (*Constant Elasticity of Substitution*) form,

$$W(C,x) = \left[(1-\beta)C^{\rho} + \beta x^{\rho}\right]^{\frac{1}{\rho}}$$

with $0 < \beta < 1$, $0 \neq \rho < 1$, while for the certainty equivalence we assume a functional form with homogeneity of degree one,

$$\mu(kx) = k\mu(x)\,,\ k > 0\,.$$

[24] See Epstein-Zin (1989, 1991) and Weil (1989).

It is well known that this kind of utility[25] has its origins in the idea of separating relative risk aversion (RRA) from the intertemporal elasticity of substitution (IES). But in our context, we will see that such feature has a negligible importance.

By adopting this preference formulation the maximization problem of the representative investor modifies as follows:

$$\text{Max} \quad U_t = W\left(C_t, \mu(U_{t+1}|I_t) + b_0 E_t\left[v(G_{S,t+1})\right]\right) \tag{6}$$

$$\text{s.t.} \qquad W_{t+1} = (W_t - C_t) R_{W,t+1} \tag{7}$$

where
$$W(C,x) = \left[(1-\beta)C^{\rho} + \beta x^{\rho}\right]^{\frac{1}{\rho}} \tag{8}$$

$$\mu(x) = \left[E(x^{\delta})\right]^{\frac{1}{\delta}}, \qquad 0 \neq \delta < 1 \tag{9}$$

$$G_{S,t+1} = \theta_{S,t}(W_t - C_t)(R_{S,t+1} - R_f) \tag{10}$$

$$v(G) = \begin{cases} G & \text{per} \quad G \geq 0 \\ \lambda G & \qquad\;\; G < 0 \end{cases} \qquad \lambda > 1 \tag{11}$$

With respect to equation (5), the new element is represented by the second argument of $W(\cdot,\cdot)$, which has been augmented for introducing the possibility to make narrow framing on the equity asset.[26] The most important difference with the BHS approach, apart the use of recursive utility, is that here the dynamic aspects of loss aversion (we have briefly discussed them in section 2) are not considered, i.e., we do not assume and do not model the dependence of loss aversion on prior financial outcomes. Instead, we have both the narrow framing of risks, introduced by function $v(\bullet)$, and the loss aversion, introduced by the particular form of $v(\bullet)$. Hence, we have narrow framing in BHS as well, but there the authors do not emphasize this aspect, pointing out the dynamic aspects of loss aversion. The certainty equivalence has been specified in a very simple form (equation 9), very used in the literature: what matters are the effects of narrow framing behavior, without entering in other difficulties potentially emerging from a richer functional form, but more complex and less tractable.

[25] In the literature it is also very used the name *Generalized Expected Utility* (GEU) preferences.

[26] In general, we can also introduce such possibility on non-financial assets. Now, we will see the case with an indefinite number of assets on which is possible to introduce narrow framing behavior. Obviously, we have to deal with risky assets.

$R_{W,t+1}$ measures the return of the entire individual wealth, i.e. of the individual's "market portfolio", between t and t+1. Obviously, the composition of this portfolio depends on the number of assets we take into account. We could consider two assets only, as in BHS model, or also three assets, but BH model can also be generalized to the case with n assets. Obviously, in the latter case, several expressions have to be properly modified. We have:

$$\text{Max } U_t = W\left(C_t, \mu(U_{t+1}) + b_0 \sum_{i=m+1}^{n} E_t[v(G_{i,t+1})]\right)^{27} \qquad (12)$$

$$\text{s.t.} \quad W_{t+1} = (W_t - C_t) R_{W,t+1}$$

$$\text{with} \qquad R_{W,t+1} = \sum_{i=1}^{n} \theta_{i,t} R_{i,t+1}$$

$$\text{where} \qquad W(C,x) = \left[(1-\beta)C^{\rho} + \beta x^{\rho}\right]^{\frac{1}{\rho}}$$

$$\mu(x) = \left[E(x^{\delta})\right]^{\frac{1}{\delta}}$$

$$G_{i,t+1} = \theta_{i,t}(W_t - C_t)(R_{i,t+1} - R_{i,z}), \qquad i = m+1, \ldots\ldots n$$

$$v(G) = \begin{cases} G & \text{per} \quad G \geq 0 \\ \lambda G & \phantom{\text{per}} \quad G < 0 \end{cases} \qquad \lambda > 1 .$$

We have n financial and/or real assets. In equation (12) we have added $n-m$ new terms to the second argument of $W(\cdot,\cdot)$, one for each one of the $n-m$ assets that the investor frames narrowly (see BH, 2004a). Relative to the expression which defines gains and losses from stock markets, we have as many equations as assets subject to narrow framing are, from $m+1$ up to n, for a total of $n-m$ equations. $R_{i,z}$ is a generic reference level useful for evaluating performances run on stock markets: as previously seen, such variable can be substituted by either the risk-free rate or 1.[28]

[27] We note that, with respect to (6), in order to keep the notation more slight, we have omitted the information set I_t.

[28] In the latter case the value of the initial wealth will be not parameterized and so it will be equal to $\theta_{i,t}(W_t - C_t)$ for every i.

5
A model of international portfolio choice with narrow framing of risks

5.1
The model

We can adopt "BH preferences" by using them in a simple international portfolio choice framework, in order to investigate the equity home bias puzzle. In the behavioral finance literature related to models which use narrow framing preferences (a very recent literature), among partial equilibrium analyses, works in such a sense do not exist; Barberis-Huang-Thaler (2003) investigate the stock market non-participation puzzle, and only with reference to USA data.[29]

We consider a simple two-country Economy, for instance Country A and the Rest of the World (RoW). In a partial equilibrium framework, we only analyze the choices of the Country A representative agent (and we suppose that Country A is the domestic one). We are in a pure-exchange economy (Lucas, 1978), hence we have no production and no labor income. The only income source is of financial nature. The time horizon of the economy is infinite.

Suppose we have in our economy three financial assets: economic agent divides his financial wealth between them. The first asset is a risk-free domestic bond (or cash on hand with a safe return). The second one is the domestic stock market: a risky asset of Country A. The third one is a foreign equity. Every asset is offered in a fixed quantity: hence, we do not investigate the supply side of the stock market. Both risky assets have an exogenous log-rate of return of the following type:

$$\log(R_{D,t+1}) = g_D + \sigma_D \varepsilon_{D,t+1} \tag{13}$$

$$\log(R_{F,t+1}) = g_F + \sigma_F \varepsilon_{F,t+1} \tag{14}$$

with $$\begin{pmatrix} \varepsilon_{D,t} \\ \varepsilon_{F,t} \end{pmatrix} \approx N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \omega \\ \omega & 1 \end{pmatrix}\right] \quad i.i.d.$$

[29] Stracca (2002b) discusses the possibility of resolving the equity home bias puzzle by means of *prospect theory*, but he do not build any model explicitly.

where mean log-returns and standard deviations, g_i e σ_i, are given and stochastic shocks ε_i are exogenous. The risk-free asset also has a rate of return known with certainty. The dividend stream is exogenous and is embedded in the log-returns. Moreover, we suppose the exchange rate between the two countries to be equal to 1 and not subject to fluctuations (fixed exchange rates). All variables are expressed in real terms.

By using the recursive preferences of the BH approach (see equation 12), the consumer/investor faces the following (recursive) utility function:

$$U_t = W\left(C_t, \mu(U_{t+1}) + b_0[E_t(G_{D,t+1})] + b_0[E_t(G_{F,t+1})]\right) \tag{15}$$

We note that by writing down the problem in this way, we have narrow framing on both risky assets, with the same intensity (b_0 is the same for both assets). With reference to equations (8) and (9) we fix $\rho = \delta = 1-\gamma$, where γ is the relative risk aversion coefficient. It is common use in the asset pricing literature, under GEU preferences, to set the exponent of aggregator function equal to the exponent of the certainty equivalence function. Then, setting such exponents equal to $1-\gamma$ means to loss the separation between risk aversion and intertemporal elasticity of substitution (IES), but in our context, as already mentioned, this fact is not a problem. Since we have that

$$W(C,x) = \left[(1-\beta)C^{1-\gamma} + \beta x^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \qquad \text{and} \qquad \mu(x) = \left[E(x^{1-\gamma})\right]^{\frac{1}{1-\gamma}}$$

the utility function maximized by the representative agent can be rewritten as

$$U_t = \left\{(1-\beta)C_t^{1-\gamma} + \beta\left([E_t(U_{t+1}^{1-\gamma})]^{\frac{1}{1-\gamma}} + b_0 \sum_{i=D}^{F} E_t[v(G_{i,t+1})]\right)^{1-\gamma}\right\}^{\frac{1}{1-\gamma}} \tag{16}$$

where $i = D, F$. The summation used above means that

$$\sum_{i=D}^{F} E_t[v(G_{i,t+1})] = E_t v(G_{D,t+1}) + E_t v(G_{F,t+1})$$

Now, it is necessary to adapt the standard wealth accumulation constraint to the simple portfolio choice model we have formulated. Taking into account the three financial assets and their returns, the agent maximizes equation (16) subject to

$$W_{t+1} = (W_t - C_t)R_{W,t+1}$$

with $$R_{W,t+1} = \left((1-\theta_{D,t} - \theta_{F,t})R_f + \theta_{D,t}R_{D,t+1} + \theta_{F,t}R_{F,t+1}\right),$$

where $\theta_{D,t}$ and $\theta_{F,t}$ are, respectively, the shares of individual financial wealth invested in domestic and foreign stock market, while $(1-\theta_{D,t} - \theta_{F,t})$ is the share invested in the risk-free (domestic) asset. Hence, it is evident that $\theta_{f,t} + \theta_{D,t} + \theta_{F,t} = 1$. Moreover,

$$G_{D,t+1} = \theta_{D,t}(W_t - C_t)(R_{D,t+1} - R_f)$$

$$G_{F,t+1} = \theta_{F,t}(W_t - C_t)(R_{F,t+1} - R_f)$$

$$v(G) = \begin{cases} G & \text{per } G \geq 0 \\ \lambda G & \text{per } G < 0 \end{cases} \qquad \lambda > 1. \tag{17}$$

5.2
Optimality conditions for the consumption/portfolio problem

Given the recursive nature of the intertemporal maximization problem, it can be solved by using dynamic programming techniques. We have the following value function (*Bellman equation*):

$$U_t = V(W_t) = \underset{C_t,\theta_{i,t}}{Max}\, W\left(C_t, \mu[V(W_{t+1})] + b_0 \sum_{i=D}^{F} E_t v(G_{i,t+1}) \right) \tag{18}$$

Taking into account the aggregator function $W(C,x)$, equation (18) changes as follows:

$$V(W_t) = \underset{C_t,\{\theta_{i,t}\}_{i=1}^{n}}{Max} \left\{ (1-\beta)C_t^{1-\gamma} + \beta \left[\mu[V(W_{t+1})] + b_0 \sum_{i=D}^{F} E_t v(G_{i,t+1}) \right]^{1-\gamma} \right\}^{\frac{1}{1-\gamma}} \tag{19}$$

We can obtain a particular formulation for the value function in order to show that consumption and portfolio decisions are separable. In fact, we observe that given the form of $G_{i,t+1}$,

$$G_{i,t+1} = \theta_{i,t}(W_t - C_t)(R_{i,t+1} - R_f), \quad i = D, F \tag{20}$$

we can guess for the value function the following form,

$$V(W_t) = A_t W_t, \tag{21}$$

where A_t is a constant (to be precise, the solution of a maximization problem); the goodness of this conjecture will be verified ex-post.[30]

By substituting equation (20), and equation (21) evaluated at t+1, in (19), and exploiting the intertemporal budget constraint $W_{t+1} = (W_t - C_t)R_{W,t+1}$, we have

$$V(W_t) = \underset{C_t,\theta_{i,t}}{Max}\left\{(1-\beta)C_t^{1-\gamma} + \beta\left[\mu[A_{t+1}(W_t - C_t)R_{W,t+1}] + b_0\sum_{i=D}^{F} E_t v[\theta_{i,t}(W_t - C_t)(R_{i,t+1} - R_f)]\right]^{1-\gamma}\right\}^{\frac{1}{1-\gamma}}$$

By exploiting the homogeneity of degree one of $\mu(\bullet)$ and $v(\bullet)$ we get

$$V(W_t) = \underset{C_t,\theta_{i,t}}{Max}\left\{(1-\beta)C_t^{1-\gamma} + \beta\left[(W_t - C_t)\mu[A_{t+1}R_{W,t+1}] + (W_t - C_t)b_0\sum_{i=D}^{F} E_t v[\theta_{i,t}(R_{i,t+1} - R_f)]\right]^{1-\gamma}\right\}^{\frac{1}{1-\gamma}}$$

Collecting $(W_t - C_t)$ and raising to $1-\gamma$ what is in square brackets, we have

$$V(W_t) = \underset{C_t,\theta_{i,t}}{Max}\left\{(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}\left[\mu(A_{t+1}R_{W,t+1}) + b_0\sum_{i=D}^{F} E_t v[\theta_{i,t}(R_{i,t+1} - R_f)]\right]^{1-\gamma}\right\}^{\frac{1}{1-\gamma}} \tag{22}$$

From equation (22) we can see that optimal consumption and portfolio choices are separable. In particular, given that portfolio problem is

$$P_t^* = \underset{\theta_{i,t}}{Max}\left[\mu(A_{t+1}R_{W,t+1}) + b_0\sum_{i=D}^{F} E_t v[\theta_{i,t}(R_{i,t+1} - R_f)]\right], \tag{23}$$

we can rewrite the value function as follows:

[30] We observe that the procedure described above is commonly used in solving dynamic optimization problems (see Stokey-Lucas, 1989).

$$V(W_t) = \underset{C_t}{Max}\left\{(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right\}^{\frac{1}{1-\gamma}}. \tag{24}$$

Obviously, equation (24) is the optimal consumption choice problem (we are assuming to know the optimal portfolio solution P_t^*): but this problem may be re-formulated differently. If $\alpha_t \equiv C_t / W_t$, we can write the problem (24) in the following way:

$$A_t = \underset{\alpha_t}{Max}\left[(1-\beta)\alpha_t^{1-\gamma} + \beta(1-\alpha_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}. \tag{25}$$

For passing by (24) to (25) it is necessary to divide for W_t both sides of the former equation (the same operation it is also necessary under the Max, i.e. for the variable with respect to which we are maximizing). We have:

$$\frac{V(W_t)}{W_t} = \underset{C_t/W_t}{Max}\frac{1}{W_t}\left[(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}};$$

by assuming $\frac{V(W_t)}{W_t} \equiv A_t$ and raising both sides to $1-\gamma$ we can rewrite the last equation as

$$A_t^{1-\gamma} = \underset{C_t/W_t}{Max}\left(\frac{1}{W_t}\right)^{1-\gamma}\left[(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right] =$$

$$= \underset{C_t/W_t}{Max}\left[(1-\beta)\left(\frac{C_t}{W_t}\right)^{1-\gamma} + \beta\left(\frac{W_t - C_t}{W_t}\right)^{1-\gamma}(P_t^*)^{1-\gamma}\right].$$

Now, exploiting the fact that $\alpha_t \equiv C_t / W_t$, we get

$$A_t^{1-\gamma} = \underset{\alpha_t}{Max}\left[(1-\beta)\alpha_t^{1-\gamma} + \beta(1-\alpha_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right],$$

and raising both sides to $1/(1-\gamma)$ we obtain equation (25). It seems to be clear that guess (21) is already verified. However, by substituting $\alpha_t \equiv C_t / W_t$ in

(25), it is possible to verify our starting guess further, i.e. that $A_t W_t = V(W_t) =$ to equation (22).[31]

Now, let's consider the problem (25). For obtaining the optimal first order condition we have to derive with respect to α_t in the *Max* argument. We have:

$$\frac{1}{1-\gamma}\left[(1-\beta)\alpha_t^{1-\gamma}+\beta(1-\alpha_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}-1}\left[(1-\gamma)(1-\beta)\alpha_t^{-\gamma}-(1-\gamma)\beta(1-\alpha_t)^{-\gamma}(P_t^*)^{1-\gamma}\right]=0\Rightarrow$$

$$\left[(1-\gamma)(1-\beta)\alpha_t^{-\gamma}-(1-\gamma)\beta(1-\alpha_t)^{-\gamma}(P_t^*)^{1-\gamma}\right]=0\Rightarrow$$

$$(1-\beta)\alpha_t^{-\gamma}=\beta(1-\alpha_t)^{-\gamma}(P_t^*)^{1-\gamma} \tag{26}$$

where P_t^*, as previously seen, is the portfolio problem solution.[32] By rendering explicit equation (26) for P_t^* and substituting the expression obtained in (25), we get

$$A_t=(1-\beta)^{\frac{1}{1-\gamma}}\alpha_t^{\frac{-\gamma}{1-\gamma}}, \tag{27}$$

and at time t+1 we have

$$A_{t+1}=(1-\beta)^{\frac{1}{1-\gamma}}\alpha_{t+1}^{\frac{-\gamma}{1-\gamma}}. \tag{28}$$

At this point, we can substitute (28) in the portfolio problem (23), getting

$$P_t^*=\underset{\theta_{i,t}}{Max}\left[\mu[(1-\beta)^{\frac{1}{1-\gamma}}\alpha_{t+1}^{\frac{-\gamma}{1-\gamma}}R_{W,t+1}]+b_0\sum_{i=D}^{F}E_t v[\theta_{i,t}(R_{i,t+1}-R_f)]\right]\quad\Rightarrow$$

$$\Rightarrow\quad P_t^*=\underset{\theta_{i,t}}{Max}\left[(1-\beta)^{\frac{1}{1-\gamma}}\mu(\alpha_{t+1}^{\frac{-\gamma}{1-\gamma}}R_{W,t+1})+b_0\sum_{i=D}^{F}E_t v[\theta_{i,t}(R_{i,t+1}-R_f)]\right] \tag{29}$$

where we have again used the homogeneity of degree one of function $\mu(\bullet)$ in order to bring out of it $(1-\beta)^{1/(1-\gamma)}$. Writing this function in the CES form,

[31] See the Mathematical Appendix.

[32] In reality, this is only the "assumed" solution. We will see that for solving problem (23) it is necessary an iterative procedure which must take into account the first order condition for consumption (26).

$$\mu(x) = \left[E(x^{1-\gamma})\right]^{\frac{1}{1-\gamma}},$$

we can rewrite the portfolio problem as follows:

$$P_t^* = \underset{\theta_{i,t}}{Max}\left[(1-\beta)^{\frac{1}{1-\gamma}}[E_t(\alpha_{t+1}^{\frac{-\gamma}{1-\gamma}} R_{W,t+1}^{1-\gamma})]^{\frac{1}{1-\gamma}} + b_0 \sum_{i=D}^{F} E_t v[\theta_{i,t}(R_{i,t+1} - R_f)]\right] \qquad (30)$$

where $$R_{W,t+1} = \left((1-\theta_{D,t} - \theta_{F,t})R_f + \theta_{D,t}R_{D,t+1} + \theta_{F,t}R_{F,t+1}\right).$$

5.3
Numerical solution of the model

How do we solve the portfolio problem stated by equation (30)? Obviously, we have to maximize with respect to portfolio shares θ_i, but the difficulty is that such shares are expressed as functions of α, i.e. as functions of the *policy* for consumption, and we do not have this policy in hand. A feasible solution strategy is the following.

We guess a possible solution for problem (25): in other words, we guess a value for α. This also means to guess a value for A (see 27). We solve (30) for such a value of α and substitute the resulting P_t^* in the first order condition for consumption (26), in order to generate a new candidate α. Then, with the last α we have in hand, we solve the problem (30) again and we go on with this iterative procedure until convergence occurs.[33]

Moreover, in solving the model we make the following further assumptions:

1) We assume that the risk-free asset share is given, for an amount equal to $\overline{\theta}_f$: hence, the investor only have to choice how to divide his stock wealth between domestic and foreign equity;
2) We impose a non-negativity constraint on asset holdings: $\theta_{i,t} \geq 0$.
3) We assume that representative agent makes narrow framing on foreign asset only: this is a simplification, because the same thing may also hold for the other risky asset, the domestic one. As an explanation for this assumption, we can suppose that domestic asset is a risk more familiar than other financial risks, with a probability distribution which is “easy” to combine with the distribution of other risks. The same thing does not hold for foreign equity. This interpretation agrees

[33] This procedure will be implemented using the software of numerical computation MatLab.

with several behavioral finance contributions. For example, Huberman (2001) argues that there is a higher propensity to invest in financial assets which are familiar: such assets give the investor the illusion to control his own investments better than in other cases (see also Goetzmann-Kumar, 2002 and Kelly, 1995).

Summing up, the economic agent have to choose between foreign and domestic asset: it will be sufficient to maximize with respect to one of the two assets, since being $\overline{\theta}_f + \theta_{D,t} + \theta_{F,t} = 1$, once that, say $\theta_{F,t}$, is determined, the unknown share ($\theta_{D,t}$) will be automatically determined. We will maximize with respect to foreign equity, $\theta_{F,t}$. In doing so, we have to guess some (constant) values for α_t and $\theta_{F,t}$, because we will not find the standard policy functions, but time-invariant solutions. Assuming the *guess*

$$(\alpha_t, \theta_{F,t}) = (\alpha, \theta_F),$$

and that only the foreign asset is subject to narrow framing, the portfolio problem (30) becomes as follows:

$$P^* = \underset{\theta_F}{Max}\left[(1-\beta)^{\frac{1}{1-\gamma}} \alpha^{\frac{-\gamma}{1-\gamma}} [E_t(R_{W,t+1}^{1-\gamma})]^{\frac{1}{1-\gamma}} + b_0 E_t v[\theta_F(R_{F,t+1} - R_f)]\right] \tag{31}$$

where $$R_{W,t+1} = \left(\overline{\theta}_f R_f + \theta_D R_{D,t+1} + \theta_F R_{F,t+1}\right)$$

with $$\theta_D = 1 - \overline{\theta}_f - \theta_F .$$

We observe that in solving the portfolio problem (31), we have analytical problems not so easy arisen by the resolution of the expected value

$$E_t(R_{W,t+1}^{1-\gamma})$$

i.e., substituting the expression for $R_{W,t+1}$ (also consider equations 13 and 14),

$$E_t\left\{\left[\overline{\theta}_f R_f + (1-\overline{\theta}_f - \theta_F)e^{g_D + \sigma_D \varepsilon_{D,t+1}} + \theta_F e^{g_F + \sigma_F \varepsilon_{F,t+1}}\right]^{1-\gamma}\right\}.$$

What kind of procedure may we use? We will use the numerical quadrature, according to Tauchen-Hussey (1991): such a procedure is widely used in the asset pricing literature for solving integrals related to some expected values.[34]

6
Applications: the model in action

We numerically solve the model with reference to some pairs of economies. In doing so, we use parameter values from Michaelides (2003) and Campbell (2003), for the time periods 1973-2001 and 1919-1998, respectively. Such values, which refer to rate of returns, volatility and correlations, are built on the international index MSCI. We will take into account data relative to USA, Italy, United Kingdom and an area of 12 countries called "Euro": Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Italy, Netherlands, Norway and Sweden.

AN ILLUSTRATIVE EXAMPLE.

Let's start with a simple application with illustrative nature. Suppose we have in our two-country Economy, Country A and Rest of the World (RoW), the following data: $R_f = 1.02$, $g_D = 0.06$, $\sigma_D = 0.20$, $g_F = 0.06$, $\sigma_F = 0.20$, $\overline{\theta}_f = 0.40$, $\beta = 0.98$. For simplicity and with a methodological purpose, we consider a zero correlation between the two returns. The two stocks have the same return and the same volatility: hence, in a frictionless economy , we could expect a "fifty to fifty" share of the residual wealth: $\theta_D = 0.30$ and $\theta_F = 0.30$. In fact, this is what happens (more or less) with $b_0 = 0$. Then, as Table 7 shows, with narrow framing and loss aversion, what emerges is that the foreign asset is hold decreasingly as the degree of narrow framing b_0 increases. The mechanism in action is the usual one: we have seen and discussed it in sections 3 and 4. The investor, in making his investment decisions, assigns more weight to his aversion about financial losses (*loss aversion*) than to his willingness to exploit diversification opportunities offered by national and international equity markets. Moreover, the prospective buy of stocks is evaluated "per se", and not mixed with the risks already faced. This facts contribute to make foreign financial investment very risky and induce the investor to hold domestic equity mostly. The foreign equity is perceived to be less attractive than it would be if the investor had

[34] In particular, we will use the so-called Gauss-Hermite quadrature, typically adopted when we deal with distributions which go from minus infinity to infinity (see Judd, 1998). The MatLab codes used for solving the entire model are available, upon request, by the author.

the optimal skills for elaborating information and hence would be able to make a combined evaluation of the two assets.

Country A - RoW

β	γ	λ	b_0	θ_D	θ_F
0.98	3	2.25	0	32%	28%,
0.98	3	2.25	0.10	37%	23%,
0.98	3	2.25	0.20	45%	15%,
0.98	3	2.25	0.30	54.4%	5.6%

Table 7

ITALY - USA.

Now, we move to see how the model works when we make some applications with data drawn from real world. Suppose that domestic economy is the italian one while foreign economy is the US one.[35] Obviously, the idea that italian investor can diversify his investments in US assets only, is a simplification: there exist many possibilities of diversifying own financial portfolio. But this simplification of reality permits us to point out the crucial features of the model. This justification also holds for the cases that we will analyze next.

In order to see the magnitude of the home bias in Italy, we can again have a look at SHIW data (1998, 2000, 2002). The three surveys show that for the period 1998 – 2002, on average, italian households' financial portfolio has been composed for the 99% by domestic assets (of every type) and for the 1% by foreign assets (see Figure 2).[36] Therefore, it is clear the level of financial under-diversification of Italy.

In Table 8 the parameter value relative to the risk-free asset share, $\overline{\theta}_f$, comes from the Bank of Italy's SHIW.[37] The choice of preference parameters approximately reflects what we find in this kind of literature (see Magi, 2004 for a short and aimed survey). We follow criteria that allow us to use parameters consistent with the prevailing literature and with econometric estimates and experimental evidence available on this topic. Otherwise, for b_0

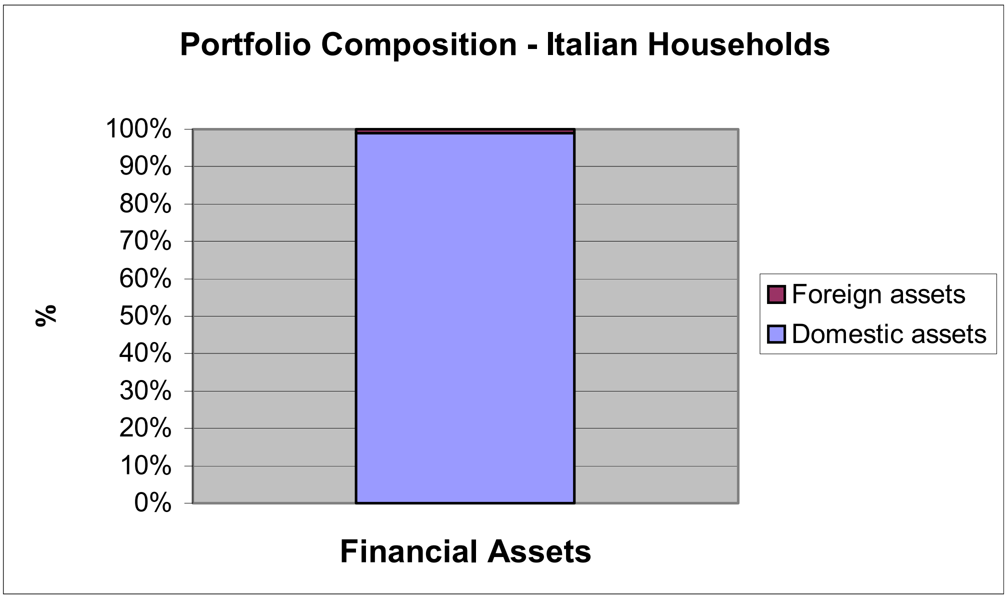
[35] In the study-cases we will see, the first country always will be the domestic economy, the second country the foreign one.

[36] We refer to total financial assets and not to stock assets only, because of homogeneity problems that there exist among different typologies of investments (home and foreign). For instance, for foreign investments, mutual funds are a single item and are not divided in equity and non-equity funds. Such a division there is for domestic investments, but for 2002 only (see Bank of Italy 1998, 2000, 2002).

[37] Considering an average of the three surveys, what emerges is that in italian households' portfolio the share of total risk-free assets (T-Bills + liquid assets) is about 64% (our elaboration based on Bank of Italy data). But some long maturity T-Bills, BTP for example, have to be considered as risky assets, henceforth $\overline{\theta}_f = 0.50$. See also, in particular for a comparison Italy - USA, Faiella-Neri (2004).

we use a range of values, in order to test the behavior of the model for different b_0's.

Figure 2



Our elaboration on Bank of Italy data 1998 – 2000 - 2002

ITA – USA (1973-2001)

	ITA	USA
R_f	1.03	
g_D	0.074	
σ_D	0.39	
g_F		0.077
σ_F		0.185
$\omega_{D,F}$	0.50	0.50
$\bar{\theta}_f$	0.50	

Table 8

ITA – USA (1973-2001)

β	γ	λ	b_0	θ_D	θ_F
0.98	3	2.5	0	12%	38%
0.98	3	2.5	0.10	17.5%	32.5%
0.98	3	2.5	0.20	23%	27%
0.98	3	2.5	0.30	28%	22%
0.98	3	2.5	0.50	32%	18%
0.98	3	2.5	0.55	41%	9%
0.98	4	2.5	0	11%	39%
0.98	4	2.5	0.10	13%	37%
0.98	4	2.5	0.55	36%	14%
0.98	5	2.5	0	9%	41%

Table 9

Now, we see how the model works. First, we note that when the narrow framing degree is zero, the model behaves as predicted by standard theories: return and volatility parameters, combined with individual preferences, lead to invest the largest fraction of own risky wealth in foreign asset (38% against 12%). If we introduce "BH preferences", as we see in Table 9, as the narrow framing degree increases the foreign asset share goes up. Note that we have such outcome despite a similar mean return, a volatility in favour of US equity and a correlation not so high.

As the Table 8 shows, half of italian representative agent's financial investments is composed by the risk-free asset: the residual half is divided between the two risky assets, with the larger share for the domestic stock market. Because of narrow framing, economic agents see the foreign equity as less attractive than it would be if the investor makes a correct evaluation of it, combined with the other risky asset. Therefore, in making his investment decisions, the investor assigns more weight to the domestic asset, declining a convenient diversification opportunity. Such behavior matches available empirical evidence and is at odds with standard portfolio theory. Here, we can again see the distinctive feature of this theoretical approach: in a descriptive context, it explains the actual (sub-optimal) choices of economic agents and not how they should behave in order to reach the optimum.

Moreover, we note that as γ raises, with λ e b_0 unchanged, the foreign equity share increases: the increased relative risk aversion implies, *ceteris paribus*, a movement of wealth to the foreign asset, which has a risk measure, the variance, lower than the domestic asset.

UNITED KINGDOM-USA.

For this case we have used parameters which refers to data relative to a longer time period, 1919-1998 (see Campbell, 2003). Table 10 shows such parameters, while in Table 11 we have the most important results we obtain from the numerical solution of the model. As we can see, the model's behavior is in line with the underlying theory. When $b_0 = 0$ foreign equity share is quite high (37%), very close to the domestic one (43%). Hence, the investor diversify his portfolio, as predicted by standard models. The introduction and the progressive increase of the narrow framing degree reduce the UK investor's propensity to invest abroad. Note that in order to generate such a behavior, with respect to the previous case, it is necessary a lower value of the narrow framing degree, but a slightly higher loss aversion.

UK – USA (1919-1998)

	UK	USA
R_f	1.0125	
g_D	0.077	
σ_D	0.22	
g_F		0.071
σ_F		0.185
$\omega_{D,F}$	0.50	0.50
$\bar{\theta}_f$	0.20	

Table 10

UK - USA (1919-1998)

β	γ	λ	b_0	θ_D	θ_F
0.98	3	3	0	43%	37%
0.98	3	3	0.10	52%	28%
0.98	3	3	0.20	66%	14%
0.98	3	3	0.25	72.5%	7.5%
0.98	3	3	0.30	78.3%	1.7%
0.98	4	3	0.10	61%	19%
0.98	4	3	0.20	62%	18%
0.98	4	3	0.30	73%	7%

Table 11

It is also of interest to observe what happens when the risk aversion γ raises, with no change in the other preference parameters. In two cases we have the same situation of the Italy-USA case: investor shifts to the lower volatility asset. Instead, when $b_0 = 0.10$, we have a opposite behavior, with a decrease in the foreign asset share.

USA-EURO.

Now, suppose that domestic economy is represented by the USA, while the foreign one is represented by an area called "EURO", which embeds Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Italy, Netherlands, Norway and Sweden. In order to get risk and return parameter measures for this area, we have simply calculated an arithmetic average; the same thing holds for the correlation parameter.[38] The idea here is to construct an european area sufficiently representative, where the US investor can diversify his financial investments. However, we stress that, within this area, taking into account the six biggest country only, we get outcomes similar to the "twelve-group".

USA – EURO (1973-2001)

	USA	EURO
R_f	1.02	
g_D	0.077	
σ_D	0.185	
g_F		0.086
σ_F		0.27
$\omega_{D,F}$	0.60	0.60
$\bar{\theta}_f$	0.20	

Table 12

[38] We continue to refer to Michaelides (2003).

USA – EURO (1973-2001)

β	γ	λ	b_0	θ_D	θ_F
0.98	3	2.8	0	56.4%	23.6%
0.98	3	2.8	0.01	56.5%	23.5%
0.98	3	2.8	0.05	57.5%	22.5%
0.98	3	2.8	0.10	64.5%	15.5%
0.98	3	2.8	0.20	78.3%	1.7%
0.98	4	2.8	0.05	66%	14%
0.98	4	2.8	0.10	72.6%	7.4%
0.98	5	2.8	0.05	69%	11%

Tabella 13

As we can see by observing Table 13, under the hypotheses of the model, US investor's behavior confirms the tendency already seen in the other cases. In particular, in order to match empirical evidence, we need a level of narrow framing relatively low and a loss aversion degree (2.8) which is in the mid of the values seen in the two previous cases. It is not surprising the fact that in the three cases we have discussed, the preference parameter values needed to get certain results are subject to changes. In fact, such values vary with the features of the economy taken into account and with the relative measures of risk and return of financial assets. In this way, we can infer, for the different countries, the appropriate values for the behavioral parameters.

By observing Table 13 again, we see that when the relative risk aversion coefficient increases, *ceteris paribus*, foreign portfolio share decreases: european equity is riskier than US equity and therefore the investor reduces the quantity of it in his portfolio.

At this point, it is important to stress that the two parameters that characterize the model as a model of behavioral finance (with prospect-type utility), are always consistent with values used in other studies and simulations.[39] In particular, in order to generate certain results, the narrow framing parameter b_0 do not need to overcome the unity (in other studies it sometimes goes above one just a little). Hence, the present paper is an important outcome and a further contribution for investigating the black-box represented by behavioral preference parameters, which attempt to fit the individual preferences more strictly related to individual emotions (b_0 and λ).

[39] See Barberis-Huang-Santos (2001), Barberis-Huang (2001), Barberis-Huang (2004a, b), Barberis-Huang-Thaler (2003) and Magi (2004).

7
Concluding remarks

In this paper we have provided a contribution based on behavioral finance preferences, for explaining what we observe in the data about household equity portfolios. Standard portfolio theory states that it would be optimal for economic agents holding a foreign stock share higher than that held actually. What happens is that good diversification opportunities are declined. What is the reason of such a behavior?

We find a satisfactory answer to this question by means of the building and numerical solution of a simple model of international portfolio choice. The mechanism in action, typical of several behavioral finance frameworks, is based on the individual's limited capabilities of processing information: foreign asset is perceived as less attractive than it would be if the investor had the optimal information skills and hence would be able to evaluate the two risky assets in conjunction. What follows is a low foreign equity share. But what are the subjects able to process optimally the huge amount of information available within stock markets? Maybe, people with an high degree of education, like graduates or more. In the italian case, empirical evidence available at the household level confirms such interpretation, showing that graduates invest in foreign equities relatively more than people with a lower education.

Finally, we note that what we have seen about the possible solution of the equity home bias puzzle has obvious consequences on international risk sharing issues. In the literature there are different competing theories (with complete and incomplete markets) which try to explain why individuals do not insure against income's stochastic fluctuations, although they have the possibility to smooth such fluctuations buying international assets, whose returns are uncorrelated with respect to domestic risky investments already faced.[40] And this uncorrelation would be the fundamental feature for foreign assets to be convenient. The foreign financial income could be used to insure against unexpected income changes in domestic financial assets and labor income. Therefore, it is clear that in portfolio choice models as those analyzed, risk sharing issues arise as direct outcome of optimal portfolio choice and the key principle which should drive such choice, the diversification one. Obviously, with reference to our model, in order to investigate in deep risk sharing topics, we should enrich it with the introduction of stochastic labor income and modify other aspects in the opportune direction.

---

[40] See, for example, Canova-Ravn (1996), Lewis (1999, 2000), van Wincoop (1994), Bottazzi-Pesenti-van Wincoop (1996), Obstfeld (1994).

MATHEMATICAL APPENDIX

Proof of the relation $V(W_t) = A_t W_t$.

We start by equation (25) and substitute into $\alpha_t \equiv C_t / W_t$, in order to verify that $A_t W_t = V(W_t)$, i.e. that $A_t W_t$ is equal to equation (22). We have:

$$A_t = \underset{\alpha_t}{Max}\left[(1-\beta)\alpha_t^{1-\gamma} + \beta(1-\alpha_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} =$$

$$= \underset{C_t/W_t}{Max}\left[(1-\beta)\left(\frac{C_t}{W_t}\right)^{1-\gamma} + \beta\left(1-\frac{C_t}{W_t}\right)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} =$$

$$= \underset{C_t/W_t}{Max}\left[(1-\beta)\frac{C_t^{1-\gamma}}{W_t^{1-\gamma}} + \beta\frac{(W_t - C_t)^{1-\gamma}}{W_t^{1-\gamma}}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} =$$

Collecting $\frac{1}{W_t^{1-\gamma}} = \left(\frac{1}{W_t}\right)^{1-\gamma}$, we get

$$= \underset{C_t/W_t}{Max}\left\{\left(\frac{1}{W_t}\right)^{1-\gamma}\left[(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]\right\}^{\frac{1}{1-\gamma}} =$$

Raising both members in braces to $\frac{1}{1-\gamma}$, we have

$$= \underset{C_t/W_t}{Max}\frac{1}{W_t}\left[(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}.$$

Therefore $$A_t = \underset{C_t/W_t}{Max}\frac{1}{W_t}\left[(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}.$$

Now, we multiply both sides for W_t (the same operation it is also necessary under the Max, i.e. for the variable with respect to which we are maximizing):

$$A_t W_t = \underset{C_t}{Max}\left[(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}(P_t^*)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} =$$

$$= \underset{C_t}{Max}\left\{(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}\left(\underset{\theta_{i,t}}{Max}\left[\mu(A_{t+1}R_{W,t+1}) + b_0\sum_{i=D}^{F}E_t v[\theta_{i,t}(R_{i,t+1} - R_f)]\right]\right)^{1-\gamma}\right\}^{\frac{1}{1-\gamma}} =$$

$$= \underset{C_t,\theta_{i,t}}{Max}\left\{(1-\beta)C_t^{1-\gamma} + \beta(W_t - C_t)^{1-\gamma}\left[\mu(A_{t+1}R_{W,t+1}) + b_0\sum_{i=D}^{F}E_t v[\theta_{i,t}(R_{i,t+1} - R_f)]\right]^{1-\gamma}\right\}^{\frac{1}{1-\gamma}} = V(W_t)$$

We note that the last expression is simply equation (22): hence, it follows that $A_t W_t = V(W_t)$.

REFERENCES

Bank of Italy (1998), *Survey on Household Income and Wealth*, Rome.

Bank of Italy (2000), *Survey on Household Income and Wealth*, Rome.

Bank of Italy (2002), *Survey on Household Income and Wealth*, Rome.

Barberis, N. and M. Huang (2004a), "Preferences with frames: a new utility specification that allows for the framing of risks", *working paper*, Yale School of Management, Yale University.

Barberis, N. and M. Huang (2004b), "The Loss Aversion/Narrow Framing Approach to stock market pricing and participation puzzles", in R. Mehra (ed), *Handbook of Investment: Equity Premium*, North Holland, Amsterdam.

Barberis, N. and M. Huang (2001), "Mental accounting, loss aversion and individual stock returns", *Journal of Finance*, 56, 1247-1292.

Barberis, N., M. Huang and T. Santos (2001), "Prospect theory and asset prices", *Quarterly Journal of Economics*, 116, 1-53.

Barberis, N., M. Huang and R. Thaler (2003), "Individual preferences, monetary gambles and the equity premium", *working paper*, Graduate School of Business, University of Chicago.

Barberis, N. and R. Thaler (2003), "A survey of behavioral finance", in G. Constantinides, M. Harris and R. Stulz (eds), *Handbook of the Economics of Finance*, North-Holland, Amsterdam.

Bottazzi, L. and P. Pesenti, E. van Wincoop (1996), "Wages, profits and the international portfolio puzzle", *European Economic Review*, 40, 219-254.

Campbell, J.Y. (2003), "Consumption-based asset pricing", in G. Constantinides, M. Harris and R. Stulz (eds), *Handbook of the Economics of Finance*, North-Holland, Amsterdam.

Campbell, J.Y. and J.H. Cochrane (1999), "By force of habit: a consumption-based explanation of aggregate stock market behavior", *Journal of Political Economy*, 107, 205-251.

Canova, F. and M. Ravn (1996), "International consumption risk sharing", *International Economic Review*, 37, 573-601.

Cooper, I. and E. Kaplanis (1986), "Costs of crossborder investment and international equity market equilibrium", in J. Edwards (ed), *Recent Advances in Corporate Finance*, Cambridge U. Press.

Cooper, I. and E. Kaplanis (1994), "Home bias in equity portfolios, inflation hedging, and international capital market equilibrium", *Review of Financial Studies*, 7, 45-60.

Epstein, L. and S. Zin (1989), "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework", *Econometrica*, 57, 937-968.

Epstein, L. and S. Zin (1991), "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: An empirical investigation", *Journal of Political Economy*, 99, 263-286.

Faiella, I. and A. Neri (2004), "La ricchezza delle famiglie italiane e americane", *Temi di Discussione*, n. 501, Banca d'Italia.

French, K. and J. Poterba (1991), "International diversification and international equity markets", *American Economic Review*, 81, 222-226.

Goetzmann, W. and A. Kumar (2002), "Equity portfolio diversification", *ICF working paper*, n. 00-59, Yale University.

Golub, S. (1990), "International capital mobility: net versus gross stocks and flows", *Journal of International Money and Finance*, 9, 424-439.

Haliassos, M. and C. Bertaut (1995), "Why do so few hold stocks?", *Economic Journal*, 105, 1110-1129.

Heaton, J. and D. Lucas (2000), "Portfolio choice in the presence of background risk", *Economic Journal*, 110, 1-26.

Huberman, G. (2001), "Familiarity breeds investment", *Review of Financial Studies*, 14, 659-680.

Judd, K. (1998), *Numerical methods in economics*, Mit Press, Cambridge (USA).

Kahneman, D. (2003), "Maps of bounded rationality: psychology for behavioral economics", *American Economic Review*, 93, 1449-1475.

Kahneman, D. and A. Tversky (1979), "Prospect theory: an analysis of decision under risk", *Econometrica*, 37, 263-291.

Kelly, M. (1995), "All their eggs in one basket: portfolio diversification of US households", *Journal of Economic Behavior and Organization*, 27, 87-96.

Kocherlakota, N. (1996), "The equity premium: It's still a puzzle", *Journal of Economic Literature*, 34, 42-71.

Lewis, K. (1999), "Trying to explain home bias in equities and consumption", *Journal of Economic Literature*, 37, 571-608.

Lewis, K. (2000), "Why do stocks and consumption imply such different gains from international risk sharing?", *Journal of International Economics*, 52, 1-35.

Levy, H. and M. Sarnat (1970), "International diversification of investment portfolios", *American Economic Review*, 60, 668-675.

Lucas, R.E. (1978), "Asset prices in an exchange economy", *Econometrica*, 46, 1429-1446.

Magi, A. (2004), *Aggregate stock market behavior and portfolio choice in Behavioral Finance models* (in italian), Ph.D. Dissertation, Department of Economics, University of Rome "La Sapienza", Rome.

Mankiw, G. and S. Zeldes (1991), "The consumption of stockholders and non-stockholders", *Journal of Financial Economics*, 29, 97-112.

Michaelides, A. (2003), "International portfolio choice, liquidity constraints and the home equity bias puzzle", *Journal of Economic Dynamics & Control*, 28, 555-594.

Obstfeld, M. (1994), “Risk-taking, global diversification and growth”, *American Economic Review*, 84, 1310-1329.
Obstfeld, M. and K. Rogoff (2000), “The six major puzzles in international macroeconomics: is there a common cause?“, in *NBER Macroeconomics Annual*.
Rabin, M. (1998), “Psychology and Economics”, *Journal of Economic Literature*, 36, 11-46.
Rabin, M. (2002), “A perspective on psychology and economics”, *European Economic Review*, 46, 657-685.
Simon, H. (1982), *Models of bounded rationality*, MIT Press, Cambridge (USA).
Slovic, P. (1972), “Psychological study of human judgment: implications for investment decision making”, *Journal of Finance*, 27, 779-799.
Solnik, B. (1974), “An equilibrium model of the international capital market”, *Journal of Economic Theory*, 8, 500-524.
Stracca, L. (2002a), “Behavioral finance and aggregate market behavior: where do we stand?”, *working paper*, ECB, Frankfurt.
Stracca, L. (2002b), “The optimal allocation of risks under prospect theory”, ECB *working paper* n. 161, Frankfurt.
Tauchen, G. and R. Hussey (1991), “Quadrature-based methods for obtaining approximate solutions to nonlinear asset pricing models“, *Econometrica*, 59, 371-396.
Tesar, L. and I. Werner (1995), “Home bias and high turnover”, *Journal of International Money and Finance*, 14, 467-492.
Tesar, L. and I. Werner (1998), “The internationalization of securities markets since the 1987 crash”, in R. Litan e A. Santomero (eds), *Brookings-Wharton papers on Financial Services*, The Brookings Institution, Washington.
Thaler, R. and E. Johnson (1990), “Gambling with the house money and trying to break even: the effects of prior outcomes on risky choice“, *Management Science*, 36, 643-660.
Tversky, A. and D. Kahneman (1981), “The framing of decisions and the psychology of choice“, *Science*, 211, 453-458.
Van Nieuwerburgh, S. and L. Veldkamp (2004), “Information immobility and the home bias puzzle“, *working paper*, Stern School of Business, New York University.
Van Wincoop, E. (1994), “Welfare gains from international risk sharing”, *Journal of Monetary Economics*, 34, 175-200.
Weil, P. (1989), “The equity premium puzzle and the risk-free rate puzzle”, *Journal of Monetary Economics*, 24, 401-421.